Duntroon Multi-client 3D and 2D Marine Seismic Survey Environment Plan

(EPP-41, EPP-42, EPP-45 & EPP-46)

PGS Australia Pty Ltd

Date: 7th November 2018

Client Details:

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Environment Resource Group Pty Ltd

Revision history

3	7th November 2018	NOPSEMA Resubmission	LC	AB	RI
2	9th March 2018	Updated for NOPSEMA RFFWI	LC	TV	TV
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Rev.	Date	Description	By	Chk'd	App.

Distribution list

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8	Marine Environment Pollution Response – Australian Maritime Safety Authority

PGS Environment Policy

Environment Policy

BU: Corporate [COR] **Scope:** PGS Group [PGS] **Subject:** HSEQ **Doc Number:** POL-COR-PGS-071

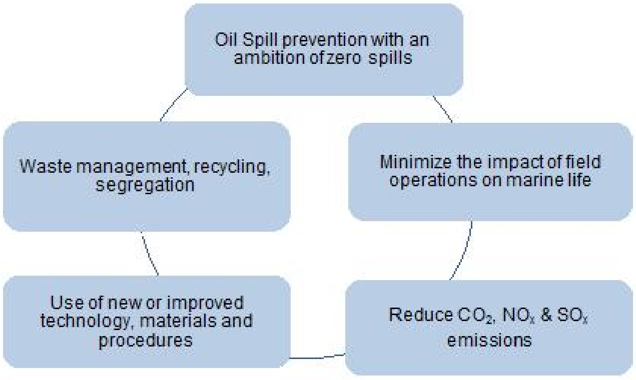
PGS RECOGNIZES THAT PROTECTION OF THE ENVIRONMENT IS OUR RESPONSIBILITY

We are committed to:

- Preventing harm to the environment by reducing risk related to our activities.
- Complying with applicable legal and industry standard requirements associated with our activities.
- Achieving continual improvement in environmental performance.

We are working in accordance with the ISO 14001 standard for environmental management in order to continuously improve how we measure, monitor and assess our environmental performance.

Key companywide environmental focus areas have been identified for monitoring environmental performance and achieving continual improvement.



Senior management participates in the review process and is responsible for resources being made available to maintain and communicate activities related to environment management within PGS.

This document applies to all employees, contractors, visitors and third parties.

PER ARILD REKSNES
EXECUTIVE VICE PRESIDENT
OPERATIONS

MAGNE REIERSGÅRD
EXECUTIVE VICE PRESIDENT
MARINE CONTRACT

SVERRE STRANDENES
EXECUTIVE VICE PRESIDENT
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RUNE OLAV PEDERSEN
CEO

GOTTFRED LANGSETH
CFO

*PGS SVP Joanna Oustad is appointed as the management representative with responsibility and authority to ensure that the Environment Management System is implemented and maintained.

Revision: 12 **Valid from:** 22/09/2017 **Author:** Joanna Oustad **Owner:** Rune Olav Pedersen **Page** 1 of 1

PGS HSEQ Commitment

Our HSEQ Commitment

BU: Corporate [COR]	Scope: PGS Group [PGS]	Subject: HSEQ	Doc Number: POL-COR-PGS-070

Ambition
Our ambition is to cause zero injury to people and minimum harm to the environment. To achieve this we are committed to be **safe, responsible, and productive. This applies to everyone, all the time.**

Policy
Health, Safety, Security, Quality and protection of the Environment are line management responsibilities fully endorsed and supported by senior management.

We commit to:

- living our HSEQ commitment at all times
- empowering our colleagues to lead by example and promote safe behavior
- acting responsibly and being accountable for our actions
- stopping any unsafe activity, intervening and welcoming intervention
- meeting customer expectations with high quality services
- complying with all applicable legal and other requirements
- ensuring continuous improvement

We shall identify, assess, mitigate and manage risks to employees, contractors, assets and the environment. This is in the best interest of all PGS stakeholders and essential for our long term business success.

Objectives

- Increase HSEQ awareness and reduce unsafe behavior
- Reduce total risk exposure
- Prevent incidents and personal injuries
- Minimize harm to the environment and achieve zero spills

This document applies to all employees, contractors, visitors and third parties.

Per Arild Reksnes
Executive Vice President
Operations

Magne Reiersgård
Executive Vice President
Marine Contract

Sverre Strandenes
Executive Vice President
MultiClient

Guillaume Cambois
Executive Vice President
Imaging & Engineering

Rune Olav Pedersen
CEO

Gottfred Langseth
CFO

*The SVP HSEQ Joanna Oustad is appointed as the management representative with responsibility and authority to ensure that the management system is implemented and maintained.

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Approvals

This Environment Plan has been prepared for PGS Australia Pty Ltd and is approved for the Duntroon MC3D and MC2D Marine Seismic Survey.

NAME	Date
Rick Irving	7th November 2018

Country Manager
PGS Australia Pty Ltd

Abbreviations

Abbreviation	Definition
2D	2-Dimensional
3D	3-Dimensional
µPa	Micro-pascal
AAD	Australian Antarctic Division
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHO	Australian Hydrographic Office
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Conservation Council
APPEA	Australian Petroleum Production & Exploration Association
AQIS	Australian Quarantine Inspection Service
AS	Australian Standard
BIA	Biologically Important Area
BOD	Biological Oxygen Demand
BOEM	Bureau of Ocean Energy Management
BOM	Bureau of Meteorology
BPC	Border Protection Command
BRS	Bureau of Rural Sciences
Bsl	Below sea level
BSSE	Bureau of Safety and Environmental Enforcement
BWMS	Ballast Water Management System
^oC	Degrees Celsius
C	Carbon
CA	Control Agency
CAMBA	China/Australia Migratory Birds Agreement
CCSA	Conservation Council of South Australia
CFA	Commonwealth Fisheries Association
CITES	Convention in International Trade in Endangered Species of Wildlife and Flora
CH_4	Methane
CMR	Commonwealth Marine Reserve
CMST	Centre for marine Science and Technology

Abbreviation	Definition
CoA	Commonwealth of Australia
CoEP	Code of Environmental Practice
COLREG	Convention on International Regulations for Preventing Collisions at Sea
Com	Commonwealth
CO_2	Carbon Dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTS	Commonwealth Trawl Sector
CV	Curriculum Vitae
dB	Decibels
DAWR	Department of Agriculture and Water Resources
DEH	Department of Environment & Heritage (now DOEE)
DEM	Department of Energy and Mining (SA)
DEWHA	Department of Environment, Water, Heritage and the Arts (now DOEE)
DEWNR	Department of Environment and Water (SA)
DIIS	Department of Industry, Innovation and Science (Com)
DOEE	Department of Environment and Energy (Com)
DNP	Director of National Parks (Com)
DPTI	Department of Planning, Transport and Infrastructure (SA)
E	East
EA	Environment Australia (now DOEE)
ECR	Environmental Commitments Register
EEZ	Exclusive Economic Zone
EIA	Environment Impact Assessment
EMBA	Environment that may be affected
ENE	East-North-East
ENSO	El Niño Southern Oscillation
EP	Environment Plan
EPA	Environment Protection Authority (SA)
EPBC	Environment Protection Biodiversity Conservation
EPO	Environmental Performance Outcome
EPP	Exploration Petroleum Permit
EPS	Environmental Performance Standard
ERA	Environmental Risk Assessment
ERC	Emergency Response Coordinator

Abbreviation	Definition
ESD	Ecologically Sustainable Development
ESE	East-southeast
FLNG	Floating Liquefied Natural Gas
GAB	Great Australian Bight
GABIA	Great Australian Bight Industry Association
GABTS	Great Australian Bight Trawl Sector
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Pollution
GHG	Greenhouse Gas
GHTS	Gillnet Hook and Trap
GIP	Good Industry Practice
GIS	Geographical Information System
GMDSS	Global Maritime Distress Safety System
GPS	Global Positioning System
GRT	Gross Registered Tonnage
HC50	Hazardous Concentration (50 percentile)
HFO	Heavy Fuel Oil
HOB	Head of Bight
HSEQ	Health, Safety, Environment, Quality
HSEMS	Health, Safety, Environmental Management System
Hz	Hertz
IAFS	International Anti-fouling Systems
IAPP	International Air Pollution Prevention (Certificate)
IAGC	International Association of Geophysical Contractors
IFAW	International Fund for Animal Welfare
IGAE	Intergovernmental Agreement on the Environment
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMDGC	International Maritime Dangerous Goods Code
IMO	International Maritime Organisation
IMS	Invasive Marine Species
IOPP	International Oil Pollution Prevention (Certificate)
in^3	Cubic inches
ISO	International Standards Organisation
ISPP	International Swage Pollution Prevention (Certificate)
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation Value

Abbreviation	Definition
JAMBA	Japan/Australia Migratory Birds Agreement
JHA	Job Hazard Assessment
JIP	Joint Industry Project
KEF	Key Ecological Feature
kHz	Kilohertz
KI	Kangaroo Island
km	Kilometre
km/hr	Kilometres per hour
km^2	Square kilometres
LC50	Lethal Concentration (50 percentile)
LCS	Legislation, Codes and Standards
µm	micrometres
m	Metres
Mg	milligrams
mm	Millimetres
m^3	Cubic metres
m/s	Metres per second
MARPOL	International Convention for the Prevention of Pollution from Ships
MC	Multi-client
MDO	Marine Diesel Oil
MFASA	Marine Fishers Association of South Australia
MFO	Marine Fauna Observer
MGO	Marine Gas Oil
MSI	Marine Safety Information
MSF	Marine Scalefish Fishery
MSS	Marine Seismic Survey
N	North
N_20	Nitrous Oxide
NATPLAN	National Marine Oil Spill Contingency Plan (Australia)
NE	North East
NEPM	National Environmental Pollution Measure
NES	National Environmental Significance
Nm	Nautical Miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

Abbreviation	Definition
NOx	Nitrous oxides
NOEC	No Observable Effects Concentration
NOHSC	National Occupational Health & Safety Commission
NOO	National Oceans Office
NOPSEMA	National Offshore Petroleum Safety & Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NSW	New South Wales
NW	North-west
NZFS	New Zealand Fur Seal
NZRLF	Northern Zone Rock Lobster Fishery
OA	Operational Area
OCS	Offshore Constitutional Settlement
ODME	Oil Detection Monitoring Equipment
ODP	Ozone Depleting Potential
OIW	Oil in Water
OPP	Offshore Project proposal
OPGGSA	Offshore Petroleum & Greenhouse Gas Storage Act 2006
OPGGS(RMA)R	Offshore Petroleum & Greenhouse Gas Storage (Resource Management & Administration) Regulations 2011
OPGGSER	Offshore Petroleum & Greenhouse Gas Storage (Environment) Regulations 2009
OPRC	International Convention on Oil Pollution (Preparedness, Response and Cooperation) 1990
OPEP	Oil Pollution Emergency Plan
OSMP	Operational & Scientific Monitoring Plan
µPa	Micropascals
PAH	Poly-aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PG	Professional Judgement
PIRSA	Primary Industries and Regions South Australia (SA)
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
PNEC	Predicted no effects concentration
POB	Persons on Board
POLREP	Pollution Report
Ppb	Parts per billion

Abbreviation	Definition
PPE	Personal Protective Equipment
ppm	Parts per million
psi	Pounds per square inch
PTS	Permanent Threshold Shift
QCS	Quality Control Supervisor
RAMSAR	The Convention on Wetlands of International Importance
RCC	Rescue Coordination Centre
rms	Root mean square
ROKAMBA	Republic of Korea/ Australia Migratory Birds Agreement
ROV	Remotely Operated Vehicle
S	South
SA	South Australia
SAMSCAP	South Australian Marine Spill Contingency Plan
SARDI	South Australian Research and Development Institute
SARLAC	South Australian Rock Lobster Advisory Council
SASF	South Australian Sardine Fishery
SASIA	South Australian Sardine Industry Association
SBTF	Southern Bluefin Tuna Fishery
SDS	Safety Data Sheet
SE	South East
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Levels
SEWPC	Department of Environment, Water, Population and Communities (now DOEE)
SIMOPS	Simultaneous Operations
SITREP	Situation Report
SOLAS	International Convention for the Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Sulphur Oxides
SPF	Small Pelagic Fishery
SPL	Sound Pressure Level
SRL	Southern Rock Lobster
STF	Skipjack Tuna Fishery
STP	Sewerage Treatment Plant
SSJF	Southern Squid Jig Fishery
SSW	South-South-West

Abbreviation	Definition
STCW	International convention for standards of training and watch-keeping for seafarers
SV	Social Values
SW	South West
TACC	Total Allowable Commercial Catch
TAP	Threat Abatement plan
TAS	Tasmania
TPH	Total Petroleum Hydrocarbons
TSSC	Threatened Species Scientific Committee
TTS	Temporary Threshold Shift
UHF	Ultra-High Frequency
UN	United Nations
UNEP	United Nations Environment Programme
UNCLOS	United Nations Convention on Law of the Sea
VIC	Victoria
VHF	Very-high frequency
VM	Vessel Manager
W	West
WA	Western Australia
WDCS	Whale and Dolphin Conservation Society
WML	Wildlife Migration limited
WNW	West-North-West
WSW	West-South-West
WTBF	Western Tuna & Billfish Fishery
WTO	World Trade Organisation

Table of Contents

1 Introduction

1.1 Purpose

PGS Australia Pty Ltd (‘PGS’) proposes to acquire MultiClient (MC) three dimensional (MC3D) and MultiClient two-dimensional (MC2D) marine seismic surveys (MSSs) within the Duntroon operational area (OA) in the South-west Marine Region offshore from South Australia (SA). The Duntroon MC3D and MC2D (‘multi-client’) survey OA covers approximately 30,100 km^2 in Exploration Petroleum Permits (EPP) EPP-41, EPP-42, EPP-45 and EPP-46.

This Environment Plan (EP) for activities within the proposed survey area has the objective of covering multi-client surveys over these specific petroleum titles and adjacent vacant acreage in the Duntroon Basin, during the period September 1 to November 30, 2019 (Season 1) and possibly September 1 to November 30, 2020 (Season 2). Survey commencement is dependent on client requirements, vessel availability and environmental considerations. The actual timing of individual surveys is not yet defined within this period..

The proposed activities will be 2D and/or 3D MSSs similar to most others conducted in Australian marine waters (in terms of technical methods and procedures). No unique or unusual equipment or operation is proposed. The survey will be conducted using a purpose-built seismic survey vessel.

The objectives of this EP are to demonstrate:

- Compliance with all applicable legislation;
- Compliance with PGS environmental policies and standards including the corporate Health, Safety and Environment (HSE) Management System;
- How the proposed operations will interact with the environment;
- The environmental and other marine user impacts and risks for the activity have been identified, assessed and impacts and risks have been reduced to a level which is acceptable and as low as reasonably practicable (ALARP);
- Appropriate environmental performance outcomes (EPOs), environmental performance standards (EPSs) and measurement criteria (MC) are in place to measure the environmental performance of the activity;
- Consultation has been undertaken with ‘relevant’ persons to understand possible activity impacts, provide feedback on the activity with any issues or concerns addressed; and
- There is systematic implementation of controls and continued assessment of hazards and risk throughout the activity to manage environmental impacts and risks.

1.2 Environmental Plan Scope & Structure

This EP scope is a proposed Duntroon multi-client survey in EPP-41, EPP-42, EPP-45 and EPP-46 and adjacent open acreage[1] utilising a purpose-built seismic vessel such as the PGS Ramform Sovereign (or equivalent vessel). The proposed timing for the survey is between 1 September to 30 November 2019 and possibly the equivalent period in 2020. The total survey period in any one season is expected to take no more than 91 days.

[1] For the purpose of defining the *petroleum activity* within this EP, all project vessels are considered to be undertaking the activity described in **Section 2** when located in the OA defined in **Section 2** from the time the survey vessel deploys its array of airguns and streamers until the time the vessel retrieves the array and departs the area. Mobilisation and demobilisation activities, and deployment from this area associated with port calls or emergencies are controlled under Australian maritime legislation (which reflect MARPOL requirements) and are **not included** within the *petroleum activity* contained in this EP.

Following this introduction, this EP is structured as follows:

- **Section 2** provides details of the location and a description of the activity and the equipment to be used during the seismic survey;
- **Section 3** provides a summary of the existing physical, biological and, socio-economic environment and values within the survey area;
- **Section 4** provides a summary of the legislative framework and relevant legislation applicable to the MSS activity;
- **Section 5** details the impact and risk assessment methodology undertaken for the survey.
- **Section 6** identifies environmental hazards associated with the MSS activity which may impact the physical and social environment, provides the environmental management strategies to control environmental impacts and risks to acceptable and ALARP levels and details the EPOs, EPSs and MC for the survey;
- **Section 7** details the implementation strategy to be adopted to manage environmental impacts and risks associated with the activity – namely the roles and responsibilities, procedures, processes and resources (e.g. consultation, training, inspection, audit, review and monitoring activities);
- **Section 8** provides details on internal and external reporting requirements; and
- **Section 9** provides details on stakeholder consultation.

1.3 Revisions to the Environment Plan

Should:

- The seismic program alters to include a **new activity**;
- A **significant modification, change or new stage** is proposed for the activity;
- A significant **new or increased environmental impact or risk** is identified during the activity and is not provided for in the EP or oil spill arrangements[2];
- A **series of new environmental impacts or risks**, or a s**eries of increases in existing environmental impacts or risks** which taken together amount to a significant new or increased environmental impact of risk and is not provided for in the EP or oil spill arrangements;
- If **a change in Titleholder** results in a change in the way the environmental impacts and risks of the activity are being managed; or
- **At the request of the National Offshore Petroleum Safety & Environmental Management Authority** (NOPSEMA).

The PGS liaison contact (refer **Section 2.1**) will ensure this plan is revised and resubmitted to the regulator for acceptance in accordance with the *Offshore Petroleum & Greenhouse Gas Storage (Environment) Regulations 2009*[3].

[2] This includes oil-spill related risks and impacts.

[3] In accordance with *Offshore Petroleum & Greenhouse Gas Storage (Environment) Regulations 2009 (*Regulation 17 & Regulation 18).

2 Seismic Program Activity

2.1 Seismic Activity Titleholder

PGS offers a broad range of products to assist oil companies to find oil and gas reserves offshore worldwide, including seismic and electromagnetic data acquisition, processing, reservoir analysis/interpretation and multi-client library data. PGS was founded in Norway in 1991, with two seismic vessels. PGS now has:

- 7 active offshore seismic vessels;
- 26 offices worldwide, employing 26 nationalities.

PGS has a presence in over 25 countries with regional centres in London, Houston and Kuala Lumpur. The company headquarters are in Oslo, Norway and PGS is listed on the Oslo stock exchange.

PGS is committed to protecting the environment and consequently has a corporate HSE&Q Commitment Statement and an Environment Policy that provide public statements of the company commitment to protecting the environment during offshore operations. PGS is committed to:

- Preventing harm to the environment by reducing risk related to our activities;
- Complying with applicable legal and industry standard requirements associated with our activities.
- Achieving continual improvement in environmental performance.

As required by OPGGSER (Regulation 15), details for PGS as Titleholder and nominated liaison person are as follows:

TITLEHOLDER DETAILS:

PGS Australia Pty Ltd (ABN 46 077 150 415, ACN 077 150 415)

Address: Level 4, IBM Building, 1060 Hay Street, West Perth, WA, 6005, Australia

Telephone: +61 8 9320 9115

Fax: +61 8 9320 9010

LIAISON PERSON:

Name:	Alyse Blake
Business Address:	Level 4, IBM Building, 1060 Hay Street, West Perth, WA, 6005, Australia
Telephone:	+61 8 9320 9091
Fax:	+61 8 9320 9010
Email:	Alyse.Blake@pgs.com

In the event of a change in titleholder, PGS and the new titleholder will liaise with NOPSEMA prior to the title transfer process to consider all compliance requirements under the OPGGSER and whether a new or revised EP for the activity is required under Regulation 17 (7). The new titleholder will utilise the advice provided by NOPSEMA to ensure that they can remain compliant once they become the titleholder and undertake the petroleum activity[4].

[4] NOPSEMA Environmental Alert 2 – Failure to comply due to titleholder asset ownership changes, August 2016

NOPSEMA will also be notified according to the requirements of Regulation 15(3), of changes to the titleholder or nominated liaison person. PGS will submit in writing to NOPSEMA, within 30 days of the change, information regarding a change in:

- The titleholder;
- The titleholder's nominated liaison person;
- Contact details for the titleholder; and
- Contact details for the liaison person.

2.2 Survey objectives

PGS Australia intends to conduct the Duntroon MSS to better define the subsurface geology of the permit areas and accurately define potential prospective petroleum targets for exploration drilling within EPP-41, EPP-42, EPP-45, EPP-46 and adjacent vacant areas. It should be noted that the Duntroon survey area has been designed to:

- Cover the most prospective parts of EPP-41, EPP-42 and EPP-46 (i.e. significantly less than the total area of the permits) with the survey area reduced in size as much as possible;
- Provide full fold seismic imaging across the areas nominated in EPP-41 to EPP-46 permits as current views of petroleum targets straddle the two permits;
- The survey streamer selection for the MC3D survey (i.e. nominally wide tow 12 x 150m separation) allows the acquisition period to be minimized compared with the use of a vessel with a smaller number of streamers, or smaller separation of streamers, which requires more seismic lines and an associated longer period to acquire data.

The Australian Government, through the National Strategy for Ecologically Sustainable Development (1992) and associated institutional arrangements, has set policy frameworks which integrate ESD principles into strategy documents such as the National Greenhouse Response Strategy, the National Strategy for the Conservation of Australia's Biological Diversity, the National Waste Minimisation and Recycling Strategy, etc. These strategies underpin legislative documents relevant to, and observed in, this EP such as Conservation Management and Threat Abatement Plans, Marine Bioregional Plans, Threatened Species Recovery Plans, Waste Minimisation and Energy Efficiency Policies. Accordingly, by adopting measures contained in all relevant legislation and underpinning policy documents in this EP, PGS will undertake the proposed survey activity consistent with the principles of ESD.

2.3 Survey location

This survey, an exploration activity, does not require an Offshore Project Proposal (OPP) acceptance by NOPSEMA prior to EP acceptance.

The Duntroon MC3D /MC2D MSS covers an operational area of up to 30,100 km^2 and is located entirely within Commonwealth waters (Refer **Figure 2-1**) of the Bight Basin (Duntroon sub-basin) (SA) in the eastern Great Australian Bight (GAB). The Duntroon MSS OA is defined by coordinates shown in **Table 2-1**. This includes the vessel turning area of up to 10 km outside the defined acquisition area. The proposed EPP-41/42 MC3D survey area covers no more than 3690 km^2. The MC2D portion of the survey, located in EPP-46 covers no more than 5100 km of survey sail lines as identified in **Figure 2-1**. The EPP-46 MC3D survey area has been assumed to cover no more than 2010 km^2 for assessment purposes.

It is noted that the MC3D survey area identified in EPP-46 is not confirmed and may vary in location. For EP assessment purposes, this MC3D survey area has been located across the most sensitive area of the permit (i.e. shelf-break/canyon system) and controls identified to ensure impacts are reduced to ALARP and acceptable levels. Any adjustment of these survey areas will be assessed for impacts and risks under the PGS Management of Change process (refer Section 7.8.1). If a significant new or increased impact or risk result from this adjustment, a revised EP revision will be submitted to NOPSEMA for assessment under OPGGSER Regulation 17.

The expected MC3D racetrack acquisition area is provided in **Figure 2-2**.

The Duntroon OA is located approximately 90 km west of Kangaroo Island (SA) and 51 km south-southwest of Cape Carnot (Eyre Peninsula) (SA). The closest landfall point is Liguanea Island (SA) located approximately 43 km north and the North & South Neptune Islands (SA) located approximately 49 km ENE of the nearest survey boundary. Most (75%) of the OA is ocean-wards of the 200 m isobath (i.e. on the continental slope area) with the water depth ranging from 100m along the northern boundary to 3500 m along the southern margin of the survey area.

The survey vessel will deploy and retrieve equipment off the continental shelf if required to avoid fishery interaction. This will be managed by close cooperation between the PGS Master, the local fishing fleet and the deployment of a scout/escort vessel to identify any conflicting fishing activities. In addition, any unplanned turning circles due to events such as proximity to cetaceans or third-party vessels/equipment will, after safety is considered, be implemented in an offshore as opposed to onshore direction.

PGS has applied for a Special Prospecting Authority (SPA) and will apply for an access authority to NOPTA for the survey OA to allow for data acquisition.

Figure 2-1: Proposed Duntroon MC3D /MC2D MSS location

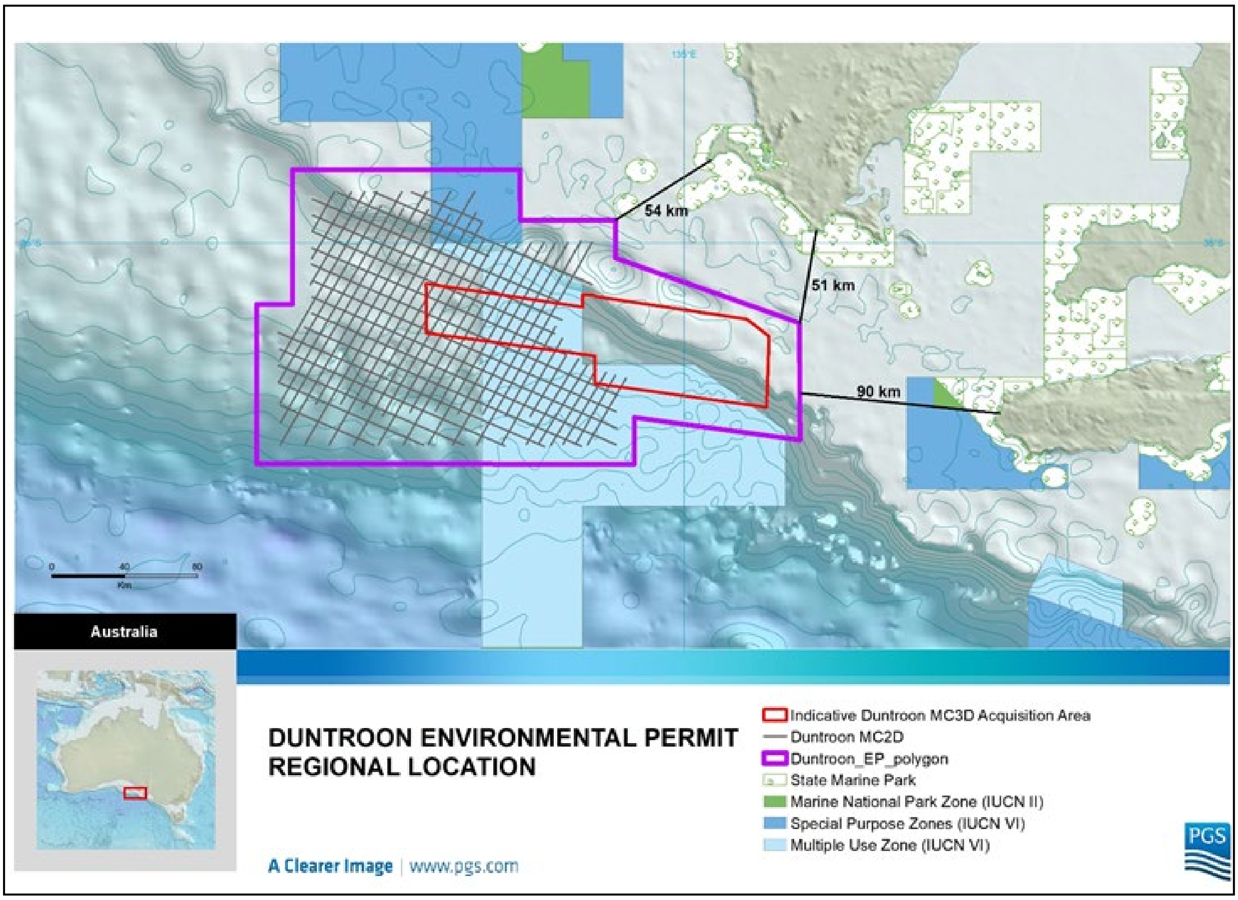


Figure 2-2: Proposed Duntroon MC3D expected racetrack layout

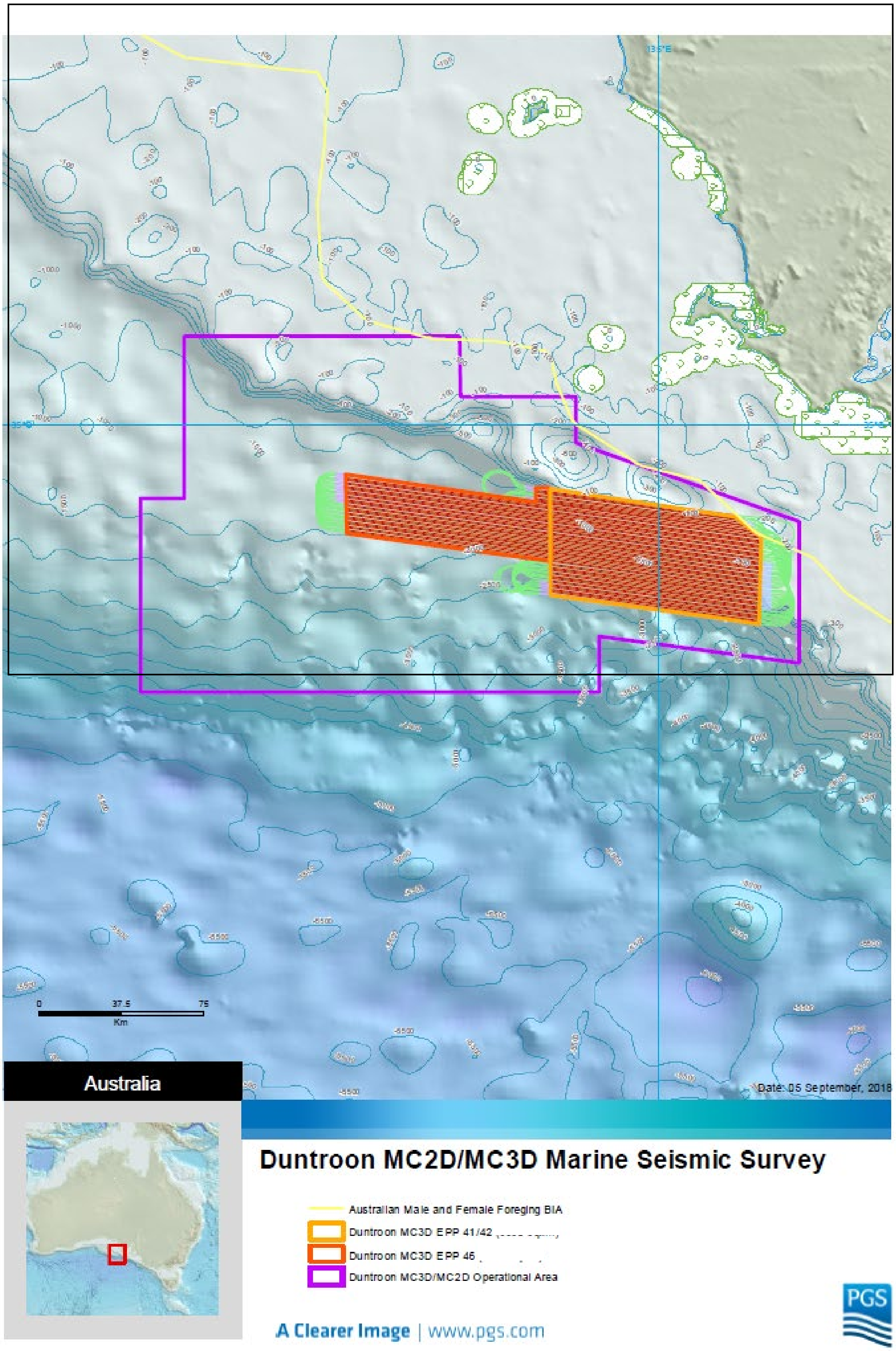


Table 2-1: Duntroon MC3D /MC2D MSS OA boundary coordinates

Latitude (South)			Longitude (East)		
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
34	38	20.29	133	03	53.06
34	38	19.64	134	11	20.22
34	53	13.20	134	11	27.60
34	53	13.20	134	39	43.20
35	04	26.40	134	39	43.20
35	23	44.00	135	34	15.96
35	58	24.92	135	34	25.03
35	51	46.80	134	45	18.00
36	05	35.12	134	45	17.71
36	05	32.93	132	53	13.77
35	18	11.66	132	53	13.77
35	18	11.66	133	03	53.06

2.4 Seismic program scope

The Duntroon multi-client survey will be undertaken by PGS utilising a purpose-built seismic vessel such as the PGS Ramform Sovereign (or equivalent), towing equipment along a series of predetermined seismic lines. The survey proposed is a conventional 2D or 3D survey like most others conducted in Australian waters in terms of technical methods and procedures. No unique or unusual equipment or operations are proposed.

The vessel will traverse a series of pre-determined sail lines within the OA at a speed of approximately 8–9 km/hr (4–4.8 knots) where a series of acoustic pulses (a frequency of approximately every 7-10 seconds) will be directed down through the water column into the seabed. Acoustic signals are attenuated through the subsea geological structure reflecting at geological boundaries with the reflected signals detected using sensitive pressure and velocity sensors arranged along cables (known in the industry as streamers) towed behind the survey vessels. Data collected by the hydrophones is stored in on-board computers for processing and analysis, allowing the underlying geological strata to be determined and identifying potential hydrocarbon reservoir targets.

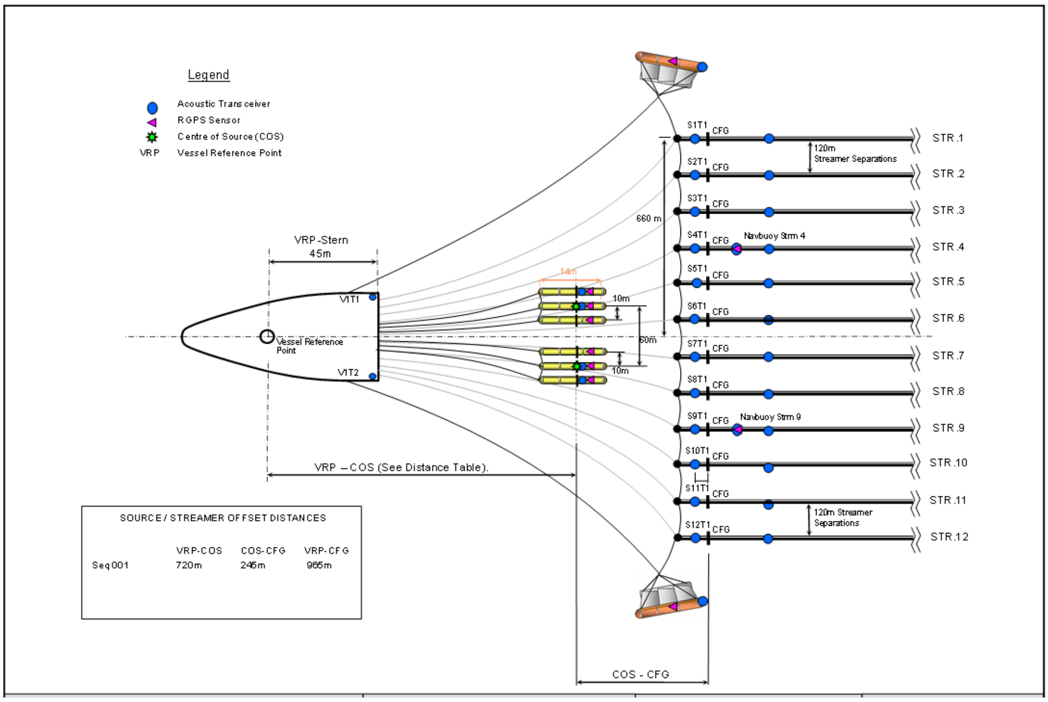
Given the seabed geology and OA water depths, it is considered that to achieve the survey objectives the most suitable operating pressure of the seismic source will be ~2,000 pounds per square inch (psi) with the two or three arrays firing alternately, each with a maximum volume of 3260in^3 ..

Source arrays will be towed at a depth of approximately 7 m below sea level (bsl) and will have a shot point interval of approximately 16.67 to 25 m. The distance and time between pulses may be adjusted if this will result in improved data.

The MC3D survey will utilise up to 12 streamers, each with a maximum length of 8,100 m separated by approximately 150 m and towed at a depth of approximately 15 to 25 m bsl. The MC2D survey will consist of a single streamer of approximately 10,000 m towed at similar depths.

A typical towing configuration for a two-source array/twelve streamer survey is shown in **Figure 2-3**. The survey vessel will traverse the survey area along defined transects (or seismic lines) approximately 500-720 m apart in water depths from approximately 100m-3500m. The overall streamer spread width is controlled by adjusting the rope lengths towing the barovane doors.

Figure 2-3: Proposed Duntroon survey source and streamer towing diagram



The survey will use solid hydrophone streamers and will maintain neutral buoyancy. Each streamer will have depth controllers and emergency recovery units and may have further positioning and steering units. The emergency recovery unit is a device attached to the streamer at intervals of ~300 m. It senses if the streamer sinks below a pre-determined depth, and in such events, deploys an automatic pressure-activated airbag to float the streamer back to the surface.

Seismic acquisition will be undertaken 24 hours per day, seven days per week and is expected to continue for a total period of up to 91 days, dependent on weather conditions and operational efficiency. *It should be noted that although the vessel may be present in the area for this period the source array will probably not operate at full power 24 hours per day due to line changes and standby due to weather, potential shipping traffic, cetacean and fishing activity and some technical downtime for maintenance. It would be unusual for the source arrays to operate at full power for more than 70% of this time.*

The proposed operational period for the Duntroon multi-client survey is September 1 to November 30, 2019 and possibly the same period in 2020. The precise commencement and completion dates will be dependent on receipt of environmental approvals, vessel availability and weather conditions suitable for marine seismic acquisition.

Table 2-2 summarises the basic acquisition parameters for the Duntroon MC3D/MC2D MSS. The minimum standards for the survey vessel are defined in Section 2.5.

Table 2-2: Duntroon MC3D /MC2D MSS acquisition parameters

Parameter	Details
Program Details	
Earliest Commencement Date	1 September 2019
Duration of Survey	91 Days (In any one season) • MC3D: 60 Days • MC2D (EPP-46): 45 Days *Noting that the total MC3D and MC2D survey duration exceeds the 91-day allocated period for any one season, the total scope of either or both surveys will be reduced to fit the 91-day period available or vessel*

Parameter	Details	
	remobilisation during the following season (September 1 to November 30, 2020) is possible.	
Speed	4-4.8 knots (Seismic vessel)	
Max. total Area (MC3D)/Length of MC2D	MC3D (EPP-41/42): 3690 km^2 MC2D (EPP-46): 5100 km data acquisition lines MC3D (EPP-46): 2010 km^2 (location not yet defined in permit)	
Vessel Turning Circle/Lead-in & Lead-out Distance (3D)	5 km / 10 km	
Depth of Water	100-3500 m	
3D Survey Line length:	MC3D (EPP-41/42): 80 km x 50 km (max.) MC3D (EPP-46): ~80 x 26 km (not yet defined)	
Approximate sail lines	MC3D (EPP-41/42): 54 MC3D (EPP-46): 30 (location not yet defined)	
Distance between adjacent seismic lines	MC3D: 500-720 m MC2D: ~ 5 km	
Distance between consecutive seismic lines	MC3D: 10 km	
Seismic Parameters		
Volume of the operating airgun array	3260 cui (max)	
Airgun operating pressure	2000 psi	
Compressed air source depth	7 mbsl (approx.)	
Peak near-field sound pressure level (PK)	Max 255.6 dB re 1µPa (Wladichuk et al, 2018)	
Primary Frequency	1-210 Hz	
Source Interval	16.67 to 25 m	
Streamers	3DMSS	2DMSS
Number of Streamer	12	1
Length	8,100m	10,000m
Streamer Spacing	~ 150m	-
Depth of Steamers	15 – 25 m (approx.)	
Streamer Type	Gel, solid	
General		
Hours of Operation	24/7	
Method of Crew Change	Port call or at sea	
Refuelling	Port call or at sea (with spatial restrictions)	
Supply/Scout Vessel	2 vessels	
Supply Port	Port Lincoln, Adelaide or Geelong	

2.5 Vessel Environmental Specification

PGS proposes to conduct the survey using a purpose-built seismic survey vessel from the PGS fleet. The PGS *Ramform Sovereign*, which is owned and operated by PGS is typical of the survey vessels that will be used to acquire data within the OA (refer **Figure 2-4**). The specifications of the PGS *Ramform Sovereign* are provided in **Appendix C** of this EP as an example of the typical specifications of the survey vessel that may be used on the Duntroon survey.

Any survey vessel used will have all necessary certification/registration and be fully compliant with all relevant MARPOL and SOLAS convention requirements specific for the vessel's size and purpose.

Figure 2-4: PGS *Ramform Sovereign*

A survey vessel operating in the Exclusive Economic Zone (EEZ) of Australia must meet the requirements of the *Navigation Act 2012* (Cth) administered by the Australian Maritime Safety Authority (AMSA). In accordance with these requirements, a survey vessel will have the following current and valid environmental specifications (appropriate to class):

- International Oil Pollution Prevention (IOPP) certificate in accordance with MARPOL Annex I (enacted under AMSA Marine Orders Part 91, Marine Pollution Prevention – Oil);
- International Sewage Pollution Prevention (ISPP) certificate in accordance with MARPOL Annex IV (enacted under AMSA Marine Orders Part 96, Marine Pollution Prevention – Sewage);
- International Air Pollution Prevention (IAPP) certificate in accordance with MARPOL Annex VI (enacted under AMSA Marine Orders Part 97, Marine Pollution Prevention – Air Pollution);
- Shipboard Oil Pollution Emergency Plan (SOPEP) in accordance with MARPOL Annex I (enacted under AMSA Marine Orders Part 93, Marine Pollution Prevention – Noxious Liquid Substances);
- Shipboard Garbage Management Plan in accordance with MARPOL Annex V (enacted under AMSA Marine Orders Part 95, Marine Pollution Prevention – Garbage); and
- International Anti-fouling System certificate in accordance with the International Convention on the Control of Harmful Anti-fouling Systems on Ships 2008 (enacted under AMSA Marine Orders Part 98, Marine Pollution Prevention – Anti-fouling Systems).

Any hydrocarbon spills to sea will be combatted in accordance with the approved Shipboard Oil Pollution Emergency Plan (SOPEP) which details actions to be taken in the event of a shipboard emergency or oil spill in accordance with MARPOL 73/78 Annex I requirements enacted under the *Protection of the Seas (Prevention of Pollution by Ships) Act 1983* (Cth). Combat of hydrocarbon spills within Commonwealth waters is the responsibility of the vessel operator and AMSA in accordance with the National Plan for Maritime Environmental Emergencies ('NATPLAN').

As required (i.e. for vessels over 400 GRT), the support vessel(s) will have an implemented and tested SOPEP.

2.6 Maritime safety precautions

Survey vessels will operate in accordance with the Convention on the International Regulations for Preventing Collisions at Sea (COLREG, 1972).

Prior to commencement of survey operations, PGS will apply to the Australian Hydrographic Service (AHS), for the issue of a Notice to Mariners (published fortnightly) for the survey. A daily AUSCOAST warning of the survey vessel location will also be issued by AMSA through the Global Maritime Distress Safety System (GMDSS) communication network. The warning will provide details of the safe distance to be maintained around the seismic survey vessel and towed equipment.

The Master and Officer of the Watch on the survey vessel are responsible for maintaining control of the seismic fleet vessel operation and for establishing and maintaining communication with other vessels and marine traffic during the survey. The support and scout vessel follow all instructions from the survey vessel and communicate with other marine traffic during the survey.

Supplementary to radar detection, the support and scout vessels will have additional transmitting beacons fitted for the duration of the survey. The vessels will use either Automatic Identification System (AIS) transponders or radio global positioning system (GPS) transponders. The addition of this equipment and the data it transmits provides accurate real-time updates of the position of all survey vessels relative to the survey vessel and the towed seismic spread.

All vessels will can communicate and operate on dedicated ultra-high frequency (UHF) working channels and or Maritime very high frequency (VHF) working channels (typically monitoring Channel 16 and working on 74).

The lighting on the survey, scout and support vessels during the survey will comply with COLREG requirements. During survey deployment, recovery and acquisition, the seismic survey vessel will display navigation warnings identifying a ‘restricted ability to manoeuvre’. In addition to mandatory navigation lighting, the working deck areas will be floodlit (as required) to provide for safe work. At night, the vessel stern will be lit to provide sufficient light to be able to view the towed equipment during acquisition, deployment and recovery operations. The floating towed equipment trailing at the tail end of the cables will be identified by flashing warning lights. The lights activate at night and the floats are a bright yellow or orange colour for identification during the day. The floats have radar reflectors to assist with tracking and provide target warning on other vessels’ radars.

2.7 Logistics Support

Port Lincoln (SA) will preferentially be used as a logistics and supply base for the operation however the Port of Adelaide (SA) or Geelong (Vic) may also be utilised.

During the survey there will be one support and one scout vessel servicing the seismic vessel for logistical, safety and equipment management support. Functions of these vessels is to escort the survey vessel; to scout ahead of the survey vessel for marine hazards; to maintain a safe distance between the towed array and other vessels or marine fauna; to manage interactions with shipping and fishing activities; to act in an emergency-response capacity and supply the survey vessel with logistical supplies. These support vessels have a typical crew size of 5 to 15 personnel.

The vessels will not anchor at sea unless required in an emergency. Refuelling of the survey vessel will occur both in port and at sea within the survey area. At sea refuelling will only take place during daylight hours and suitable weather conditions.

Crew changes will preferably occur during port calls or at sea. Helicopter transfer from Port Lincoln or Adelaide may be required in the event of an operational emergency, medical evacuation or other non-routine circumstance. Air ambulance services are based in Adelaide. There will be no helicopter refuelling on-board the seismic vessel.

Emergency medical facilities are available at Port Lincoln. If required, crew can be airlifted to Adelaide’s medical facilities (Royal Adelaide Hospital).

2.8 Simultaneous Third-Party surveys

PGS is not aware of any MSSs with accepted EPs that may take place in the eastern Great Australian Bight (GAB) during the proposed Duntroon survey period.

However, it is possible that other surveys may occur in the same region at similar times. PGS will monitor the NOPSEMA website for additional possible survey activities in the eastern GAB and consult with the titleholders on these proposed activities as they arise.

3 Description of Environment

The physical, biological and socio-economic environment in and around the operational area and the 'region' in general are described in this section, together with the values and sensitivities of the region.

The area encompassed by the environment which may be affected (EMBA) by a significant oil spill is used in this section to define the environmental boundary of this EP. The EMBA is defined as:

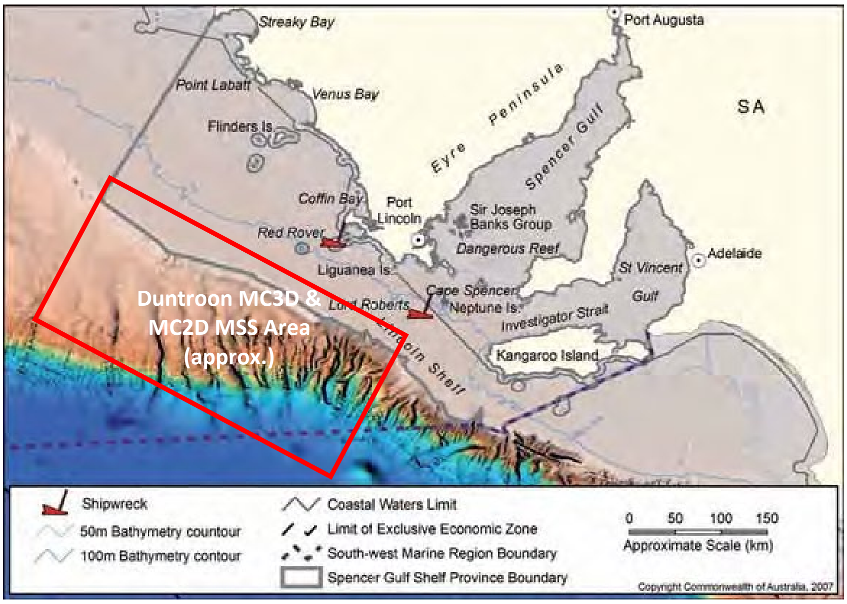
> *The probable extent of hydrocarbon exposure to the sea-surface in concentrations greater than 0.5 g/m^2 for social impacts and greater than 10 g/m^2 for ecological impacts; shoreline concentrations greater than 100 g/m^2 and entrained phase concentrations above 70.5 ppb (x 96 hrs or 6788 ppb.hrs) as a result of the loss of fuel from the survey vessel's largest fuel tank (as measured from the survey boundary coordinates) and the calculated entrained phase which is predicted to extend 208 km from the survey boundary coordinates.*

Justification for the EMBA definition is presented in Section 6.10.

3.1 Regional Setting

The Duntroon MC2D/MC3D MSS is in the South-West Marine Bioregion (DEWHA, 2007) and lies within the **Spencer Gulf Shelf Province** and **Southern Province Bioregions** (refer Figure 3-1).

Figure 3-1: Spencer Gulf/Southern Province marine bioregion (DEWHA, 2007)



The **Spencer Gulf Shelf Province**[5] extends east from Ceduna to Cape Jaffa, occupying the 0-200m isobath range (DEWHA, 2007). Within this bioregion, seasonal winds and ocean currents interact with the seafloor features to produce irregular seasonal upwellings high in biological productivity. The Duntroon OA lies adjacent to an irregular upwelling area on the shelf to the west of Kangaroo Island, known as the "Kangaroo Island Pool". This is a 'pool' of sub-surface, cold, nutrient rich water which is upwelled along the shelf south of Kangaroo Island during late spring and summer, advected north-west along the western Eyre Peninsula (Pattiaratchi, 2007) and entrained between the 100 m and 200 m isobaths (McClatchie et al. 2006; cited in Blue Whale Study Inc., 2012). This upwelling relies on upwelling favourable south-easterly winds and coastal trapped waves to create upwelling events which can occur over 3-10 days and some 2-4 times per season.

[5] This province consists of the following mesoscale bioregions – Eyre (72,165 km^2), Spencer Gulf (11,874 km^2), St Vincent Gulf (12,838 km^2) and North Spencer Gulf (4,448 km^2) (DEH, 2006)

The along-shore currents can be large (~40 cm/s) and the vertical scale of the upwellings are of the order of 150 km (off Kangaroo Island) (Middleton & Bye, 2007). Analysis of wind records obtained from Neptune Island during the summer (November to April) identified upwelling favourable winds were present 50% of the time (Ward et al. 2006; cited in Pattiaratchi, 2007). Inter-annual variability in upwelling activity (i.e., stronger events) appears linked to El Nino events (Pattiaratchi, 2007).

This province is regarded as a productive commercial fishing area in Australia, producing sardines and anchovies (finfish fishery) and for supporting migratory tuna (Ward et al. 2006; cited in Blue Whale Study Inc., 2012; Pattiaratchi, 2007). Due to this high biological productivity, aggregations of marine life such as New Zealand fur seals, Australian sea lions, dolphins, penguins, sharks, seabirds and cetaceans are also drawn to the area (DEWHA, 2007).

The **Southern Province** bioregion extends from the shelf break south of Kangaroo Island (SA) to the southern edge of the Naturaliste Plateau (WA) occupying waters deeper than 200 m (DEWHA, 2007). The canyons south of Kangaroo Island, located approximately 120 km southeast of the survey area, and the adjacent shelf-break receive upwellings of nutrient-rich water. Canyon areas, both at the shelf edge and on the slope, appear to be an important aggregation area (spawning, mating and feeding) for a range of commercial species especially during winter (DEWHA, 2007). There is highly productive giant crab; lobster; and gummy shark grounds along the shelf edge. Commercially important south-eastern Australia slope species including blue grenadier, blue eye trevalla, ling, hapuka, warehou, gemfish, orange roughy and school shark are fished, or have been fished, in the area (DEWR, 2006). Given the area's high level of productivity the water column also supports large predator groups such as sharks, cetaceans and New Zealand fur seals (DEWHA, 2007).

3.2 Conservation values and sensitivities

Conservation values and sensitivities in an around the survey area are described in this section with Table 3-1 providing a basic outline of matters protected under the *Environment Protection and Biodiversity Act 1999* ('EPBC Act') based upon the nature and scale of the activity and the Department of Environment's (DoE) Protected Matters Search Tool (PMST) (DoEE, 2017a).

Table 3-1: Conservation Values in the vicinity of the survey area

Category	Conservation Classification	EP Section
Commonwealth Heritage	Commonwealth Marine Reserves	Described in Section 3.2.1
	Commonwealth Heritage List	Described in Section 3.2.5
EPBC Act matters of National Environmental Significance (NES)	World Heritage Properties	Described in Section 3.2.4
	National Heritage Places	Described in Section 3.2.5
	Wetlands of International Importance (RAMSAR)	Described in Section 3.2.6
	Nationally threatened species and ecological communities	Described in Section 3.7
	Migratory Species	Described in Section 3.7
	Commonwealth marine areas	Described in Sections 3.3 to 3.8
	Great Barrier Reef Marine Park	Not Applicable
	Nuclear Actions	Not Applicable
	A water resource, in relation to coal seam gas development and large coal mining development	Not Applicable
State Protected Areas	Marine Parks & Sanctuaries	Described in Section 3.2.2
	Terrestrial Parks	Described in Section 3.2.3

3.2.1 Commonwealth Marine Reserves

The Duntroon OA is in the South-west Commonwealth Marine Park (CMP) Network, which has been established to ensure the conservation and sustainable use of Australia's marine environment. The selection of CMP locations maximise conservation outcomes ensuring provincial bioregions and seafloor features are represented, the reserves represent all depth ranges in the region and benthic and demersal biological features at a broad sub-provincial scale are represented (DoE, 2016b).

The Duntroon OA is in, or near the following CMPs:

- Western Eyre CMP (survey overlaps CMR);
- Western Kangaroo Island CMP – approximately 47 km east of nearest OA boundary;
- Southern Kangaroo Island CMP – approximately 155 km east of nearest OA boundary
- Great Australian Bight CMP – approximately 130 km west of nearest OA boundary. Note the Duntroon survey is approximately 180 km from the boundary of the former GAB CMR (Benthic Protection Zone);
- Murray CMP – approximately 130 km east from the nearest OA boundary.

These CMRs are briefly described below.

3.2.1.1 *Western Eyre CMP*

The Duntroon survey area is located within the Western Eyre CMP (Zoned Multiple Use Zone (IUCN VI) & & Special Use Zone (IUCN VI)) (refer **Figure 3-2**). Exploration activity is permissible in these zones with the approval of the Director of National Parks (DNP). The SW Marine Parks Networks Management Plan 2018 (DoEE, 2018) details constraints on activities within CMPs.

The CMP, covering an area of 57,944 km^2, is located off South Australia's western Eyre Peninsula coastline in water depths between 15 m to 6000 m extending from continental shelf waters south to the abyssal plain. Biologically important areas within the CMP include (DoE, 2018a):

- Foraging habitat for the threatened Australian sea lion, white shark and blue whale and the migratory sperm whale;
- Breeding and foraging habitat for seabirds;
- A calving buffer area for the threatened Southern Right Whale (inshore areas of CMP).

Ecosystems represented include the westernmost ecosystem of the Spencer Gulf Shelf Province, the easternmost ecosystem of the Great Australian Bight Shelf Transition and the easternmost ecosystem of the Southern Province;

Key ecological features (KEFs) include the:

- Ancient coastline (between 90-120m which are areas of benthic biodiversity and productivity) (refer Section 3.3.1);
- Kangaroo Island Pool, canyons and adjacent shelf-break and Eyre Peninsula upwelling (area of nutrient-rich upwellings that enhance productivity supporting seasonal aggregations of marine species) (refer Section 3.3.2);
- Meso-scale eddies (important transporters of nutrient and plankton communities which form at predictable location sof the western and southwestern shelf-break) (refer Section 3.3.3);
- Benthic invertebrate communities of the eastern Great Australian Bight (soft-sediment benthic invertebrate communities of the eastern GAB shelf forming diverse soft-sediment ecosystems) (refer to Section 3.3.4); and
- Areas important for small pelagic fish (species with an important ecological role with trophic link between plankton communities and larger fish-eating predators in the area) (refer Section 3.3.5).

Cultural vaues include indigenous cultural activities of the Mirning people in the far west coast region of South Australia along the coastline of the Nullabor Cliffs and Nutys Archipeligo, supporting a sea-based traditon and culture.

The Duntroon MC3D acquisition area spatially overlaps the Multiple Use Zone (IUCN VI) of the Western Eyre CMP by 2,060 km^2 (13% of Multiple Use Zone[6]). The MC2D survey spatially overlaps the Multiple Use Zone (1565.4 km seismic lines, area 5,533 km^2 or 35% of the Multiuse Zone) and Special Purpose Zone (172 km seismic lines, area 640 km^2 or 2.6% Special Purpose Zone[7]). The EMBA (surface and entrained oil) will contact this CMP.

3.2.1.2 Western Kangaroo Island CMP

This CMP, covering an area of 2,335 km^2, is in Commonwealth waters to the west of Kangaroo Island in water depths between 15 m to 165 m extending along the continental shelf. The major conservation values identified for this CMP are (DoE, 2016d):

- Important foraging habitat for the threatened Australian sea lion, white shark and blue whale; the migratory sperm whale, migratory short-tailed shearwater and Caspian tern;
- Seasonal calving habitat for the threatened Southern Right Whale;
- Examples of the southernmost ecosystems of the Spencer Gulf Shelf Province;
- KEFs including the:
  - Ancient coastline (high productivity) (refer Section 3.3.1); and
  - Kangaroo Island Pool, canyons and adjacent shelf-break and Eyre Peninsula upwelling (high productivity and feeding aggregations) (refer Section 3.3.2).

The EMBA (surface and entrained oil) may contact this CMP.

3.2.1.3 Southern Kangaroo Island CMP

This CMP, covering an area of 630 km^2, is in Commonwealth waters to the southwest and south of Kangaroo Island in water depths between 15 m to 100 m extending along the continental shelf. The major conservation values identified for this CMP are (DoE, 2016e):

- Important foraging habitat for the threatened Australian sea lion and white shark;
- Important seasonal calving habitat for the threatened Southern Right Whale;
- Examples of the southernmost ecosystems of the Spencer Gulf Shelf Province; and
- The key ecological feature (KEF) of the Kangaroo Island Pool, canyons and adjacent shelf-break and Eyre Peninsula upwelling (high productivity and feeding aggregations) (refer Section 3.3.2).

The EMBA (entrained phase oil) may contact this CMP.

3.2.1.4 Great Australian Bight (GAB) CMP

This CMP, covering an area of 45, 926 km^2, is in Commonwealth waters south of the Head of Bight in water depths between 15 m to 6000 m extending from continental shelf waters south to the abyssal plain. The major conservation values identified for this CMP are (DoE, 2016f):

- Important foraging habitat for the threatened Australian sea lion, white shark, the migratory sperm whale and short-tailed shearwater;

[6] Multiuse zone is 15,900 km^2
[7] Special Use Zone is 24,370 km^2

- Examples of the western ecosystems of the Great Australian Bight Shelf transition and the easternmost ecosystems of the Southern Province;
- KEF including the:
    - Ancient coastline (90-120 m) (high productivity) (refer Section 3.3.1);
    - Benthic invertebrate communities of the eastern GAB (communities with high species diversity) (refer to Section 3.3.4); and
    - Areas important for pelagic fish (refer to Section 3.3.5).

The EMBA (entrained phase oil) may contact this CMP.

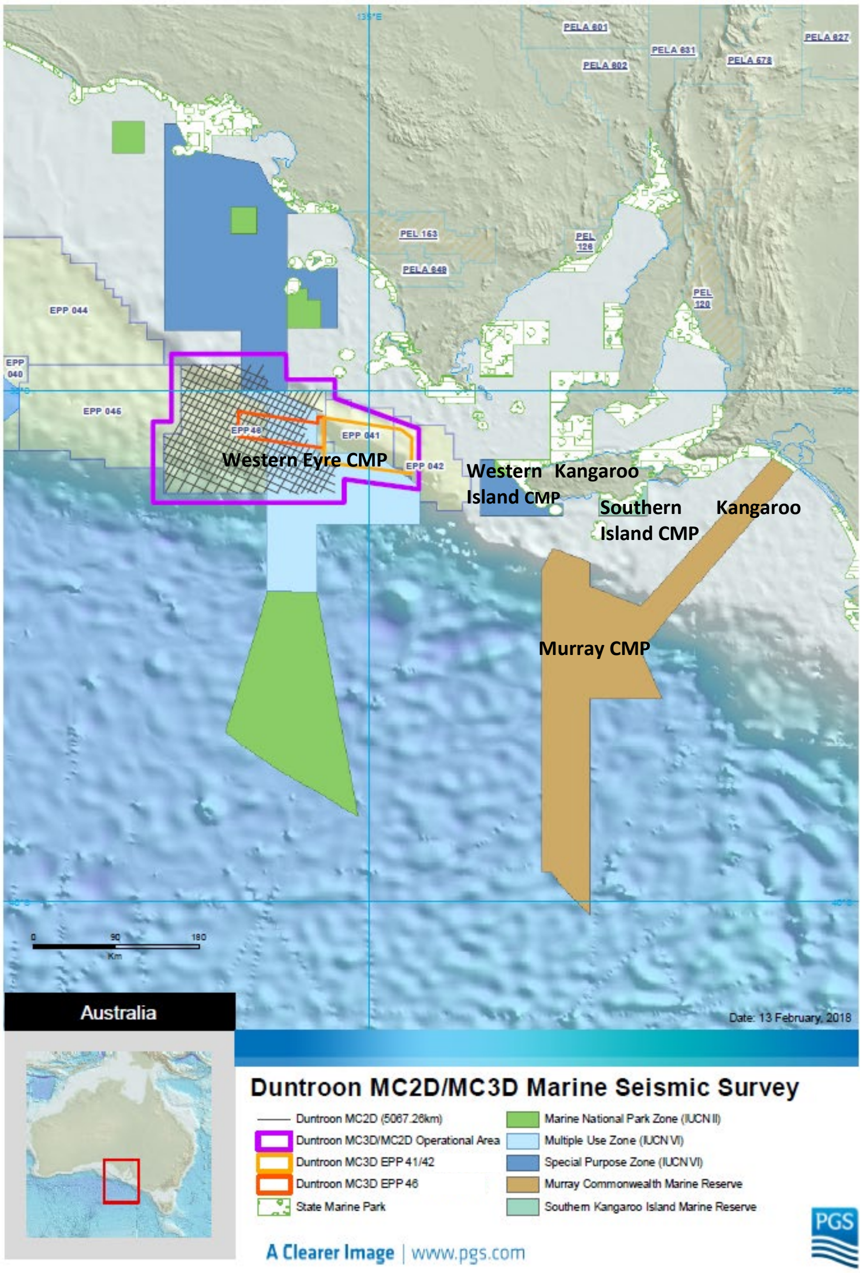
3.2.1.5 Murray CMP

This CMP, covering an area of 25,803 km^2, is in Commonwealth waters to the south and southeast of Kangaroo Island extending across the continental shelf, continental slope and abyssal plain to depths of 4500m including the Murray and Sprigg Canyons. The major conservation values identified for this CMR are (DoEE, 2017h):

- Important foraging habitat for the blue, sei and fin whale; Australian sea lion; wandering, black-browed, yellow-nosed and shy albatrosses; great-winged petrels; flesh-footed and short-tailed shearwaters and white-faced storm petrel;
- Important seasonal calving habitat for the threatened southern right whale;
- Important migration area for the humpback whale;
- Examples of ecosystems habitats and communities associated with the Spencer Gulf Shelf Province, the Southern Province and the West Tasmanian Transition with associated subsea features including the abyssal plain/deep ocean floor, canyon, escarpment, knoll/abyssal hill, shelf, slope and terrace;
- The KEF of the Bonney Coast Upwelling and shelf rocky reefs and hard substrate (refer Section 3.3.6 and Section 3.3.7).

The EMBA (entrained phase oil) may contact this CMP.

Figure 3-2: Commonwealth Marine Parks & Reserve Zones within Bight Basin



3.2.2 *South Australian marine reserves*

The Duntroon OA lies in proximity to the following South Australian (SA) marine parks (measured from the nearest OA boundary to marine park boundary):

- Neptune Islands Marine Group Marine Park located approximately 45km ENE;
- Western Kangaroo Island Marine Park located approximately 60 km east;
- Thorny Passage Marine Park located approximately 4 km NE (Rocky (south) Island; 29 km north (Greenly Island); 36 km ENE (Four Hummocks Island) and 58 km NE (SA coastal waters);
- Investigator Marine Park located approximately 97km NNE; and
- Sir Joseph Banks Group Marine Park located 85 km NE;
- Gambier Island Group Marine Park located 85 km NE;
- South Spencer Gulf Marine Park located 115 km east; and
- South Kangaroo Island Marine Park located 157 km east.

All distances are measured from the nearest survey boundary to the marine parks.

These marine parks are described briefly in Table 3-2 and shown in Figure 3-3.

Table 3-2: South Australian Marine Parks within EMBA

Reserve Name	Conservation Description
Neptune Islands Marine Group Marine Park.	The Neptune Islands Group Marine Park is situated in offshore waters 58 km SSE of Port Lincoln and south of the Thorny Passage Marine Park (DENR, 2012a). The Neptune Islands group consist of the Northern and Southern Neptune Islands and waters 2nm from their rocky shorelines. The Marine Park was initially established to protect a New Zealand fur seal colony and currently hosts critical baseline habitats to measure changes to the State's marine ecosystems that may arise over time from pollution or climate change (DENR, 2012). This island group rises steeply from deep water and is exposed to strong wind and waves. The park's habitats range from exposed granite mountains, inter-tidal reefs and sandy seafloor including areas of sheltered seagrass and deep-water habitats with a range of marine life from reef fish (western blue groper, wrasse species, harlequin fish and western blue devil) to various species of sharks (shortfin mako and porbeagle sharks, spotted spurdog, spotted wobbygong, bronze whales, blue shark, smooth hammerhead, school shark and dusky whaler) (DENR, 2012a). These habitats support breeding populations of sea lions, SA's most important New Zealand Fur Seal pup production site (almost half of the Australian population) and roosting and nesting seabirds such as the short-tailed shearwater, cape barren goose, white bellied sea eagle, fairy tern, rock parrot, osprey and peregrine falcon (DENR, 2012a). The Northern Neptune Islands Group is internationally significant for white shark habitats and hosts ecotourism activities such as cage diving and berleying which attract the species. Anchorages utilised by tourism operators lie on the eastern side of Northern Neptune Island Group (by permit only) (Calypso Star Charters, 2014a). The CSIRO also undertakes research at the Neptune Islands and other activities include recreational and charter fishing, expedition cruise ships and marine mammal watching (DENR, 2012a). Many shipwrecks can be found within the Park listed on the State Heritage Register (DENR, 2012a). Five commercial fisheries operate in the Marine Park including the Northern Rock Lobster Fishery, Sardine Fishery, Marine Scale Fishery, Abalone Fishery and Charter Fishery targeting shark, ocean leatherjacket, pilchards and rock lobster (DENR, 2012a).

Reserve Name	Conservation Description
Western Kangaroo Island Marine Park (MP)	The Western Kangaroo Island MP spans waters from Cape Forbin to east of the Remarkable Rocks and includes Lipson Reef, the North and South Casuarina Islets and partially overlays Ravine des Casoars and Cape Torrens Wilderness Protection area to the median high-water mark (DENR, 2012c). The southern and western coasts of the park are exposed to strong winds and large swells and experience seasonal nutrient-rich upwellings. The park's shoreline is dominated by rugged, exposed cliffs and headlands interspersed by pocket beaches. Reefs extend from intertidal wave-cut shore platforms along most of the coastline and transition to sandy seafloor habitats in deeper waters (DENR, 2012c). Three species of pinnipeds (seals and sea lions) are found within this park with Cape du Couedic having ten recorded breeding sites for NZFSs and another at North Casuarina Islet. North Casuarina Islet hosts an Australian sea lion haul-out and occasional breeding site and a significant breeding site for Australian fur seals. Fish species found in the park include the long-lived and site-attached western blue groper, harlequin fish, the western blue devil and shark species including the shortfin mako, porbeagle, dusky whaler, white-spotted spurdog, spotted wobbygong, blue shark, smooth hammerhead and the white shark (DENR, 2012c). The deeper portions of the marine park are thought to be important feeding grounds for migratory cetaceans such as pygmy blue whales, sperm whales, dwarf sperm whales, pygmy sperm whales, pygmy right whales, short-finned pilot whales, false killer whales, some species of beaked whales and dolphin species such as southern right whale dolphins and Risso's dolphin (DENR, 2012). Bird species such as the southern giant petrel, shy albatross and yellow-nosed albatross have all been recorded in the area. Other species include the Cape Barren goose, musk duck, fleshy-footed shearwater, fairy tern and eastern reef egret (DENR, 2012). Terrestrial-based tourism (e.g., Flinders Chase National Park, Admirals Arch and Remarkable Rocks) is an important economic contributor to the region and provides significant employment opportunities for the Kangaroo island population (DENR, 2012c). Commercial fisheries operating in the MP include the Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Sardine Fishery, Charter Fishery and the Marine Scalefish Fishery (Gulf St Vincent/Kangaroo Island). These fisheries are important to regional economies of the area both directly, and indirectly, through a range of additional services such as processing, local transport, marketing, local retail and food services (DENR, 2012c). The MP is rich in European history and contains many protected shipwreck sites and State and Commonwealth Heritage listed lighthouses, jetties, store and landing sites (DENR, 2012c).
Thorny Passage MP	The Thorny Passage MP spans waters from Frenchman Bluff to Thorny Passage including both Rocky and Greenly Islands (DENR, 2012b). Habitats within the park include sheltered bays and inlets, reefs, seagrass meadows, tidal sandflats (Coffin Bay), rocky coastlines with exposed steep headlands and cliffs, exposed high-energy surf beaches, offshore islands and large areas of sandy seafloor. Species within the park include the white shark, shortfin mako shark, porbeagle, school shark, dusky whaler, spotted wobbygong, Australian sea lion, southern bluefin tuna, the uncommon deep velvetfish, the velvet octopus, thirteen whale species, site-attached reef fish such as the western blue groper and western blue devil; and many nationally and internationally protected shorebirds and seabirds (DENR, 2012b). The area is an important aggregation area for the southern right whale at Sleaford Bay. Liguanea and Greenly Islands host a breeding and haul-out site for New Zealand fur seals. Thorny Passage MP supports an aquaculture industry predominantly based upon Pacific oysters farmed at Coffin Bay with abalone also farmed in the area. Commercial fisheries operating in the Thorny Passage MP include the Western Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the West Coast Prawn Fishery, the Sardine Fishery, the Marine Scalefish Fishery, the Miscellaneous Fishery (Urchin) and the Charter Fishery (DENR, 2012b). Tourism is an important contributor to the region. Key activities include recreational and charter fishing, scenic cruises, diving and expedition cruise ships (DENR, 2012b).

Reserve Name	Conservation Description
Investigator MP	Investigator MP spans coastal waters of the western Eyre Peninsula from Point Drummond to Elliston and includes the Offshore Investigator Group of islands (Pearson & Veteran Isles, Dorothee Island, Ward Islands, Flinders Island and the Top Gallant Isles) and Cap Island Conservation Park (DEWNR, 2012c). The MP consists of granitic island mountains; intertidal and deep-water boulder reefs; sheltered seagrass meadows in the lee of some islands; and cliffs and high energy surf beaches along the mainland coast. Fauna present in the park include the golden roughy (not known anywhere else in Australia) and the western blue groper; white-bellied sea eagles and ospreys which nest on coastal cliffs, headlands and islands; little penguins and other seabirds nesting and roosting on Ward, Veteran and Pearson Islands; and the Australian sea lion and New Zealand fur seal which breed and rest in the park. The MP also contains (DEWNR, 2012c): • Commercial fishers which target greenlip and blacklip abalone, southern rock lobster and scale-fish species such as snapper and King George whiting; • Historic features in the park include architectural relics of the sealing industry and two shipwrecks, the *Lady Flinders* and *Kapara*; and • Recreational fishing and Charter boat fishing as well as diving at Pearson and Topgallent Islands.
Sir Joseph Banks Group MP	The Sir Joseph Banks Group MP lies in the lower Spencer Gulf and includes waters adjacent to Tumby Bay, the islands of the Sir Joseph Banks Group and Dangerous Reef (DEWNR, 2012b). The MP habitats include shallow reefs, sheltered sandy bays and rocky limestone shores, seagrass meadows, saltmarsh communities and islands. Dangerous reef has one of the largest breeding colonies of Australian sea lions and it is also an important feeding area for the great white shark, particularly for breeding females. A range of seabirds also nest on the islands associated with the Sir Joseph Banks Group. The MP also contains (DEWNR, 2012b): • Commercial fishers targeting pilchards, abalone, rock lobster and scale-fish species; • Aquaculture such as sea cages; • Numerous sites of historical significance such as the Governor Gawler and Eleanor shipwrecks; • Sailing, fishing, swimming, snorkelling, diving and kayaking are popular with the Sir Joseph Banks Group Islands a well-known destination for scuba divers.
Gambier Island Group MP	The Gambier Islands Group MP is in the waters of the mouth of Spencer Gulf (DEWNR, 2012d). The Gambier Islands Conservation Park, including North Island, South West Rock and Peaked Rocks, and the south-western edge of Wedge Island is overlaid by the marine park. Habitats vary from exposed cliffs and rocky shores to long sandy beaches and seagrass meadows. Commercially important fish species including King George whiting, trevally, Western Australian salmon and Australian herring (tommy ruff) inhabit the waters around the islands at one or more stages of their lives. Red and brown macro-algae and invertebrates are abundant in the waters surrounding the islands and the islands themselves are important habitat for Australian sea lions and seabirds. Commercial fisheries operating in the Marine Park include the Sardine Fishery, Charter Fishery, Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Marine Scalefish Fishery and Spencer Gulf Prawn Fishery. A jetty, lighthouse and an airstrip are located on Wedge Island to facilitate tourism and local access. Diving, fishing charters and sightseeing occur in the waters around the islands. The remoteness of the MP limits recreational activities, however fishing, diving, snorkelling and swimming are activities known to occur within the area (DEWNR, 2012d).

Reserve Name	Conservation Description
Southern Spencer Gulf MP	The Southern Spencer Gulf MP spans waters from Hardwicke Bay (western tip of Yorke Peninsula) around the peninsula to Hillock Point and across Investigator Strait to the north coast of Kangaroo Island (DEWNR, 2012e). The marine park overlays the Althorpe Islands Conservation Park and parts of Innes National Park, Leven Beach Conservation Park and Western River Wilderness Area. The MP habitats are influenced by varying seafloor depths and wind and wave exposures. Low energy beaches backed by extensive sand dunes, shallow embayments dominated by seagrass meadows and low-profile reefs dominate the habitats on the north coast of the park from Hardwicke Bay to Corny Point. The remainder of the park from Corny Point to Foul Bay and part of the North coast of Kangaroo Island comprises various habitats from exposed cliffs, offshore islands and headlands fronted by high energy intertidal reefs and rocky shore platforms, to both sheltered and high energy sand beaches backed by sand dunes. Hardwicke Bay contains extensive seagrass meadows and the long expansive beach is home to nesting hooded plovers. The Althorpe Islands Conservation Park includes a haul out site for the vulnerable Australian sea lion and the New Zealand fur seal. Commercial fisheries operating in the Marine Park include the Spencer Gulf Prawn Fishery, the Central Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the Sardine Fishery, the Marine Scalefish Fishery and the Charter Fishery. Tourism is an important economic contributor to the region with key activities including recreational and charter fishing, charter sailing, recreational diving and expedition cruise ships. The MP is rich in European history and many ships were wrecked in Investigator strait or the south west coast of Yorke Peninsula. At least 40 known shipwrecks lie in the park, 26 of which are included in the Investigator Strait Maritime Heritage Trail.
South Kangaroo Island MP	The Southern Kangaroo Island MP spans waters from Point Reynolds to the western boundary of the Seal Bay Conservation Park and includes an area offshore at North Rock, Young Rocks and South West Rock. The MP also partially overlays the Seal Bay Conservation Park and borders the Cape Gantheaume Wilderness Protection Area (DEWNR, 2012f). Exposed cliffs, rocky headlands and wave-cut shore platforms dominate the park with high energy sandy beaches and dunes at Seal Bay and Bales Beach. Fringing and deep-water reefs are interspersed by sandy seafloor whilst the slightly more sheltered waters of D'Estrees Bay support the only significant seagrass bed on the south coast of the island. A breeding colony for the vulnerable Australian sea lion is present at Seal Bay. The park also includes the two largest New Zealand fur seal colonies on Kangaroo Island at Cape Gantheaume and Berris Point. Nesting seabirds such as osprey and the endangered white-bellied sea eagle are present on cliffs, whilst the beaches are home to nesting hooded plovers. The entire coastline of the Cape Gantheaume Conservation Park is listed as a Wetland of National Importance with shorebirds present from October to March each year. Seal Bay is a very popular destination for Kangaroo Island tourists each year. Tourists to the Cape Gantheaume Conservation Park also enjoy marine activities such as boating, fishing, scuba diving and snorkelling. Commercial fisheries operating in the Marine Park include the Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Marine Scalefish Fishery (Gulf St Vincent/Kangaroo Island), Charter Fishery and the Giant Crab Fishery. These fisheries are important to regional economies of the area both directly, and indirectly, through a range of additional services such as processing, local transport, marketing, local retail and food services. The early European history of the Marine Park is based on exploration, whaling and sealing, resulting in many shipwrecks and a whaling station established at the southern end of D'Estrees Bay (DEWNR, 2012f).

Figure 3-3: South Australia Marine Park Locations

3.2.3 South Australian terrestrial parks

South Australian terrestrial parks extend to the low water mark. Accordingly, the inter-tidal zone lies within the EMBA for a Duntroon spill. Table 3-3 provides details of coastal SA terrestrial parks within the EMBA. Locations of these parks are shown in **Figure 3-4** and **Figure 3-5**.

Table 3-3: South Australian coastal terrestrial parks within EMBA

Reserve Name	Conservation Description
Waldegrave Islands Conservation Park (CP) (IUCN Category 1a Protected area) Reserve Is located 125 km NE from the nearest survey boundary (refer Figure 3-5).	The encompasses Waldegrave Island and Little Waldegrave Island and the Watchers; and is separated from the mainland by a 3km passage and lies 7km north-west of Elliston. The island is a domed granite base with a calcarenite mantle. The island is characterised by spectacular coastal cliffs and sandy beaches. The island comprises extensive areas of cleared land supporting introduced grasses, infestations of African Boxthorn and some native vegetation. Little Waldegrave Island is largely a granite rock with enough area to support a few salt tolerant plant and animal species. Waldegrave Islands and the Watchers were constituted to conserve Cape Barren Geese *(Cereopsis novaehollandiae*) breeding habitat and Australian Sea-lion haul-out areas. The park covers 432ha (DEH, 2006).
Investigator Group CP Reserve Is located 70 km north from the nearest survey boundary (refer Figure 3-5).	The Investigator Group CP is made up of five steep domed granite island groups Topgallant Island (6km east of Flinders Island), Ward Island (15km west of Flinders Island), Pearson Island (25 km south-east of Flinders Island), The Veteran Isles and Dorothée Island (4km south of Pearson Island) (DEH, 2006). Investigator Group CP was constituted in 1972 to protect delicate island ecology and Australian Sea-lion and New Zealand Fur-seal haul-out areas (DEH, 2006).
Cap Island CP (IUCN Category 1a Protected area) Reserve Is located 115 km NE from the nearest survey boundary (refer Figure 3-5).	Cap Island is located 7.5km offshore, west of Mount Misery. Like many of the islands off the Western Eyre Peninsula, Cap Island is composed of a granite base with a calcarenite mantle. The margins of the island are steeply over-hanging and eroded (DEH, 2006). Cap Island CP was constituted by statute in 1972 to conserve a sea bird breeding area and Australian Sea-lion and New Zealand Fur-seal (*Arctocephalus forsteri*) haul-out areas (DEH, 2006).
Greenly Island CP (IUCN Category 1a Protected area) Reserve Is located 28 km NNE from the nearest survey boundary (refer Figure 3-5).	Greenly Island is located 30km west-south-west of Whidbey Point. Greenly Island is a large granite dome with steep sides plunging vertically into deep water, split by two large crevasses which effectively break the island into three blocks. The top of the island is capped with Drooping Sheoak (Allocasuarina verticillata) and Dryland Tea-tree (*Melaleuca lanceolata*) woodlands while the lower slopes have either a Coastal Tussock (*Poa poiformis var. poiformis*) grassland or a Marsh Saltbush (*Atriplex paludosa var. cordata*) shrubland. The main part of the island rises to the east to a steep peak of 230m (DEH, 2006). Greenly Island CP was constituted by statute in 1972 to protect the island's delicate ecology and Australian Sea-lion and New Zealand Fur-seal haul-out areas (DEH, 2006).
Rocky Island North CP (IUCN Category 1a Protected area) Reserve Is located 90 km NE from the nearest survey boundary (refer Figure 3-5).	North Rocky Island is a remote and isolated gneiss and granite hump 13km south of Drummond Point which supports a small area of Grey Saltbush (*Atriplex cinerea*) shrubland with a large area of bare rock. It provides a resting point for oceanic birds and a breeding site for Australian Sea-lions (DEH, 2006). Rocky Island (North) CP was constituted by statute in 1972 to conserve seal haulout areas and associated island habitat (DEH, 2006).
Rocky Island South CP (IUCN Category 1a Protected area) Reserve Is located 10 km NE from the nearest survey boundary (refer Figure 3-5).	Rocky Island (South) lies 51km west-south-west of Point Avoid, and 18km south-south-west of Greenly Island. A reef extends 400m from the western side of the southern point of the island, but the remainder of the island is surrounded by deep water. The dome-shaped granite island rises 68m above the ocean (DEH, 2006). Rocky Island (South) Conservation Park was constituted by statute in 1972 to conserve New Zealand Fur-seal breeding areas and associated island habitat (DEH, 2006).
Neptune Islands CP (IUCN Category 1a Protected area) Reserve Is located 49 km ENE from the nearest survey boundary (refer Figure 3-5).	The rocky cragged coves of the Neptune Islands are an important breeding site for fur seals with half Ausralia's population breeding there. On the islands are bird species such as the white-breasted sea eagle, osprey and albatross sprecies (National Parks SA, 2017). No Management Plan is currently available for the terrestrial portionof the islands.

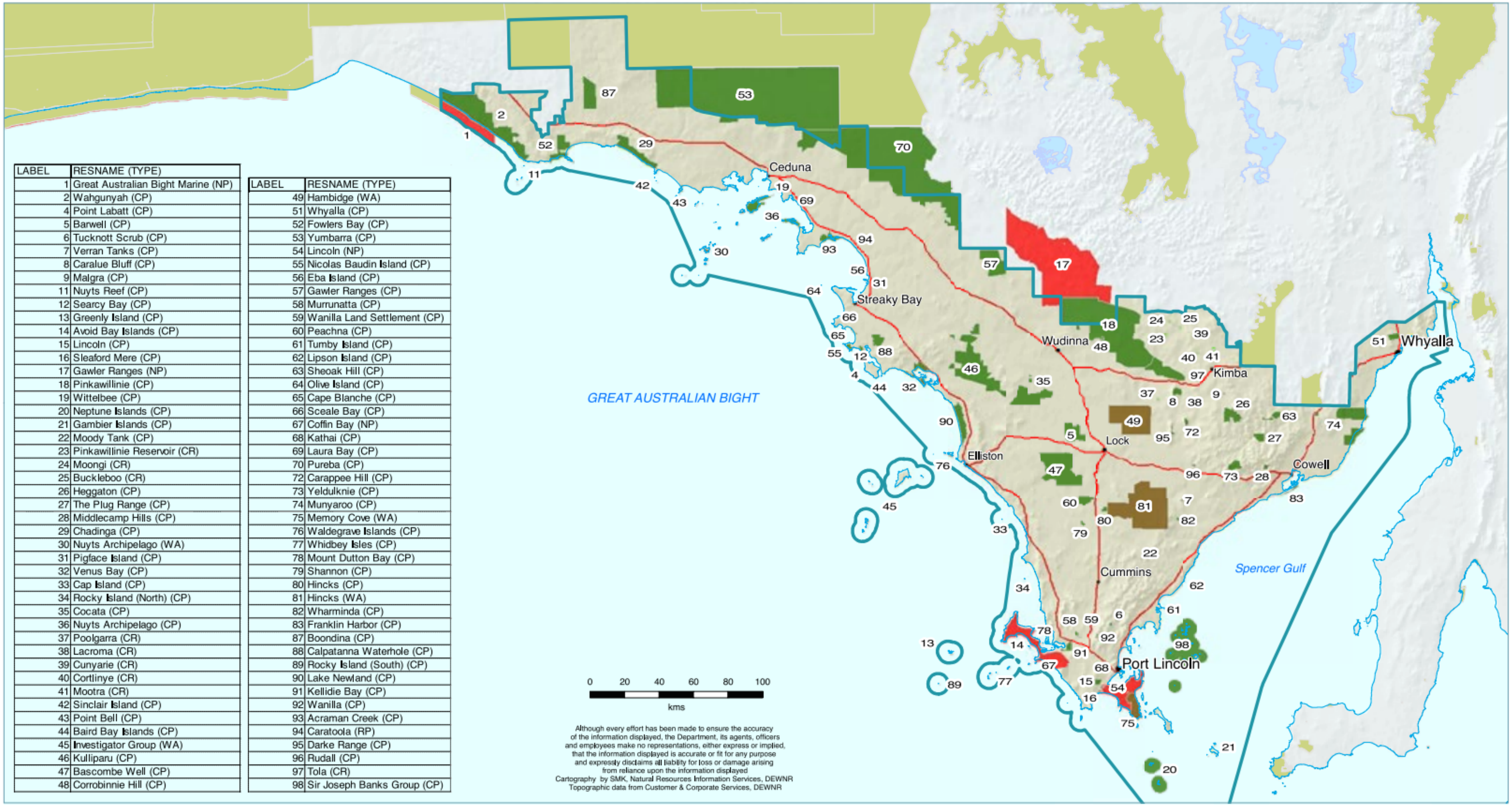
Reserve Name	Conservation Description
Gambier Islands CP (IUCN Category 1a Protected area) Reserve Is located 84 km ENE from the nearest survey boundary (refer Figure 3-5).	The Gambier Group consist of Wedge Island, South-west Rock and Peaked Rock and North Islet (2.3km north of Wedge island) Islands located ~ 40 km from the Yorke Peninsula. On Wedge, the northern coast comprises of sandy beaches lying at sea level and increasing to 202 m at its south coast, where there are near vertical cliffs to a fringe of wave-cut. The cliffs on the eastern flank are less severe and support pockets of heath that extend from the upper platform and support nesting sites for the peregrine falcon. The coastal zone is also inhabited by White-bellied Sea-eagles, Pied Cormorants, Crested Terns, and Silver and Pacific Gulls (Robinson et al. 1996). SouthWest Rock lies 3.2 km south-west of Wedge Island. The granite has been eroded to divide the platform with a ribbon of channelled surge. A low cap of calcarenite clings to the highest levels of each portion, the highest rising 21 m above sea level. Peaked Rocks are two granite platforms similar in proportions to Southwest Rock, lying 925 m south-west and 460 m south-south-east respectively from Wedge Island's south-eastern extremity. Their remnant calcarenite cap rises to steep, conical summits respectively 65 m and 43m high. Australian Sea lions have been regularly recorded on these islets (Robinson et al. 1996).
Memory Cove Wilderness Protection Area (IUCN Calegory IB) Reserve Is located 61 km NE from the nearest survey boundary and lies adjacent to Lincoln National Park (refer Figure 3-5) and approximately 15 km south-east from Port Lincoln.	Reserve includes Little Island, Lewis Island, Hopkins Island, Smith Island and Williams Island. Memory Cove Wilderness Protection Area protects an abundance of native flora and fauna, including several species of conservation significance at state or national levels (Cape Barren Goose (*Cereopsis novoehollandiae*), the Rock Parrot (*Neophema petrophila*), the Fleshy-footed Shearwater (*Puffinus carneipes*), the White-bellied Sea-eagle (*Haliaeetus leucogaster*) and the Hooded Plover (*Thinornis rubricollis*)). The Australian Sea-lion (*Neophoca cinerea*) has been located on Hopkins Island (DEH, 2005). Memory Cove Wilderness Protection Area also holds a significant cultural history. Prior to European settlement, two groups of Aboriginal people, the Barngarla and the Nauo groups occupied the area. In 1802, Matthew Flinders sailed the coast in the Investigator. The nearby islands were named after the eight lost men, and Memory Cove was named to commemorate a cutter which capsized duringthe journey (DEH, 2005).
Sir Joseph Banks Group Conservation/ Marine Park (IUCN Category 1a Protected area) Reserve Is located 105 km NE from the nearest survey boundary (refer Figure 3-5).	The Sir Joseph Banks Group (20 low-lying islands) Marine Park spans waters from just north of Bergs Beach to Point Bolingbroke and includes the islands of the Sir Joseph Banks Group and Dangerous Reef. The Park is adjacent to Tumby Bay, a wetland of national importance, and 35 km NE of Port Lincoln. The park contains islands, shallow reefs, sheltered sandy bays and rocky limestone shores, seagrass meadows, saltmarsh communities and deep water habitats of lower Spencer Gulf.Dangerous Reef hosts one of the largest breeding colonies of Australian sea lions in the world and pregnant female white sharks are often found in the area, perhaps due to the abundance of their sea lion prey. King George whiting utilises the area as breeding and nursery grounds and the endemic leafy seadragon inhabits the inshore seagrass beds (DEWNR, 2012b) The Lower Eyre Peninsula aquaculture zone lies in this marine park. Southern bluefin tuna, mussels, abalone and other finfish farming occurs in the policy area. The Western Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Spencer Gulf Prawn Fishery, Sardine Fishery, Marine Scalefish Fishery and Charter Fishery are commercial fisheries which operate within the Sir Joseph Banks Group Marine Park (DEWNR, 2012b). Tourism is an important economic contributor to the region. Key activities include recreational and charter fishing, charter sailing and diving, marine mammal watching and scenic cruises (DEWNR, 2012b). No Management Plan is currently available for the terrestrial portion of the islands.
Lincoln National Park (IUCN Category II) Reserve Is located 57km NNE from the nearest survey boundary and is located 10 km south from Port Lincoln (refer Figure 3-5).	Outcroppings of basement rocks (granite) within the park are generally restricted to coastal exposures forming prominent points and bluffs on the coast.The coastline consists of granite outcrops, sandy beaches and sand dunes (including the Sleaford Bay coastline) (DEH, 2004) Islands included within Lincoln National Park range in size from Donington Island (6.8 ha) to the larger Liguanea Island (187 ha) (DEH, 2004). Animal species of conservation significance in the park include the Australian Sea-lion, New Zealand Fur-seal, Bush Stone-curlew, Slender-billed Thornbill, Southern Emu-wren, Western Whipbird, Hooded Plover, Osprey and White-bellied Sea-eagle. White-bellied Sea-eagle (Haliaeetus leucogaster) and Osprey (Pandion haliaetus) nest along the coastline, usually on a detached pinnacle or rocky stack.The availability of undisturbed coastal cliff habitats and rocky islands offshore makes the area a significant breeding refuge for these birds. Offshore islands also support breeding populations of seabirds and marine mammals. Breeding colonies and haul-outs of the Australian Sea-lion (*Neophoca cinerea*) and New Zealand Fur-seal (*Arctocephalus forsteri*) occur on many of these islands. Bottle-nosed Dolphins (*Tursiops truncatus*) and Common Dolphins (*Delphinus delphis*) are frequently seen within the waters around the park. Southern Right Whales (*Balaena glacialis australis*) are regularly seen along the southern coastline of Lincoln National Park during early winter, as they migrate towards their breeding grounds at the head of the GAB (DEH 2004). Within the park boating, fishing, beachcombing, swimming and bird-watching are all popular activities (National Parks SA, 2014).

Reserve Name	Conservation Description
Tumby Bay CP (IUCN Category 1a Protected area) Reserve Is located 119 km NNE from the nearest survey boundary and is located 45 km NE from Port Lincoln (refer Figure 3-5).	Tumby Island lies a few hundred metres off the headland of Tumby Bay. The island is calcarenite sandstone that supports a cap of reddish mottled iron-bearing clays and deep sand. The exposed sections of coast (south-east) have been carved into perpendicular cliffs. Dunes rise on the more sheltered northern coast from a sandy beach. Tumby covers 30 ha and reaches a height of 11 m (Robertson et al. 1996). Fauna identified during surveys included scrub birds such as Singing Honeyeaters, Black-faced Wood-swallows and a Willy Wagtail, Black Swans, Australian Grey Teals, a White-faced Heron and a breeding colony of Little Pied Cormorants in hollows on the steep clay cliffs of the south-eastern tip (Roberston et al. 1996).
Coffin Bay National Park (including Kellidie Bay Conservation Park, Mount Dutton Bay Conservation Park, Whidbey Isles Conservation Park and Avoid Bay Islands Conservation Park) Conservation Parks: All (IUCN Category 1a Protected area) Coffin Bay NP: IUCN Category II Reserve Is located 66 km ENE from the nearest survey boundary (refer Figure 3-5).	The southern tip of Eyre Peninsula is characterised by shallow, relatively infertile, calcareous soils and some extensive sand dune formations near the coast. Dunes have retained much of their mallee and mallee-heath vegetation, due to the unsuitability of these areas for extensive livestock grazing (DEH, 2004b). The offshore islands are formed largely of similar material, overlain by recent limestone sediments. Many islands are capped with either bare or vegetated sand dunes. Steep cliffs typically face the prevailing south-westerly winds and sea swell. Some islands have sandy beaches or bays on the sheltered north-eastern side (DEH, 2004b). About 10% of the bird species recorded are pelagic frequenting off-shore and/or ocean water, while a further 15% are wading species. The White-bellied Sea-eagle (*Haliaeetus leucogaster*) and Osprey (*Pandion haliaetus*) are both moderately common in the parks. The availability of undisturbed coastal cliff habitats and rocky offshore islands makes the Coffin Bay area a significant breeding refuge for these species. The Pied Oystercatcher (*Haematopus longirostris*), Hooded Plover (*Thinornis rubricollis*) and Redcapped Plover (*Charadrius ruficapillus*) all breed on the beaches of the peninsula in summer (DEH, 2004b). Islands of Whidbey, Avoid Bay and Mount Dutton Bay Conservation Parks support breeding populations of seabirds and marine mammals. Colonies of the Australian Sea-lion (*Neophoca cinerea*) and New Zealand Fur-seal (*Arctocephalus forsteri*) occur on many of these islands (DEH, 2004b). Bottle-nosed Dolphins (*Tursiops truncatus*) are common within the Coffin Bay waterway, and Common Dolphins (*Delphinus delphis*) are frequently seen in offshore waters. Southern Right Whales (*Balaena glacialis australis*) are often seen along the southern coastline of Coffin Bay National Park during early winter, as they migrate towards their breeding grounds at the Head of the Great Australian Bight (DEH, 2004b). The area is rich in Aboriginal cultural heritage. A number of sites of significance, including the remains of campsites and stone fish traps, exist in the Coffin Bay area. However, no comprehensive survey has been carried out to date (DEH, 2004b). Whidbey Isles CP was constituted by statute in 1972 to conserve wildlife habitat (DEH, 2006). Avoid Bay Islands CP was constituted to conserve sea bird breeding areas and Australian Sea-lion (Neophoca cinerea) haul-out areas (DEH, 2006).
Flinders Chase National Park (IUCN Category II), Ravine Des Casours Wilderness Protected Area and Cape Bouger Wilderness Protected Area (IUCN Category IB) Reserve Is located 100 km east from the nearest survey boundary (refer Figure 3-4).	The reserves have the following locations on Kangaroo Island (DEHAA, 1999): • Flinders Chase National Park located at the western end of Kangaroo Island is approximately 110 km west of Kingscote and 65 km west of Parndana; • Ravine des Casoars Wilderness Protection Area is located at the north-western end of Kangaroo Island, approximately 35 km west of Parndana; • Cape Bouguer Wilderness Protection Area is located 84 kilometres south-west of Kingscote on the South Coast Road of Kangaroo Island. New Zealand fur-seals are often seen hauling out around the coast of Kangaroo Island and are known to breed at Cape du Couedic and Cape Gantheaume. The New Zealand fur-seal population in the Cape du Couedic/Casuarina Islets area within Flinders Chase National Park is one of the largest in South Australia. Bird species present along the coastline include the white-bellied sea-eagle (*Haliaeetus leucogaster*), osprey (*Pandion haliaetus*), hooded plover (*Thinornis rubricollis*), Cape Barren goose (*Cereopsis novaehollandiae*) and fairy tern (*Sterna nereis*) (DEHAA, 1999). Flinders Chase National Park includes the geological coastline features of the Remarkable Rocks and Cape du Couedic and Admirals Arch which are subject to high visitor use. Along the west coast of Ravine des Casoars Wilderness Protection Area and the south coast of Flinders Chase National Park, calcarenite karst environments extend to approximately a kilometre inland. Numerous coastal and inland caves occur in this area, including the coastal cave at the mouth of Ravine des Casoars River, Possum Skin Cave near Cape Borda and West Bay Hollow south of West Bay (DEHAA, 1999). Aboriginal sites have been identified at Cape du Couedic, Rocky River, West Bay and Ravine des Casoars (DEHAA, 1999).

Reserve Name	Conservation Description
Cape Gantheaume Conservation Park [(IUCN Category 1a Protected area)] and Wilderness Protection Area (IUCN Category IB) and Seal Bay Conservation Area [(IUCN Category VI Protected area)] Reserve Is located 170 km east from the nearest survey boundary (refer Figure 3-4).	Cape Grantheaume is dedicated to conserve large areas of natural scrub, Murray's Lagoon and water fowl habitat. Seal Bay protects one of the largest and most viable Sea Lion colonies in Australia. Cape Grantheaume is an area of pristine coastal environment important for biodiversity providing a continuous block of vegetation adjoining Seal Bay Conservation Park and critical corridor and habitat for a range of rare and threatened species (DoE, 1977). Bird species present along the coastline include the white-bellied sea-eagle (*Haliaeetus leucogaster*), osprey (*Pandion haliaetus*), hooded plover (*Thinornis rubricollis*), Cape Barren goose (*Cereopsis novaehollandiae*), short-tailed shearwater (*Puffinus tenuirostris*, flesh-footted shearwater (*Puffinus carneipes*), little penguin (*Eudyptula minor*), wandering albatross (*Diomedea exulans*), black-browed albatross (*Diomedea melanophyrs*), yellow-nosed albatross (*Diomedea chlororhynchos*), grey-headed albatross (*Diomedea chysostoma*), giant petrel (*Macronectes giganteus*), Australian Pelican (*Pelecanus conspicillatus*), Caspian tern (*Sterna bergii*), Crested tern (*Sterna nereis*) and fairy tern (*Sterna nereis*) (DoE, 1977).
Vivonne Bay Conservation Park (IUCN Category 1a Protected area) Reserve Is located 160 km east from the nearest survey boundary (refer Figure 3-4).	Along the coast southwest of Vivonne Bay is the Vivonne Bay Conservation Park which is dedicated to conserve coastal vegetation containing open scrub and heath dominated by *Eucalyptus diversifolia* and *E. rugosa*, with low *Calocephalus brownii* shrubland on the coastal dunes and cliffs (DEP, 1987). Coastal bird species present in the reserve include the little penguin (*Eudyptula minor*), osprey (*Pandion haliaetus*), white-bellied sea eagle (*Haliaeetus leucogaster*), hooded plover (*Charadrius rubricollis*), silver gull (*Larus novaehollandiae*), pacific gull (*Larus pacificus*), fairy tern (*Sterna nereis*) and crested tern (*Thalosseus bergii*) (DEP, 1987).
Cape Torrens and Western River Wilderness Protection Area (IUCN Category IB) Reserve Is located 109 km east from the nearest survey boundary (refer Figure 3-4).	The reserves are located on the north coast of Western Kangaroo Island. Western River Wilderness Protection Area is 65 km west of Kingscote, and Cape Torrens Wilderness Protection Area is a further 12 km west. Coastal cliffs and creek walls within the reserves are almost sheer. The coastal cliffs of both reserves are the highest in South Australia (DEH, 2006b). Bird species present in these areas include Ospreys (*Pandion haliaetus*) and White-bellied Sea-eagles (*Haliaeetus leucogaster*) which nest on inaccessible, rugged cliffs. Both areas are key breeding sites for these species in South Australia (DEH, 2006b). Aboriginal artefacts have been found in both reserves. The north coast of Kangaroo Island has been the site of several disastrous shipwrecks in South Australia's history, however there are no relics of non-indigenous occupation known within the boundaries of either area (DEH, 2006b).
Innes National Park (IUCN Category II) Reserve Is located 115 km east from the nearest survey boundary.	Located on the southern tip of Yorke Peninsula, South Australia, Innes National Park incorporates the largest remnant of native vegetation on the Yorke Peninsula, including 115 plant species of conservation significance. The park provides essential habitat for the threatened Western Whipbird and Malleefowl, and conserves important intertidal ecosystems, beaches and dunes, coastal heathlands, mallee woodlands, salinas, and small off-shore islands. Innes National Park is an undulating plain with dunes, salt lakes and coastal cliffs. The cliffs include wave cut platforms, undermined faces and blowholes (DEH, 2003b). The New Zealand Fur Seal and Australian Sea lion have been recorded withinthe park. Bird species present along the coastline include the white-bellied sea-eagle (*Haliaeetus leucogaster*), osprey (*Pandion haliaetus*), hooded plover (*Thinornis rubricollis*), little penguin (*Eudyptula minor*), southern giant petrel (*Macronectes giganteus*), silver gull (*Larus novaehollandiae*), great cormorant (*Phalacrocorax carbo*), great skua (*Catharacta skua*), Australian Pelican (*Pelecanus conspicillatus*), Caspian tern (*Sterna bergii*), Crested tern (*Sterna nereis*), little tern (*Sterna albifrons*) and fairy tern (*Sterna nereis*) (DEH, 2003b). Innes National Park attracts large numbers of visitors and makes a significant contribution to the regional tourism economy. Recreation opportunities include fishing, surfing, diving, camping, walking and exploring historic sites. The park conserves extensive aboriginal cultural heritage sites and remnants of South Australia's maritime and mining past (DEH, 2003b)..

Figure 3-4: Parks of Kangaroo Island (Sealink Kangaroo Island, 2017)

Figure 3-5: Parks of Eyre Peninsula (DEWNR, 2017))



LABEL	RESNAME (TYPE)
1	Great Australian Bight Marine (NP)
2	Wahgunyah (CP)
4	Point Labatt (CP)
5	Barwell (CP)
6	Tucknott Scrub (CP)
7	Verran Tanks (CP)
8	Caralue Bluff (CP)
9	Malgra (CP)
11	Nuyts Reef (CP)
12	Searcy Bay (CP)
13	Greenly Island (CP)
14	Avoid Bay Islands (CP)
15	Lincoln (CP)
16	Sleaford Mere (CP)
17	Gawler Ranges (NP)
18	Pinkawillinie (CP)
19	Wittelbee (CP)
20	Neptune Islands (CP)
21	Gambier Islands (CP)
22	Moody Tank (CP)
23	Pinkawillinie Reservoir (CR)
24	Moongi (CR)
25	Buckleboo (CR)
26	Heggaton (CP)
27	The Plug Range (CP)
28	Middlecamp Hills (CP)
29	Chadinga (CP)
30	Nuyts Archipelago (WA)
31	Pigface Island (CP)
32	Venus Bay (CP)
33	Cap Island (CP)
34	Rocky Island (North) (CP)
35	Cocata (CP)
36	Nuyts Archipelago (CP)
37	Poolgarra (CR)
38	Lacroma (CR)
39	Cunyarie (CR)
40	Cortlinye (CR)
41	Mootra (CR)
42	Sinclair Island (CP)
43	Point Bell (CP)
44	Baird Bay Islands (CP)
45	Investigator Group (WA)
46	Kulliparu (CP)
47	Bascombe Well (CP)
48	Corrobinnie Hill (CP)

LABEL	RESNAME (TYPE)
49	Hambidge (WA)
51	Whyalla (CP)
52	Fowlers Bay (CP)
53	Yumbarra (CP)
54	Lincoln (NP)
55	Nicolas Baudin Island (CP)
56	Eba Island (CP)
57	Gawler Ranges (CP)
58	Murrunatta (CP)
59	Wanilla Land Settlement (CP)
60	Peachna (CP)
61	Tumby Island (CP)
62	Lipson Island (CP)
63	Sheoak Hill (CP)
64	Olive Island (CP)
65	Cape Blanche (CP)
66	Sceale Bay (CP)
67	Coffin Bay (NP)
68	Kathai (CP)
69	Laura Bay (CP)
70	Pureba (CP)
72	Carappee Hill (CP)
73	Yeldulknie (CP)
74	Munyaroo (CP)
75	Memory Cove (WA)
76	Waldegrave Islands (CP)
77	Whidbey Isles (CP)
78	Mount Dutton Bay (CP)
79	Shannon (CP)
80	Hincks (CP)
81	Hincks (WA)
82	Wharminda (CP)
83	Franklin Harbor (CP)
87	Boondina (CP)
88	Calpatanna Waterhole (CP)
89	Rocky Island (South) (CP)
90	Lake Newland (CP)
91	Kellidie Bay (CP)
92	Wanilla (CP)
93	Acraman Creek (CP)
94	Caratoola (RP)
95	Darke Range (CP)
96	Rudall (CP)
97	Tola (CR)
98	Sir Joseph Banks Group (CP)

3.2.4 World Heritage Properties

There are no listed world heritage properties within, or near, the EMBA. The closest World Heritage site to the survey area is the Australian Fossil Mammal Site at Naracoorte (SA) located approximately 475 km ESE of the survey area (DoE, 2016g). Survey activities will not affect this location.

3.2.5 National Heritage Places

There are no listed national heritage places within, or near, the EMBA. The closest site to the survey area is the South Australian Old and New Parliament Houses in Adelaide (SA) located approximately 275 km ENE of the survey area (DoE, 2016h). Survey activities will not affect this location.

3.2.6 Wetlands of International Importance

There are no wetlands of international importance (i.e., RAMSAR sites) within, or near, the EMBA. The closest site to the survey area is the Coorong and Lakes Alexandrina and Albert located approximately 302 km east of the survey area (DoE, 2016i). Survey activities will not affect this location.

3.3 Key Ecological Features (KEFs)

KEFs are elements of the Commonwealth marine environment that, based on current scientific understanding, are of regional importance for either the region’s biodiversity or ecosystem functioning and integrity.

The biological activity of the south-west marine region is low by global standards and compared with other Australian marine regions because of the low-nutrient tropical waters carried by the Leeuwin Current suppressing upwelling of nutrients from deeper cold waters; and the absence of rivers contributing nutrients to the marine environment. Small seasonal upwellings occur at known locations and, because of the overall nutrient-poor nature of the region’s waters these hotspots of productivity have a disproportionate influence on the region’s ecosystems (SEWPC, 2012b).

The Duntroon survey area is situated within the following KEFs as listed in the South-west Bioregional Plan and South-east Bioregional Plan (for Murray CMP):

- Ancient Coastline (90 to 120 m water depths);
- Kangaroo Island Pool, Canyons and adjacent shelf-break and Eyre Peninsula Upwelling;
- Meso-scale eddies;
- Benthic invertebrate communities of the eastern GAB;
- Small pelagic fish of the south-west region;
- Bonney Upwelling; and
- Shelf rocky reefs and hard substrates.

KEFs are discussed further in this section.

3.3.1 Ancient Coastline

The ancient coastline forms a prominent escarpment close to the middle of the continental shelf at a depth of 90-120 m. Where prominent escarpments occur, they create topographic complexity and may facilitate localised upwellings which accelerate water movements, benthic biodiversity and enhanced productivity (SEWPC, 2012b). Both benthic habitats and associated demersal communities are of conservation value (DoEE, 2017d). Parts of the ancient coastline may support some demersal fish species travelling across the continental slope to the upper continental slope providing ecological connectivity. In the western GAB the sea floor is dominated by sponge communities of significant biodiversity and structural complexity (SEWPC, 2012b).

The SW Bioregional Plan (SEWPC, 2012b) identifies pressures of concern or potential concern on the integrity of this KEF to include physical habitat modification (e.g. bottom trawling (fishing)), changes to sea temperature, changes to oceanography, ocean acidification and extraction of living resources (i.e. fishing).

3.3.2 Kangaroo Island Pool, canyons and adjacent shelf-break & Eyre Peninsula upwelling

3.3.2.1 KEF Characteristics

The Kangaroo Island canyons are a small group of steep-sided narrow canyons extending from the Ceduna Terrance to the Murray Canyons in the south-east of the marine region (SEWPC, 2012b). The canyons support a distinct Kangaroo Island-Eyre Peninsula marine 'upwelling' system originating to the south and south-east of Kangaroo Island resulting in the inflow of nutrient-rich cold water from a deep thermocline within the Flinders Current (~ 600m deep) onto the continental shelf during the summer months (November – April) (Seuront et al. 2010). McClatchie et al. (2006) identified via modelling where the shelf is narrow and bathymetry is steep, upwelling occurs within 10 km of the coast raising cooled water and nutrients to the surface, where phytoplankton concentrations then develop. Zooplankton patches lag the development of phytoplankton concentrations and generally occurs downstream (Baird, 2003; cited in McClatchie at al, 2006). Gill et al. (2011) identifies that this water may drift inshore or offshore from the shelf-break depending on the wind direction, explaining the depth range of foraging blue whales where 50% of all sightings were sighted west of Kangaroo Island in water depths > 200 m.

During winter (June to August), the Leeuwin Current and local winds act to drive eastward currents that average 20-30 cm/s (Middletone & Bye, 2007). The currents associated with the intense coastal-trapped wave field (6 to 12-day band) are of the order 25-30 cm/s and can peak at 80-90 cm/s (Middleton & Bye, 2007). Wintertime winds and cooling also lead to down-welling to depths of 200 m or more and the formation of dense coastal water withinthe GAB and South Australian sea (Middleton & Bye, 2007). The dense salty water formed within the Spencer Gulf is known to cascade as a gravity current to depths of 200 m off Kangaroo Island (Middleton & Bye, 2007).

During summer (December to February), the average coastal winds reverse and surface heating leads to the formation of warm water in the western GAB and South Australian sea (Middletone & Bye, 2007). No significant exchange of shelf water and gulf water appears to occur due to the presence of a dense, nutrient-rich (sub-surface) pool that is upwelled off Kangaroo island (Middleton & Bye, 2007). The winds lead to weak average coastal currents (< 10 cm/s) that flow to the north-west. In the eastern GAB, upwelling favourable winds and coastal trapped waves can lead to deep upwelling events off Kangaroo Island and the Bonny upwelling that can occur 2 to 4 times a year, each over a period of 3 to 10 days during 'upwelling favourable' south-easterly wind regimes (McClatchie et al. 2006; Seuront et al. 2010; Middleton & Bye, 2007). These upwellings can arise from the presence of high-pressure systems that sit in the South Australian Basin for 3-10 days with upwelling favourable wind stresses of the order of 0.1-0.2 Pa (Griffin et al, 1997; cited in Middleton & Bye, 2007). These stress values are 2-4 times larger than the summer average and act to lower sea level, generate coastal trapped waves and lead to upwelling (Middleton & Bye, 2007). The alongshore currents can be large (~40 cm/s) and upwelling-favourable winds can transport this water 215-430 km, as far as the Eyre Peninsula, over a 10-day period (Griffin et al. 1997; Hahn, 1986; cited in Middleton & Platov, 2003). The vertical scale of upwelling is of the order of 150 m (off Kangaroo Island) and 250 m (off the Bonney Coast) (Middleton & Bye, 2007).

Studies (Middleton & Bye,2007; McClatchie et al, 2006) identify these upwelling favourable events prevail between December and March, although coastal upwellings have been reported during November-April (Van Ruth, 2009). SARDI **(Stakeholder Record 18)** confirmed that the upwelling season occurs between December 15 and March 10 with upwellings unlikely in November (refer Stakeholder records). The seasonal wind rose (refer **Figure 3-10**) for the Duntroon OA supports the prevailing south-easterly wind regime during November to March with a heavy bias in the months December to March.

McClatchie et al. (2006) found strong evidence that up-welled shelf-break nutrient rich water is confined to the southwest of Kangaroo Island and does not occur further to the west (i.e., off the Eyre Peninsula). It is thought that the upwelled water is likely to remain in the Kangaroo Island “subsurface pool” until subsequent upwelling favourable winds draw the water into shallower coastal regions west of the Eyre Peninsula. McClatchie et al (2006) established this water remains nutrient rich, supported by conductivity-temperature-depth (CTD) sections collected in 2004, with the upwelled signal diminishing in width and intensity with increasing distance from Kangaroo Island. The coastal upwelling was shown to produce surface phytoplankton patches within one week of the upwelling event that may sink and form the observed sub-surface *chlorophyll-a* maxima (Kampf et al, 2004; cited in McClatchie et al, 2006).

Figure 3-6 provides seabed water temperature distributions which have been observed during summer upwellings. Note that only sea water temperatures between 13-16°C have been colour-coded and dark lines correspond to the 100m and 200m isobaths.

Figure 3-7 provides modelled summer water circulation currents at a depth of 35 m. During summer the shelf currents are generally to the north-west and largest where the shelf is narrow (i.e. Eyre Peninsula and Kangaroo Island) (McClatchie et al. 2006).

Middleton (2007; cited in Pattiaratchi, 2007) identified inter-annual variability in the upwelling events and stronger upwelling events appeared to be associated with El Nino conditions (2003, 1998).

Figure 3-8 provides the spatial overlap of the Duntroon OA with the Kangaroo Island Canyons, Pool and Eyre Peninsula Upwelling. The total spatial overlap of thie KEF with the Duntroon OA is 7412 km^2 which is approximately 19% of the KEF area (i.e. total KEF area is 38,580 km^2). It is to be noted that the main overlap with this KEF is in the EPP-41/42 MC3D inner racetrack (closest to shore) and in the southern area of the MC2D area over the canyon systems.

Figure 3-6: Bottom Water Temperature within the Kangaroo Island/Eyre Peninsula Upwelling Area (McClatchie et al. 2006; Kampf, 2010)

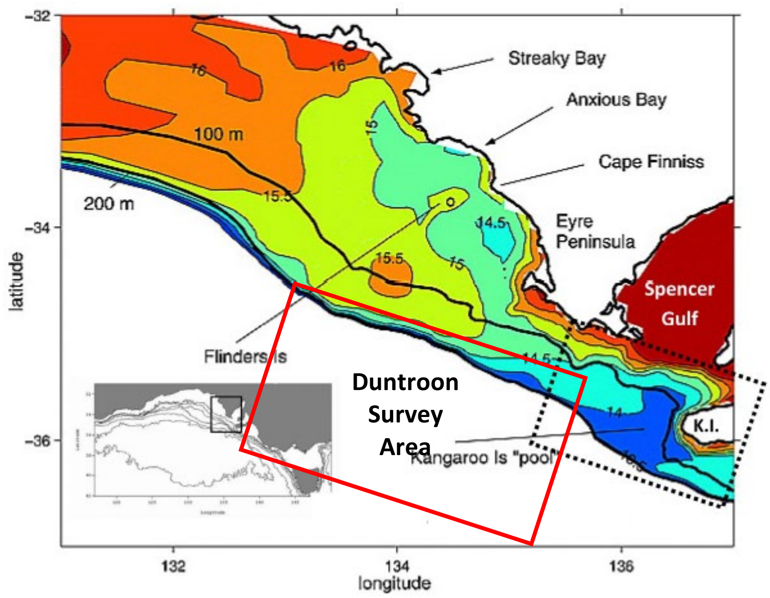
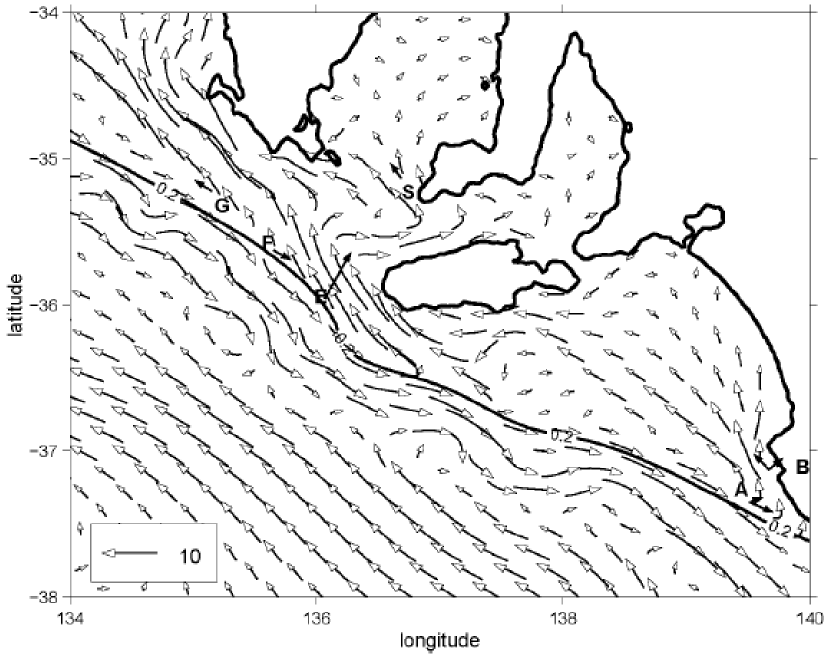
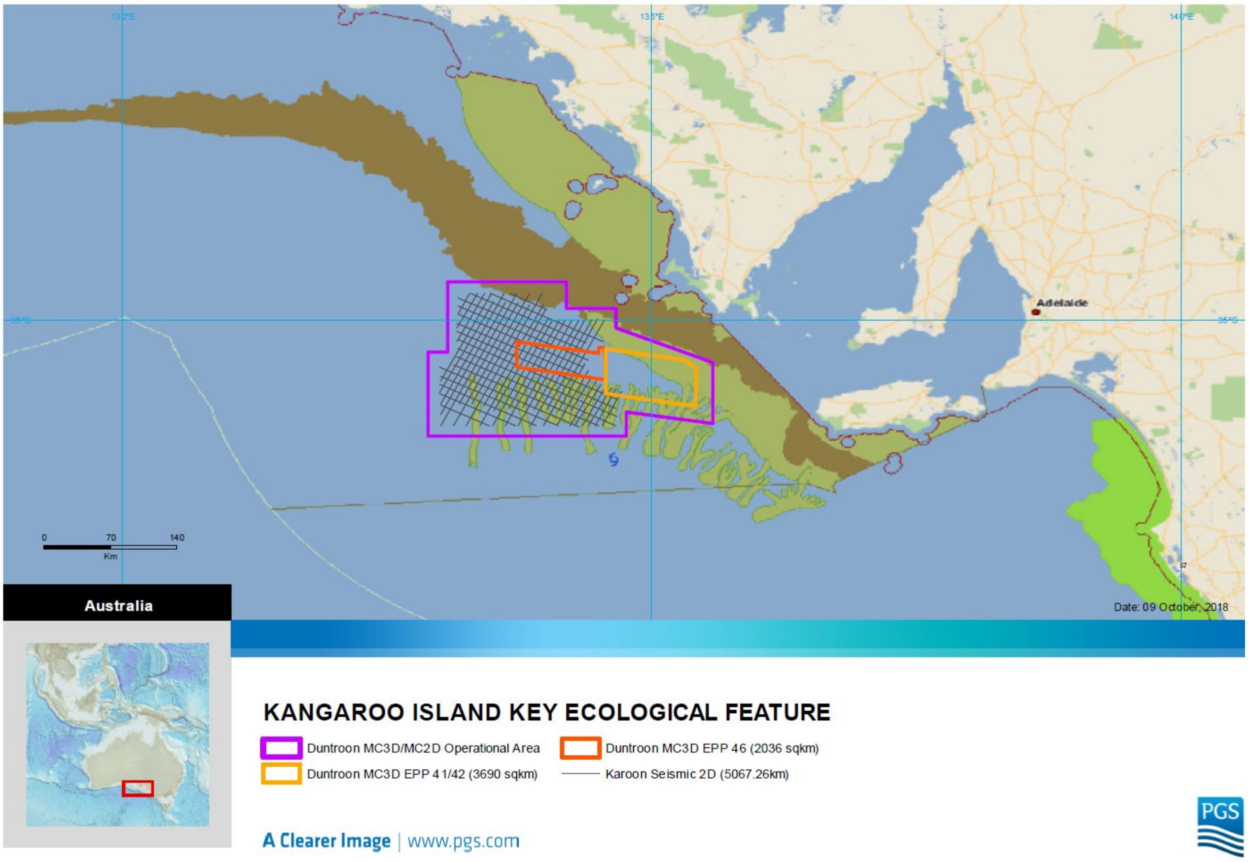


Figure 3-7: Detail of the surface flow (depth 35 m), as obtained in the numerical model of Middleton and Platov (2003; cited in McClatchie et al. 2006).



Note: A reference vector of 10 cm/s is indicated. The dark arrows represent summer averages from current meters at depths of 10 m or so and at the sites S, G, F, E and A indicated. The solid dark line is 200 m isobath.

Figure 3-8: Spatial overlap of the Duntroon OA with the Kangaroo Island Poll associated canyons and Eyre Peninsula upwelling KEF



The El Niño – Southern Oscillation (ENSO), identified as a potential driver of upwelling strength along the south Australian coast, is a major contributor to Australia's climate which influences Australia's marine waters (Holbrook et al. 2009). The two phases of ENSO, El Niño and La Niña, produce distinct and different changes to the climate. Middleton et al. (2007; cited in Pattiaratchi, 2007) examined meteorological and oceanographic data and concluded that upwelling was related to the ENSO cycle, with El Niño events since 1982 resulting in colder water on the shelf. The authors concluded that El Niño events lead to enhanced upwelling along Australia's southern shelves. Nieblas et al (2009) however, found that relationships between ENSO events and upwelling and production indices off southern Australia are weak due to the high inter-annual and inter-seasonal variability in these indices.

3.3.2.2 *Ecological Significance*

Coastal upwelling events in the eastern GAB during summer/autumn are characterised by low sea surface temperatures and elevated concentrations of zoo-plankton biomass (Ruth, 2009) (refer also to **Section 3.7.2** for plankton biomass distribution). During upwelling events, enriched coastal waters with nutrients promote high levels of primary productivity which are utilised by small pelagic fish and higher trophic levels including southern bluefin tuna, seabirds and marine mammals (Ruth, 2009). The shelf break, south of Kangaroo Island adjacent to the canyons is known for high yields of giant crab and southern rock lobster (SEWPC, 2012b).

This area supports Australia's largest finfish fishery consisting of species associated with areas of large-scale upwelling (i.e., sardines (*Sardinops sagax*) and anchovies (*Engraulis australis*)). Data collected between 1986 and 2001 showed peak spawning periods of these species on the South Australian shelf from January to March corresponding to peak upwelling periods. Sardine and anchovy eggs and larvae were abundant and widely distributed in the shelf waters in this period, with increased densities in areas of high zooplankton biomass (Dimmlich et al. 2004; cited in Pattiaratchi, 2007). Note also, sardines account for more than half of the prey species of the juvenile southern bluefin tuna (SBT) (*Thunnus maccoyii*). Refer to **Section 3.8.3** for further information on fisheries present in the area.

The blue whale (*Balaenoptera musculus*) is seasonally present within the KEF and feeds on krill during summer/autumn. Studies undertaken in 2003 identified a strong correlation of whale presence with satellite-derived '*chlorophyll a'* concentrations (Morrice et al. 2004; cited in Pattiaratchi, 2007). Whales were present in waters with *chlorophyll a* concentration ranging from 0.3 to 0.4 mg/m^3 and located along a tongue of higher surface *chlorophyll a* concentration which followed the 200 m contour towards the north-west (Morrice et al, 2004; cited in Pattiaratchi, 2007). Refer to **Section 3.7.5** for further information on seasonal cetacean presence in the area.

The SW Bioregional Plan (SEWPC, 2012b) identifies pressures of concern or potential concern on the integrity of this KEF as oil pollution[8] with the potential for severe oil spills to affect aggregations of species at upwellings; extraction of living resources and by-catch; changes in sea temperature, changes in oceanography and ocean acidification as a result of climate changes; and noise pollution[9] to marine mega-fauna (blue whale, southern right whale, humpback whale, sperm whale, sea lion, turtle species).

3.3.3 *Meso-scale Eddies*

The most significant known influence on ecosystem structure and function in the South-west Marine Region is the Leeuwin Current. Associated with this current are eddies which form at predictable locations (i.e., Eyre Peninsula) in the region. Eddies can be either upwelling or down-welling. Upwelling eddies enhance local biological productivity and down-welling eddies concentrate and transport communities away from the coast (SEWPC, 2012b). They are important transporters of nutrients and meso-zooplankton communities and become hot spots for a complex range of higher trophic levels, such as marine mammals, seabirds, tuna and billfish. These eddies play a critical role in determining species distribution, are consistently associated with high phytoplankton biomass, transport coastal phytoplankton communities offshore and recruitment to fisheries through the movement of larval fish offshore (SEWPC, 2012b).

Eddy systems may have a profound effect on pelagic production in the region, driving offshore production by transporting nutrients and pelagic communities offshore and generating upwellings of nutrient-rich deeper water, however these processes have not been studied in detail.

The SW Bioregional Plan (SEWPC, 2012b) identifies pressures of concern or potential concern on the integrity of the KEF as changes in sea temperature, change in oceanography and ocean acidification due to climate change.

3.3.4 *Benthic invertebrate community of the eastern GAB*

The GAB has been recognised for its global significance for cool-water carbonate habitats with the soft-sediment benthic invertebrate communities of the eastern GAB shelf forming some of the world's most diverse soft-sediment ecosystems. A 2002 benthic survey sampled 798 species, including 360 species of sponge, 138 ascidians and 93 bryozoans, many of which were new to science (Ward et al. 2006; cited in DOEE, 2017f). Invertebrate skeletons and shells make up more than 80 % of the shelf sediments. The high levels of biodiversity have been attributed to the unusual width of the continental shelf, the high degree of geographic isolation from similar habitats, and the opportunities for incursions by tropical species in the Leeuwin Current.

[8] The Duntroon MSS does not introduce a 'new source' which has the potential for 'severe oil spills'. Vessels utilised for the survey generally represent a lower spill risk than containerships and oil tankers which routinely utilise SA ports in the gulf areas and transit the area.
[9] The SW Bioregional Plan recommends for referrals involving impacts on cetaceans from seismic survey sound that the action is undertaken in accordance with the *EPBC Policy Statement 2.1: Interaction between Offshore Seismic Exploration and Whales*

Benthic invertebrate communities of the eastern GAB shelf are highly diverse. Seabed sediments are dominated by heterozoan carbonate fragments comprising bryozoans, molluscs, porifera, rhodoliths and other invertebrates (Richardson et al. 2005; cited in DoEE, 2017f). Unimpeded south-westerly waves and swells create a high-energy environment where seabed wave abrasion occurs to depths of 60 m. In deeper environments, sediments are moved intermittently during winter storms, transporting fine-grained sediments off-shelf. This is the major physical process down to approximately 120 m (James et al. 2001).

Epifaunal assemblages are dominated by filter feeders (primarily porifera, but also ascidians and bryozoans), which provide habitat and resources for a diverse community of crustaceans and molluscs (Ward et al. 2006; cited in DOEE, 2017f). The relative abundance of these filter-feeding communities is largely determined by the availability of deep-water nutrients, controlled by processes of upwelling and downwelling across the shelf (James et al. 2001; cited in DoEE, 2017f). There is a significant positive relationship between species richness and biomass, both declining with increasing depth and increasing percentage of fines (mud) in sediment (Ward et al. 2006; cited in DoEE, 2017f). The spatial boundary of the KEF has not yet been defined.

The benthic invertebrate community of the eastern GAB also includes the Great Australian Bight Marine Park, which has a Benthic Protection Zone. This zone experiences a year-round down-welling and arrested carbonate production (James et al. 2001; cited in DoEE, 2017f). Studies have identified that the Benthic Protection Zone of the park effectively represents the regional biodiversity, epi- and infaunal assemblages of the eastern GAB (DoEE, 2017f).

The SW Bioregional Plan (SEWPC, 2012b) identifies pressures of concern or potential concern on the integrity of the KEF as changes in sea temperature, change in oceanography and ocean acidification due to climate change and physical habitat modification.

3.3.5 *Small pelagic fish of the south-west region*

Small pelagic fish are considered important for ecological functioning and integrity, providing critical links between primary production and higher predators (Freon et al. 2005; cited in DoEE, 2017g). Small pelagic fish collectively form the link between upwelled nutrient-rich water within the euphotic zone that supports the herbivorous, planktonic food web and a diverse range of predatory species. This includes large pelagic predatory fish (SBT, samson fish and kingfish), marine mammals (pygmy blue whales, southern right whales, dolphins, New Zealand fur seals and Australian sea lions), cephalopods and seabirds (short-tailed shearwaters, crested terns, petrels and little penguins) (Hayes et al. 2008’ cited in DoEE, 2017g). Fluctuations in abundance of small pelagic fish have serious implications for the functioning of pelagic ecosystems. Some predatory species (such as SBT, pygmy blue whale, southern right whale, short-tailed shearwater and petrel) migrate annually during the upwelling season to take advantage of the increased prey opportunities, while others (e.g. New Zealand fur seal and crested tern) establish colonies next to these regions. The spatial boundary of the KEF has not yet been defined.

'Small pelagic fish' refers to shoaling, epipelagic fish that are supported by summer upwelling events in the Bonney and Eyre pelagic ecosystems. Fluctuations in abundance of small pelagic fish have serious implications for the functioning of pelagic ecosystems. In the South-west Marine Region, the small pelagic fish include 10 species: sardine, scaly mackerel, Australian anchovy, round herring, sandy sprat, blue sprat, jack mackerel, blue or slimy mackerel, red bait and saury. This group of fish also supports Australia’s largest fishery (by weight), the South Australian Sardine Fishery. This fishery suffered mass mortality events in 1995 and 1998, when more than 70% of the adult stock was thought to have perished. The distribution and abundance of anchovy expanded during these events, but this has since decreased as stocks of sardine recovered (Ward et al. 2008; cited in DoEE, 2017g).

The SW Bioregional Plan (SEWPC, 2012b) identifies pressures of concern or potential concern on the integrity of the KEF as changes in sea temperature, change in oceanography and ocean acidification due to climate change.

3.3.6 Bonney Upwelling[10]

The Bonney Coast Upwelling is a predictable, seasonal upwelling bringing cold nutrient rich water to the sea surface and supporting regionally high productivity and high species biodiversity in an area where such sites are relatively rare and mostly smaller scale (DoE, 2015a). Surface upwelling of cold, nutrient rich water typically occurs in the summer and autumn along the narrow continental shelf between Robe, SA, and Portland, Victoria. Surface expression of the upwelling is only intermittent further to the southeast where the shelf is wider. This upwelling generally starts in the eastern part of the GAB in November/December and spreads eastwards to the Otway Basin around February (Gill *et al.*, 2011) as the latitudinal high-pressure belt migrates southward.

The area is significant as one of the largest and most predictable upwellings in south-eastern Australia. This is not the only upwelling in southeast Australia driven by the prevailing south-easterly winds, but it is the most prominent. In addition to whales, many endangered and listed species frequent the area, possibly also relying on the abundance of krill that provide a food source to many seabirds and fish. The high productivity of the Bonney Upwelling is also capitalised on by other higher predator species such as little penguins and Australian fur seals feeding on baitfish (Commonwealth of Australia, 2015).

While the general characteristics of the Bonney Coast upwelling are broadly understood, virtually nothing is known of the longer-term variability of the KEF. Alongshore wind is the predominant mechanism in the upwelling, which is, therefore, directly impacted by any changes to the strength or frequency of these winds. However, it should be noted, as Butler et al. (2002) identified, that not all favourable upwelling winds lead to an upwelling event.

This KEF is located 300 km east of the Duntroon EMBA and does not overlap with the oil spill EMBA or acoustic footprint of the Duntroon survey activities. This KEF will not be considered further in this EP.

3.3.7 Shelf Rocky Reefs and Hard Substrates

Shelf rocky reefs and hard substrates are in all continental shelf areas of the South-east Marine Region, from the sub-tidal shore zone to the continental shelf break. This shelf break generally occurs in 50 m to 150–220 m water depth with the shallowest depth at which the rocky reefs occur in Commonwealth waters at approximately 50 m. This KEF is an area of high productivity with aggregations of marine life and has not been spatially defined.

On the continental shelf, shelf rocky reefs and hard substrates provide attachment sites for macro-algae and sessile invertebrates, increasing the structural diversity of shelf ecosystem. The reefs provide habitat and shelter for fish and are important for aggregations of biodiversity and enhanced productivity (DoE, 2015b). Indicators for monitoring the marine ecosystem health of this KEF include coral, demersal fish, filter feeders and invertebrates (Dambacher et al. 2012).

This KEF may lie within the Duntroon EMBA, however does not lie within the Duntroon OA.

3.4 Threatened Ecological Communities

Threatened Ecological Communities (TECs) provide wildlife corridors and/or habitat refuges for many plant and animal species. The terrestrial Subtropical and temperate coastal saltmarsh TEC, listed as vulnerable is listed as likely to occur in the area.

This TEC occurs on the coastal margin, along estuaries, coastal embayments and on low wave energy coasts. It is typically found on sandy or muddy substrate and may include coastal clay pans or similar areas. It occurs in places with at least some tidal connection, including rarely-inundated supratidal areas (mean high

[10] This has been included for completeness based upon the EPBC Protected Matters Database Search for the EMBA.

water for spring tides), intermittently opened or closed lagoons, and areas with groundwater tidal influences. The ecological community may also include areas that have groundwater connectivity to tidal water bodies.

The ecological community consists of dense to patchy areas of mainly salt-tolerant vegetation (halophytes) including: grasses, herbs, sedges and shrubs that may also include bare sediment as part of the mosaic). It is inhabited by a wide range of in-faunal and epi-faunal invertebrates such as prawns fish and birds. It often constitutes an important nursery habitat for fish and prawn species and insects are abundant.

The conservation advice for this TEC has been assessed for the Duntroon MSS and the following threats are identified as being applicable (TSSC, 2013):

- Pollution/Litter: Pollution and litter from stormwater or dumping of waste can smother coastal saltmarsh plants and introduce contaminants such as heavy metals or organic chemicals. Oil spills are also a major potential threat.

The action items relevant to the Duntroon MSS within the Conservation Advice is to *Identify Coastal Saltmarsh as important habitat in all oil spill contingency planning at National and State levels and monitor the application of protocols on the management of spills involving saltmarshes.*

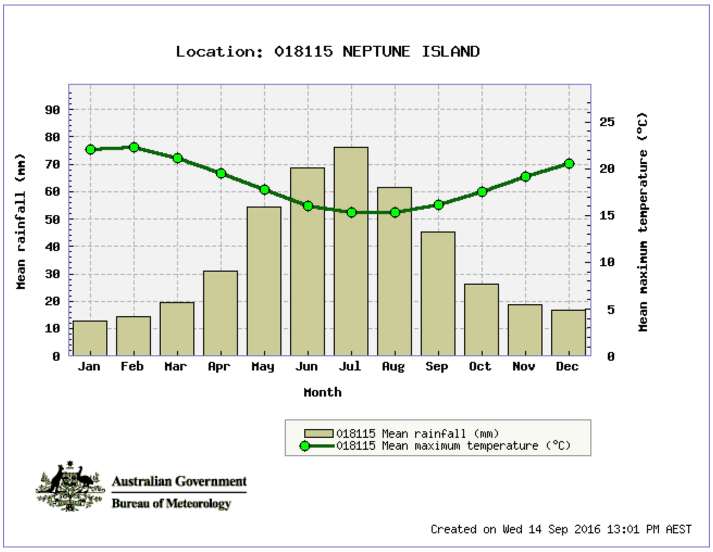
3.5 Physical Environment

3.5.1 Climate

The climate of the region is temperate with moderate to high rainfall mostly in winter. During summer large high-pressure systems typically dominate and drive an anti-cyclonic wind stress field punctuated by occasional cold fronts that leads to westerly winds and localised cooling. During winter, the high-pressure systems migrate to the north allowing for a greater number of cold fronts near the coast and associated eastward winds (Rogers et al. 2013).

The area has a mean maximum temperature of 22.3°C (February) and a mean minimum temperature of 11.1°C (August) (BOM, 2016a). The annual average rainfall is 445mm with the predominant rainfall falling between May and September (refer Figure 3-9) (BOM, 2016a).

Figure 3-9: Mean Rainfall and Mean Maximum Temperature for Neptune Island (BOM, 2016a)



Wind roses for September and October show winds predominate from the west. During November, south-easterly winds are possible (APASA, 2012). The wind rose for the Duntroon OA is provided in **Figure 3-10.**

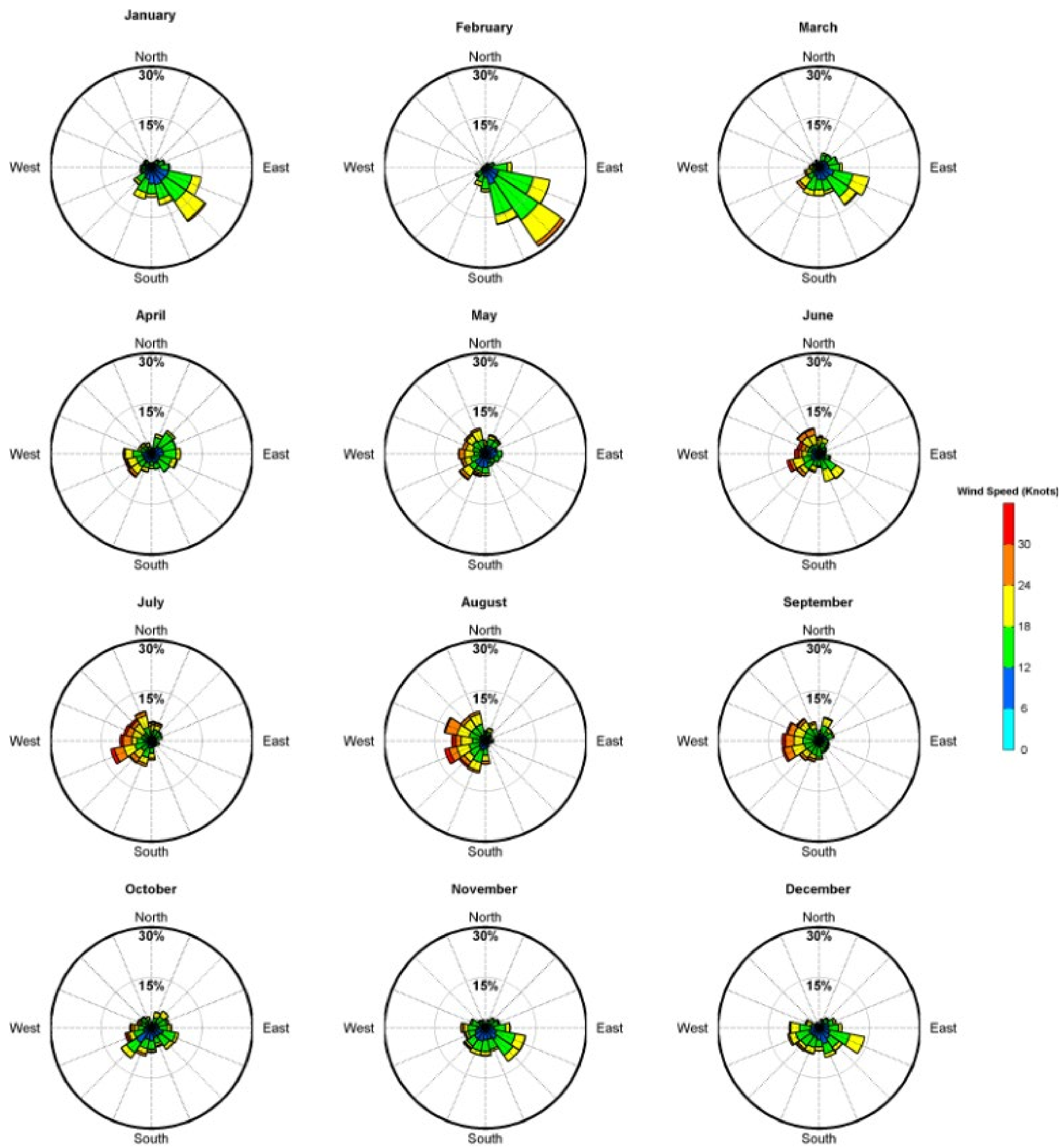
3.5.2 Oceanography

Currents in the survey area are dominated by the Leeuwin current influencing the biological productivity and biodiversity of ecosystems in the area (refer Figure 3-11). The Leeuwin current is a shallow (<300 m), narrow (<100 km wide) current transporting warm, nutrient-depleted water from the tropics along the southern coast of Western Australia, east to Tasmania. This current has marked seasonal variation with the strongest flows occurring in winter. During winter, the Leeuwin Current and local winds act to drive eastward-flowing shelf currents with an average speed of 20-30 cm/s which are about twice that at the shelf edge (Rogers et al. 2013). During summer the Leeuwin current significantly weakens and winds generate west-bound coastal currents along the inner shelf. Beneath the Leeuwin current is the cooler westward flowing Flinders current which extends from the surface to a depth of 1000 m with peak currents of 20 cm/s at about 600 m depth. The Flinders current is stronger in summer (Pattiaratchi, 2007) with its strength affected by wind and water body density on the shelf (DEWHA, 2007). The Flinders current facilitates irregular coastal upwellings during summer and autumn (Ward et al. 2008) onto the shelf when south-easterly winds, favourable for upwelling events can dominate, however the timing of upwelling events is variable (Ward et al. 2008).

The survey area lies adjacent to the 'Kangaroo Island Pool'. This 'pool' of cold, nutrient rich water upwells along the shelf south of Kangaroo Island between December and April (DEWHA, 2007) and moves north-west along the south and west of the Eyre Peninsula along the 100m isobath (DEWHA, 2007). Downwellings from the inner to outer-shelf and shelf-break occur during winter. Shallow gulf waters are cooler than the continental shelf waters in winter (~12ºC) and warmer in summer (~24ºC). In autumn when these waters cool, high salinity water at the head of the Spencer Gulf becomes dense enough to form a current known as 'Bonaparte's tongue'. This dense, salty water is around 20 km wide and 20 m thick flows out across the Lincoln shelf and falls over the edge of the shelf to approximately 250 m water depth. This occurs in regular pulses over a period of approximately three (3) months (DEWHA, 2007).

Seasonal surface current roses for the Duntroon survey area are provided in **Figure 3-12**.

Figure 3-10: Wind Roses for the Duntroon OA (APASA, 2012)

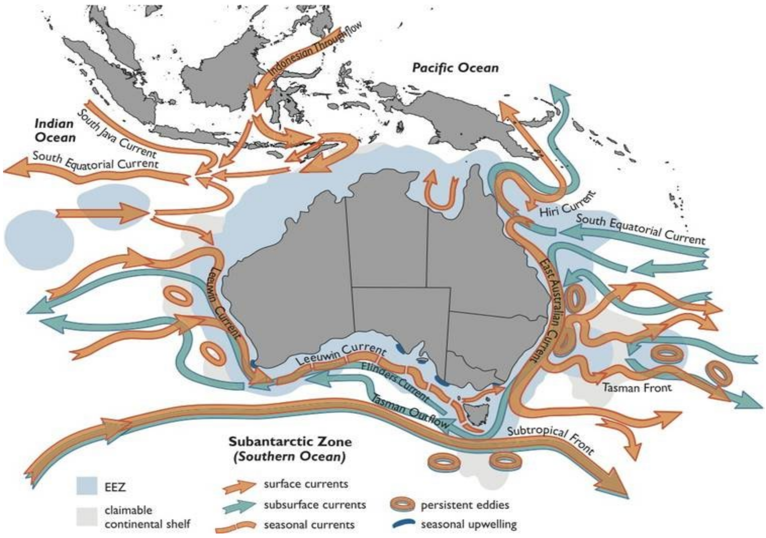


The region has a moderate to high energy coastline with the tidal range in the order of 0.8-1.2 m (IMCRA, 1998). Swells predominate from the southwest and the eastern GAB coastline is subjected to moderate to high wave energies with strong south-west to westerly swells. Locations such as Cape du Couedic and Cape Borda on Kangaroo Island experience swells of 2 – 4 m for at least half the year. Swell waves are generally 2-2.5 m high and can reach 12-14 m on the outer shelf (Richardson et al. 2005). Observations made by Wood and Terray (2005; cited in Rogers et al 2013) for the April – September (2004) period just south of Portland (water depth 1395m) approximately 600 km southeast of the survey area found the waves to have a significant wave height of 3.7 m, period of 13 seconds and were directed from the south-west. Wave heights exceeded 8 m, 1.3% of the time and 5m, 17% of the time.

The wave climate is mildest in February and most extreme in September (Rogers et al. 2013).

Shelf waters are well mixed in winter due to a strong Leeuwin current and swell/storm waves; and stratified (up to 7°C) in summer from cooler Southern Ocean water intruding onto the shelf (Richardson et al. 2005). Sea surface temperatures are generally higher offshore than inshore during both winter and summer-autumn. Offshore waters are warmer during summer-autumn (19-23°C) than during winter (~17°C) (Ward et al. 2008).

Figure 3-11: Ocean current surrounding Australia



3.5.3 Geomorphology, geology, bathymetry & seabed sedimentation

3.5.3.1 Geomorphology & bathymetry

The survey area is in depths of approximately 100-3500m over two distinct features:

- The Australian continental shelf; and
- The continental slope incorporating a portion of the Murray Group of Canyons (specifically the Topgallant, Lincoln and Whidbey Canyons).

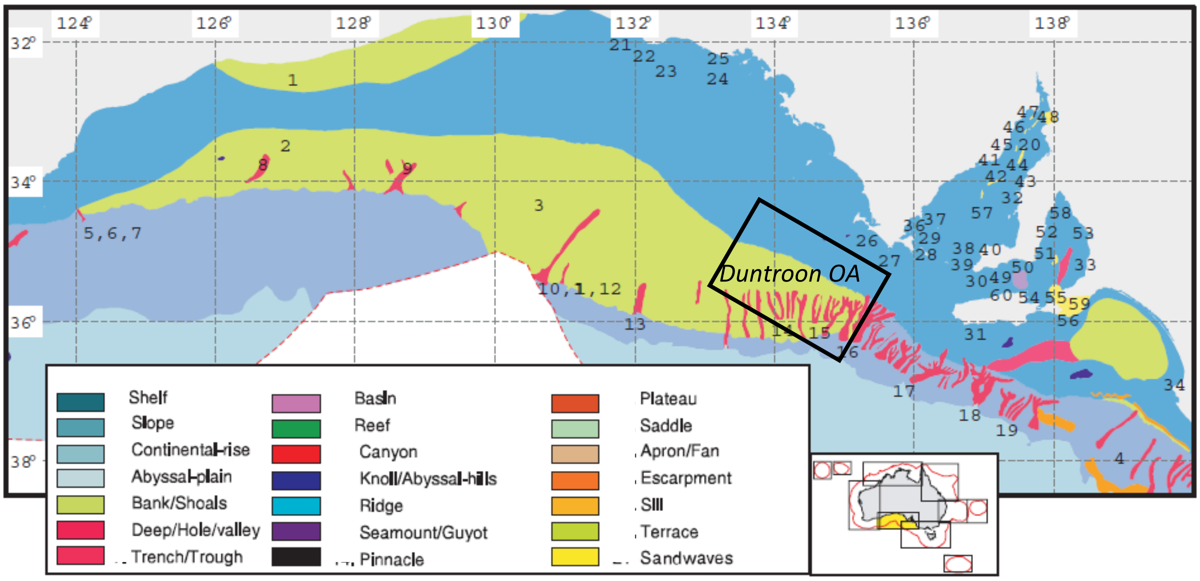
In the eastern GAB, the gently sloping continental shelf narrows from a width of approximately 100 km to 30 km adjacent to Kangaroo Island (Harris et al. 2005). The continental shelf extends approximately 85 km offshore from the Eyre Peninsula with the continental slope commencing at the 200 m isobath.

The continental slope consists of two marginal terraces; the Ceduna Terrance in the east and Eyre Terrance in the west (Connolly et al. 1970, Willcox et al. 1988; cited in Rogers et al. 2013). The Ceduna Terrace is located between 130 and 134°E in the eastern GAB. The continental slope along this area contains numerous submarine canyons which are generally oriented perpendicular to the shelf-break (Harris et al. 2005). The eastern part of the Ceduna Terrace is incised with at least six canyons. The Ceduna canyon is located at 133°E and consists of a small V-shaped canyon with flat floor, lying opposite the boundary between the Eucla Basin and basement rocks (Harris et al. 2005). The Murray Canyon Group is located between longitudes 135-138°E (refer Figure 3-13) where the continental slope is narrow (i.e. east of the survey area). The topography of the canyons is extremely rough and is characterised by small steep furrows and several large deep canyons. The Murray and Sprigg Canyons located approximately 200 km SE of the survey area, are particularly large features each with a vertical relief more than 2000 m. The heads of the canyons in this group contain both amphitheatre and dendritic shapes (Harris et al. 2005). The canyons average around 35 km in length and are approximately 5 km wide (Potter et al. 2006).

These canyons provide pathways for transporting sediment, nutrients and biota off the continental shelf and slope onto the abyssal plain and conduits for upwelling and down-welling which influence nutrient availability, water temperature and form a link between habitats of different water depths (Richardson et al. 2005).

Figure 3-12: Current Roses for Duntroon OA (APASA, 2012)

Figure 3-13: Geomorphic Features of the Southern Margin (Harris et al. 2005)



Key: 13- Ceduna Canyon, 14 – Fowlers Canyon, 15 – Topgallant Canyon, 16 - Lincoln Canyon, 17 - De Couedic Canyon, 18 – Murray Canyon, 19 – Sprigg Canyon

3.5.3.2 Seabed sedimentation & geology

Geology

The continental shelf is underlain by deep continental margin basins (Bradshaw et al., 2003; cited in Harris et al. 2003) filled with Mesozoic terrigenous sediment and capped by approximately 800 m thick, largely cool water, Cenozoic, carbonate sediments (James et al., 2001; cited in Harris et al. 2003). Calcarenite, a soft limestone, makes up most of the western and southern continental shelves of Australia (Duncan et al. 2013). Calcarenite seabeds assume a layered structure and wave action and/or currents erode the seabed until a relatively hard layer is reached. Accordingly, these types of seabed have a harder rock cap overlying softer materials (Duncan et al. 2013).

Sedimentation

Swell and storm waves from the Southern Ocean influences seafloor sedimentation to depths of ~120 m. Most erosion occurs on the middle shelf with ripples present at ~80 m and little sedimentation occurring at shallower depths. In water depths 70-120 m (outer shelf), exposed limestone substrate is inter-dispersed with patches of mobile sediment which is reworked by swell and storm waves during winter allowing some sedimentation to occur during summer (Richardson et al. 2005).

Continental Shelf: Given the lack of rivers depositing sediment into the GAB, the GAB shelf bed-forms are largely biogenic and form one of the world's largest expanses of temperate carbonate sediments (Connolly and Von der Borch 1967, Wass et al. 1969: cited in Rogers et al, 2013). Shelf sediments are principally composed of fragments of bryozoan, mollusc, foraminifera and coralline algae with minor amounts of sponge, crustacean and echinoderm (Connolly and Von der Borch 1967, Wass et al. 1969, Gostin et al. 1988; cited in Rogers et al. 2013) and minor amounts of quartz sand in the inshore areas (Ward et al. 2006). Around western Kangaroo Island, strong ocean swells mobilise the sand and provides constantly unstable benthic conditions (Kangaroo Island Council, 2012). There are expanses of mobile bare sand, overlying bare platform reefs from approximately 10 m to 30 m deep with deeper fossil dune-rock reefs to 100 m+ (Kangaroo Island Council, 2012).

The middle shelf is an area of erosion and winnowing, while the outer shelf is a region of sedimentary deposition and variable sediment production (James et al. 2001; cited in Rogers et al. 2013). Sediments are therefore generally course-grained/gravel inshore and become progressively finer and muddier with increasing depth and distance offshore (Connolly and Von der Borch 1967; cited in Rogers et al. 2013). In the eastern GAB off the western Eyre Peninsula, summer upwellings promote bryozoan growth and sediment production across shelf areas (Rogers et al. 2013).

The sediment composition present on the continental shelf in the survey area is provided in Table 3-4.

Table 3-4: Sediment composition (Passlow et al. 2005)

Parameter	Continental Shelf
Sand	40-60wt%
Gravel	40-60wt%
Mud	0%
Mean Grain Size	0.5-1mm
Carbonate Content	80-100%

Continental Slope: Surveys identify a transition from sand-dominated to mud-dominated sediments as water depth increases from the outer shelf to the slope, rise and abyssal plain (Potter et al. 2006). The sediments of the continental slope are characterised by muddy foraminiferal, spicule and pteropod oozes and may contain large quantities of skeletal organic remains derived from the shelf (Rogers et al. 2013).

Continental Rise: The continental rise extends from approximately 3000 m to 5000 m and flanks the foot of the slope towards the abyssal plain. The seabed here is soft and the surficial sediments characterised by foraminiferal and coccolith oozes (Connolly and Von der Borch 1967, Harris et al. 2000; cited in Rogers et al. 2013).

3.5.4 Background sound levels

McCauley and Duncan (2001) concluded from a desk-top review into ambient marine sound sources likely to be encountered in the Otway Basin[11] that natural sea sound sources were dominated by wind noise, but also include rain noise, biological noise and the sporadic noise of earthquakes; and man-made underwater sound sources comprised of shipping and small vessel traffic, petroleum-production and exploration-drilling activities and sporadic petroleum seismic surveys.

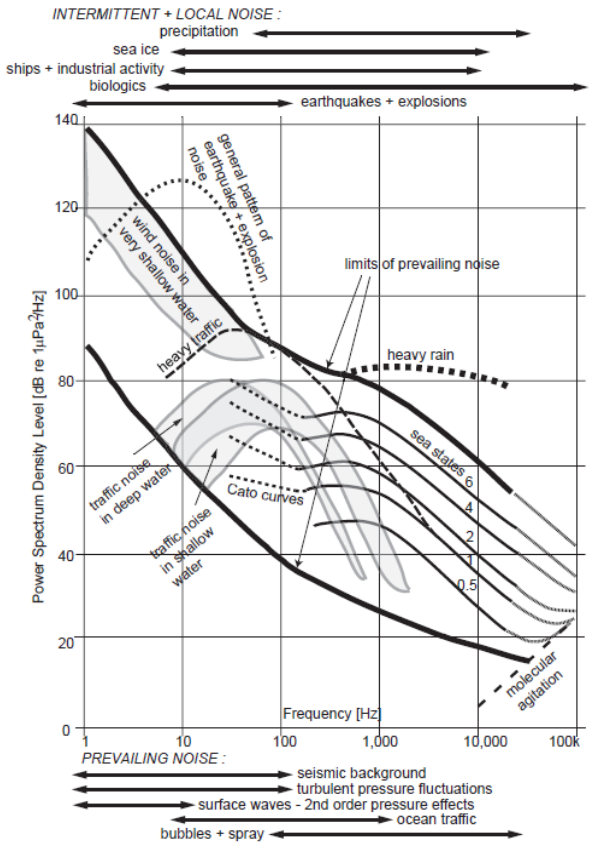
3.5.4.1 Natural sound levels

Physical and biological processes contribute to natural background sound. Physical processes include wind and waves whilst biological sources include marine species vocalisation (WDCS, 2004). Iceberg calving, shoaling and disintegration has recently been identified as a dominant source of low frequency (<100 Hz) noise in the Southern Ocean. Wind is also a major contributor to noise between 100 Hz- 30 kHz (WDCS, 2004) and can reach 85-95 dB re 1µPa^2/Hz under extreme conditions. Rain may produce short periods of high underwater sound with a flat frequency spectra to levels of 80 dB re 1µPa^2/Hz and magnitude 4 earthquakes have been reported to have spectral levels reaching 119 dB re 1µPa^2/Hz at frequency ranges 5-15 Hz. It is noted that earthquakes of this magnitude are relatively frequent along Australia's continental shelf in the southern margin (i.e. tens of small earthquakes per year) (McCauley & Duncan, 2001).

These sources contribute to background sound levels in the marine environment of 100-140 dB re 1µPa in frequencies from less than 10 Hz to 20 kHz (Wenz, 1962). Figure 3-14 provides generalised ambient noise spectra attributable to varies sources (Wenz, 1962).

[11] While this study focussed on the Victorian Otway coastline 750 km to the south-east of the Duntroon survey location given the similarity of the receiving environment (rocky coastlines interspersed with sand beaches), similar met-ocean conditions, continental shelf characteristics (bathymetry, depth and seafloor type), water characteristics (temperature and salinity) and coastal activities (predominantly coastal shipping) comparison is considered relevant.

Figure 3-14: Generalised ambient noise spectra (Wenz, 1962)



Iceberg Calving

Recent work using ocean sound recordings stations has shown that sound from iceberg calving, shoaling and disintegration in Antarctic waters is a major contributor to the overall sound budget of the Southern Ocean. Annually tens of thousands of icebergs drift out from Antarctica into the open waters of the Southern Ocean, creating a ubiquitous natural source of low frequency sound as they calve, shoal and disintegrate (Matsumoto et al. 2014).

For example, Dziak et al. (2013) measured the sounds from the iceberg A53a (area ~ 55 × 25 km) as it drifted out of the Weddell Sea and through Bransfield Strait during April–June 2007. Sound levels during disintegration of this iceberg were estimated to average a Sound Pressure Level (SPL) ~ 220 dB re 1 µPa @ 1 m yielding a total Sound Energy Level (SEL) of 252 dB re 1µPa^2.s over an ~ 20 minute duration. Dziak et al. (2013) identified that the energy flux density released, just a fraction of the total acoustic energy released during the life of this iceberg, was equivalent to the sound energy of a ~214 supertanker operating over the same 20-minute interval. Dziak et al. (2013) noted that the transient acoustic signals generated by icebergs last typically from a few tens of seconds to up to 20 min with spectral contents exceeding 400 Hz.

Chapp et al. (2005) acoustically located iceberg B15d (area ~215 km^2) within the Indian Ocean in 2005 and estimated a maximum source SPL of 245 dB re 1 µPa @ 1 m for its tremor signals, generated when the icebergs shoal or collide with other icebergs. Moreover, this study recorded tremor strengths from 119 to 133 dB re 1µPa (PK-PK) at an approximate distance of 6600 km from the source (Diego Garcia) and 126 to 142 dB re 1µPa (PK-PK) at an approximate distance of 3500 km from the source (100 km southwest of Cape Leeuwin (WA).

Matsumoto et al. (2014) tracked the sound propagation of two large icebergs, B15a and C19a, which calved off the Ross Ice Shelf in the early 2000s and drifted eastward to the warmer South Pacific Ocean in late 2007. From 2008 to early 2009, the disintegration of B15a and C19a continuously projected loud, low-frequency sounds into the water column which propagated efficiently to lower latitudes, influencing the soundscape of the entire South Pacific basin. The icebergs' sounds were recorded at Juan Fernández Islands

(34°S, 79°W) and by a deep-water hydrophone in the northern hemisphere (8°N, 110°W) approximately 10,000 km from the icebergs.

More broadly Matsumoto et al. (2014) concluded that seasonal variations in ocean noise, which are characterized by austral summer-highs and winter-lows, appear to be modulated by the annual cycle of Antarctic iceberg drift and subsequent disintegration. This seasonal pattern is observed in all three oceans of the Southern Hemisphere. The study identified that icebergs were a dominant noise source in the southern hemisphere.

Spectrogram plotting shows that icebergs' sounds dominate the frequency range below 100 Hz (Matsumoto et al. 2014). Notably this frequency range encompasses the dominant frequencies at which baleen whales vocalize.

Biological sound levels

Biological noise arises in all oceans from a variety of sources. Marine mammals are major contributors, but certain fish and shrimp can also be significant. Frequencies of biological noises extend from ~12 Hz (some blue whale calls) to over 100 kHz. Depending on the situation, biological noise can range from near-absence to dominant over narrow or event broad frequency ranges. When biological noise is dominant in any frequency band, like other ambient noise, can interfere with detection of other sounds at those frequencies. Turnpenny and Nedwell (1994) found that in some species continuous ambient sound alone resulted in auditory masking, and that sound had to be 20 dB above ambient sound to be audible.

Richardson et al. (1995) has summarised published sound characteristics for marine mammals. Table 3-5 provides information for key species which may be present in the survey area during the Duntroon survey.

McCauley (2011) studied noise levels (marine and man-made) at Scott Reef for the Browse Floating Liquefied Natural Gas (FLNG) project. An example of the pygmy blue whale spectral signals recorded close to a data logger is provided in Figure 3-15. The whale's song is comprised of three complex long tonal components which have most energy over 15 – 26 Hz with harmonics and a secondary source with energy up to 75 Hz (i.e., 10-120 seconds on Figure 3-15). Normally the three-component song has a repeat interval of 170-200 seconds.

The gross signal structure was identical to signals recorded in the Perth Canyon and attributed to pygmy blue whales (McCauley, 2011).

Ambient sound studies

Significant levels of marine sound can be generated at shoreline locations given the presence of breaking waves. Wave noise in the surf zone is dependent on the size and character of the breaking wave (i.e. variable bottom and wave structure). The wave structure itself is a function of wind speed, swell and wave-wave interaction. Wilson et al. (1985; cited in Parsons & Duncan, 2009) showed that surf breaking onto beaches, parallel to the direction of wave front, can generate sound that propagates many kilometres seaward.

Studies have been undertaken to understand the magnitude waves contribute to ambient sound levels in the marine and near-shore environments. The following studies are relevant:

- Wilson et al. (1985; cited in Parsons & Duncan, 2009) measured SPLs produced during periods of 'heavy surf' in Monterey Bay California at various distances from the surf zone, running onto a gently sloping beach. The frequency distribution of ambient noise levels at varying ranges from the surf zone is provided in Figure 3-16. Water depths at each station were 48 m (Station 6); 64 m (Station 5) and 90 m (Station 7).

Table 3-5: Characteristics of underwater biological sounds

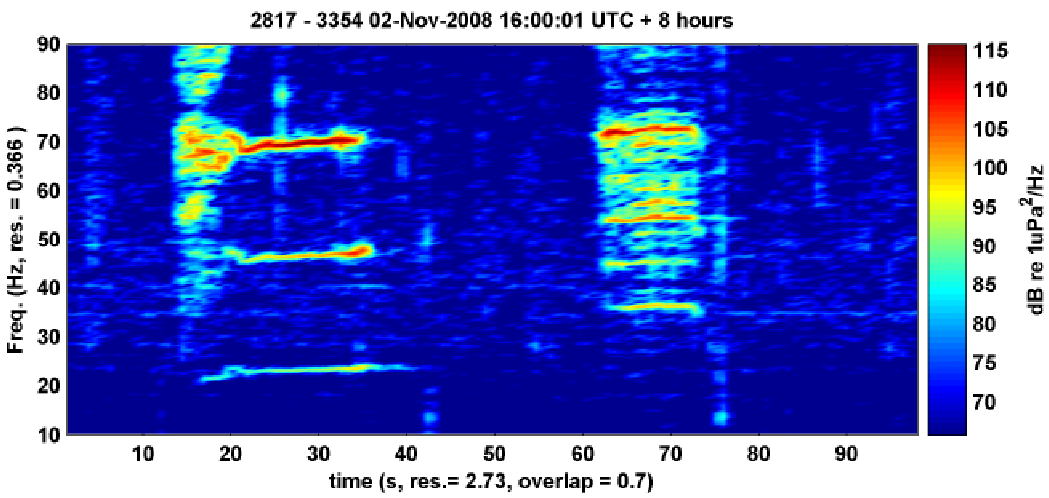
Species	Frequency Range (Hz)*	Dominant Frequencies (Hz)	SPL (dB re 1µPa @ 1 m)	Reference
Humpback whale				
- Song Components	30-8000	120-4000	144–174	
- Shrieks	-	750-1800	179-181	[1]
- Horn Blasts	-	410-420	181-185	
- Grunts	25-1900+	-	190	
Fin whale				
- Moans (down-sweeps)	14-118	20	160-186	
- Constant call	20-40	-	-	[1]
- Moans (up-sweeps)	30-750	-	155-165	
-Whistles/Chirps	1500-5000	1500-2500	-	
Blue whale				
- Moans	12-390	16–25	188	[1]
- Clicks	6000-8000	6000-8000	130-159	
Sei Whale	1500 – 3500	-	-	[1]
Southern right whale				
- Tonal	30-1250	160-500	-	[1]
- Pulsive	30-2200	50-500	172 – 187	
Sperm whale (clicks)	100 – 30000	2000–4000 10,000-16000	160 - 180	[1]
Californian Sea Lion	75 – 75,000	1000-40000	-	[2] [3]

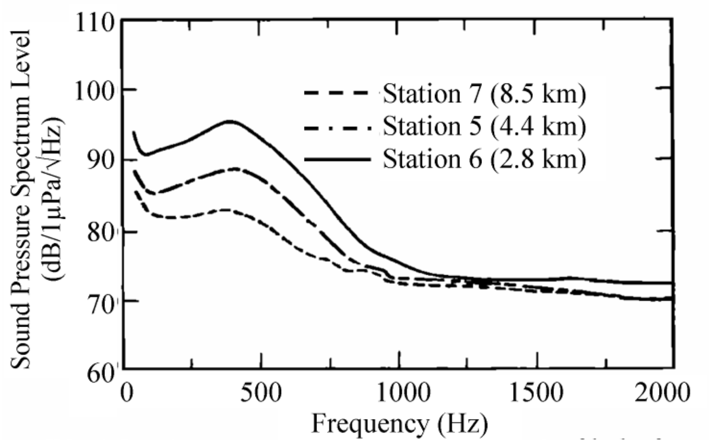
* Covers a variety of signal types which has be exhibited by individual species (e.g., tonal, pulsive, clicks, fluke flaps)
+ Echolocation frequencies and sound levels

References:

1. Richardson et al. 1995
2. Kastak & Schusterman
3. Southall et al. (2007)

Figure 3-15: Spectrogram of pygmy blue whale detected at Scott Reef (McCauley, 2011)





Source: Parsons and Duncan (2009), adapted from Wilson et al. (1985)

Figure 3-16: Frequency distribution of ambient noise levels at varying range from the surf zone (Adapted from Wilson et al, 1997; cited in Parsons & Duncan, 2009)

Using a 200Hz bandwidth, the spectral peaks of 96, 88 and 83dB re 1µPa/√Hz (at 2.8, 4.4 and 8.5 km from the surf zone respectively), shown in Figure 3-16, produced broadband SPLs of 119, 114 and 110 dB re 1µPa respectively (Parsons and Duncan, 2009).

- Background sound levels have been measured by BP (McCauley et al. 2012) in the GAB to understand the underwater sound characteristics of the area. Sound loggers were deployed near the Head of Bight in a water depth of 50 m and two along the shelf break at water depths of approximately 200 m for approximately 6 months. The measurements were assessed over the bandwidth of 3 to 3180 Hz. Background sound was higher at the shelf break sites compared with the Head of Bight site, with ambient sound levels increasing over summer into early winter. The results, in SPL, were:
  - Head of Bight: 73.5 to 131.9 dB re 1µPa (median of 97.1 dB re 1µPa); and
  - Shelf Break: 74.5 to 144.9 dB re 1µPa (median of 111.7 dB re 1µPa).
- Passive acoustic monitors (PAM) commissioned by Origin in coastal areas between Moonlight Head and Warrnambool between April 2012 and January 2013 measured ambient sound levels in the Otway region. A data logger situated 5 km from the coastline east of Warrnambool identified high ambient underwater spectral levels, with a mean of 110 dB re 1 µPa^2/Hz and peaks up to 161 dB re 1 µPa^2/Hz (McCauley & Gavrilov, 2013).
- Ambient sound levels were measured in the Otway Basin, approximately 750 km southeast of the Duntroon OA as part of impact assessment activities for the Thylacine development. Loggers recorded broadband underwater sound of 93 to 97 decibels dB re 1 µPa (units not specified) (Santos, 2004). Loggers were placed approximately 70 km from the coastline in a water depth of 100 m.

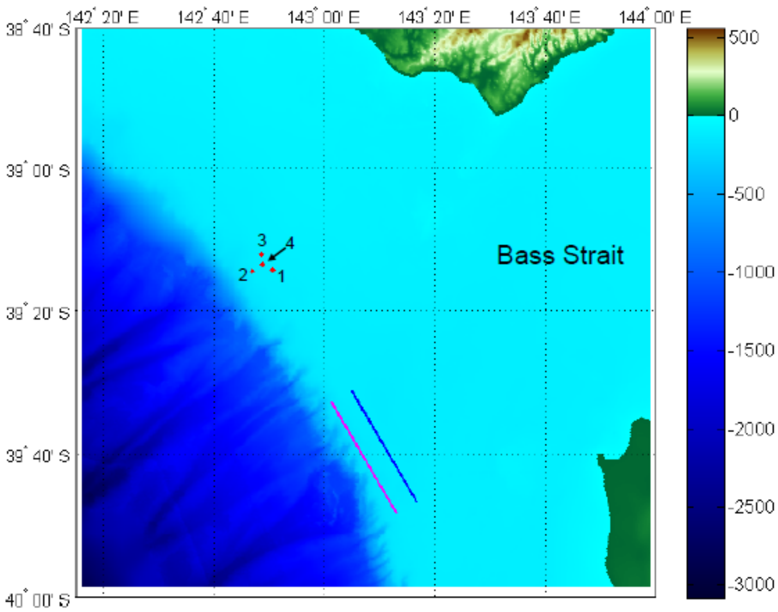
  As part of this study a logger was placed within the main east-west shipping lane located approximately 60 km due south of Port Fairy from November 2001 to March 2002 to understand the noise produced by commercial ships and its contribution to ambient sound levels. The spectra displayed from the shipping noise fell into two general groupings, those with higher frequency energy (>100 Hz) and those without. The higher frequency noise was attributed to higher levels of cavitation from ship propellers. Study results identified that broadband sound levels exceeded 100 dB re 1µPa (units not specified) 13.3% of the time, 110 dB re 1µPa (units not specified), 2.5% of the time and 120 dB re 1µPa (units not specified), 0.23% of the time (Santos, 2004).

3.5.4.2 *Sound propagation characteristics over continental shelf environments*

Seabed geology can have significant effects on sound transmission. Recent work on the continental shelf in western Bass Strait (Duncan *et al.* 2013) has demonstrated that transmission losses associated with low frequency sound propagation where bottom sediments consist primarily of calcarenite are generally much higher than those observed over other continental shelves. Transmission losses remained low only in a few narrow frequency bands.

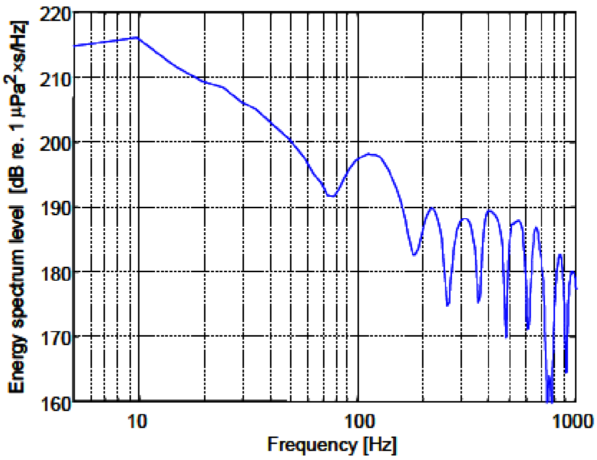
Duncan et al. (2013) undertook measurements of sound transmission loss of airgun signals from an offshore seismic exploration survey (in 2011) in the western part of Bass Strait as part of an 8-month sea noise monitoring and blue whale tracking program. Measurements were made using an array of four autonomous sea noise recorders positioned on the sea floor on the continental shelf near the continental slope. The distances of the loggers to the airgun array varied from 38 km to 75 km. The survey undertook several parallel seismic transects southeast of the hydrophone array at the edge of the continental shelf. During all transects the seismic vessel ran towards the hydrophone array with approximate transect lengths of 33 km. Each inshore transect was followed by an offshore transect and then by another inshore transect translated to the southwest of the previous one. The locations of the easternmost inshore (blue line) and offshore (magenta line) transects are shown in **Figure 3-17**.

Figure 3-17: Location and geometry of the sea noise recorders in Bass Strait (Gavrilov et al. 2012)



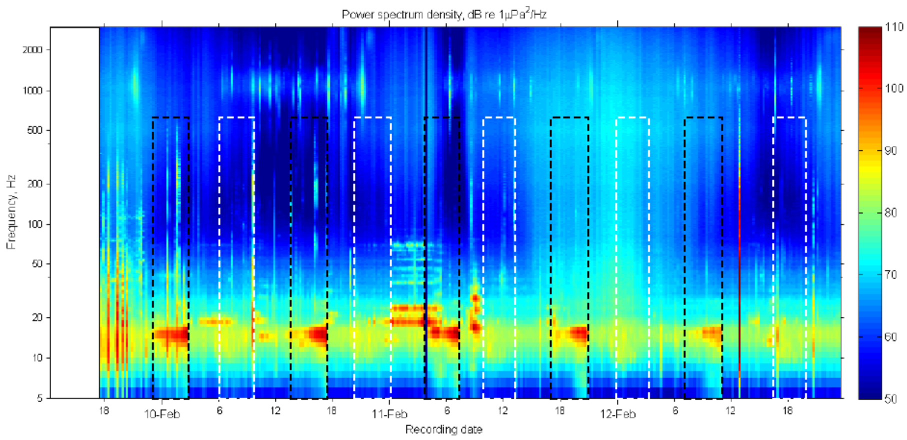
Source shots were repeated at approximately 8 second intervals and produced by a rectangular array of airguns with a total volume of 3090 cui towed at about 7 m below the sea surface. Figure 3-18 shows the frequency spectrum of the airgun signal transmitted normalised to 1 m from the array centre. The spectrum of the transmitted signal had a maximum at approximately 10 Hz followed by a relatively gradual decline in the energy spectrum at higher frequencies.

Figure 3-18: Source energy spectrum density of array (Gavrilov et al. 2012)



Variations in the spectrum level of sea noise were obtained from the data loggers, with an example from Recorder 3 provided in Figure 3-19. The black dashed rectangles identify the time intervals where the survey was made along the inshore transects. Sound from the airgun array is clearly seen at frequencies around 15 Hz. During each transect the airgun sound was gradually increasing with time as the survey vessel moved toward the recorders. This plot demonstrates that the airgun sound level decreased gradually with each subsequent inshore transect made further towards the shelf edge. The white dashed rectangles indicate the time intervals when the offshore transects were made.

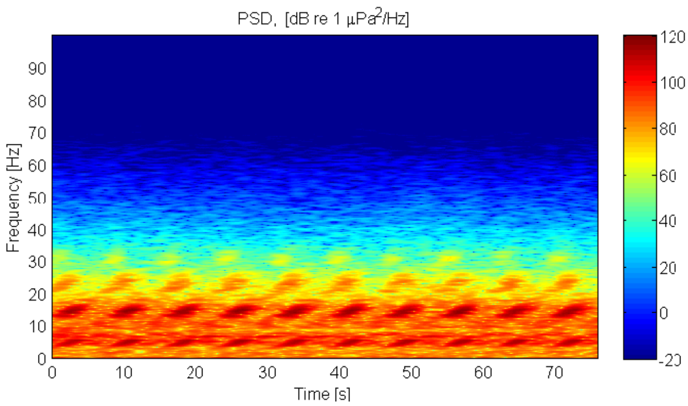
Figure 3-19: Long-term variations in the spectrum level of sea noise obtained from the power spectrum density averaged over each 500 second recording during the first four days of data collection on Recorder 3 (Gavrilov et al. 2012)



Analysis of the air gun signals revealed the spectrum of signals received at recorders contained noticeable energy components only within a few narrow frequency bands (particularly 5 Hz and 15 Hz) and with no energy above approximately 35 Hz (refer Figure 3-20). The signal spectrum also revealed frequency dispersion within these frequency bands with the lower frequencies propagating significantly faster than the higher ones. These results show transmission losses are relatively small only within three narrow low-frequency bands at about 5 Hz, 15 Hz and 25 Hz, and very high at frequencies above 40 Hz. Comparison of the measured and modelled power spectral density values from the airgun signal at approximately 42 km from the source was reasonably good (Duncan et al. 2013).

Gavrilov et al. (2012) attribute these sound propagation characteristics to the layering structure and characteristics of the seafloor sediments in the study area which resulted in much higher attenuation of the higher frequency component. Gavrilov et al. (2012) determined for these types of environments, the shear wave velocity in calcarenite is somewhat lower than the sound speed in water and the acoustic channel works as a band-pass filter in the low-frequency range, resulting in relatively low attenuation of propagated acoustic energy only within narrow frequency bands.

Figure 3-20: Spectrogram of a series of airgun signals received at recorder 3 from the first inshore seismic transect (Gavrilov et al. 2012)



The results of this measurement and monitoring study are important in the context of sound transmission from seismic surveys within the marine environment. It shows that sound above 40 Hz within seismic frequency band attenuate rapidly (refer Figure 3-20).

3.6 Coastal Environment

The description of the adjacent South Australian coastline is primarily based upon information obtained from Enviro Data SA (DNRE, 2016). Other references are acknowledged within the text. *Note that shoreline environments are not expected to be affected by oil spill residues above threshold values*.

The description of the coastline is discussed in an easterly direction from the Eyre Peninsula through to Thistle, Neptune and Kangaroo Island. An overview of shoreline classifications is summarised in Figure 3-21 (Coffin Bay to Streaky Bay) and Figure 3-21 (Lower Eyre Peninsula and Kangaroo Island).

- Eyre Peninsula (Streaky Bay to Coffin Bay): The coastline is dominated by cliffs interspersed with sand beaches. Towards Streaky Bay there are pockest of nagrove and saltmarsh.
- Eyre Peninsula (Point Widbery to Memory Cove): This coastline is dominated by granite platforms backed by high bluff cliffs at Point Whidbey, Misery Bay Headland, Cape Wiles and West Point interspersed by sand beaches with main stretches located at Sensation Beach, Avoid Bay, Gunyah Beach and Sleaford Bay. Many sections are limited to foot or boat access.
- Eyre Peninsula (Memory Cove to Tumby Bay): Coastline consists predominantly of sand beaches intersepeced with cliffs and bedrock platforms.
- Thistle Island: Coastline is dominated by granite platforms with calcarenite cliffs of medium height (Shag Point, Nose Point, Carrington Point, Waterhouse Point, Horny Point, Trevally Bay) interspersed by sand beaches at Waterhouse Bay, Hecla Cove, Nautilus Beach, Crawford Beach and Observation Point. Most sand beaches are on the eastern side of the island.
- Neptune Islands: The islands area a series of granite formations rising steeply from waters approximatley 60-100m deep. The islands comprise of two groups, North and South Neptune Islands which are 12 km apart. Each island group comprises of two main islands and various rock outcrops. Shorelines are dominated by rock platforms and boulder beaches (Bruce, 2011).
- Lower Yorke Peninsula: Shoreline is dominated by sandy beaches interspersed by cliffs and bedrock platforms.
- Kangaroo Island: Shoreline is dominated by boulder/cobble beaches and calcarenite cliffs on a granite base. In some sections the cliffs drop stright to the sea. Small pocket sand beaches are present along this coastline section.

Figure 3-21: Shoreline classification adjacent to Duntroon OA (Streaky Bay to Coffin Bay)

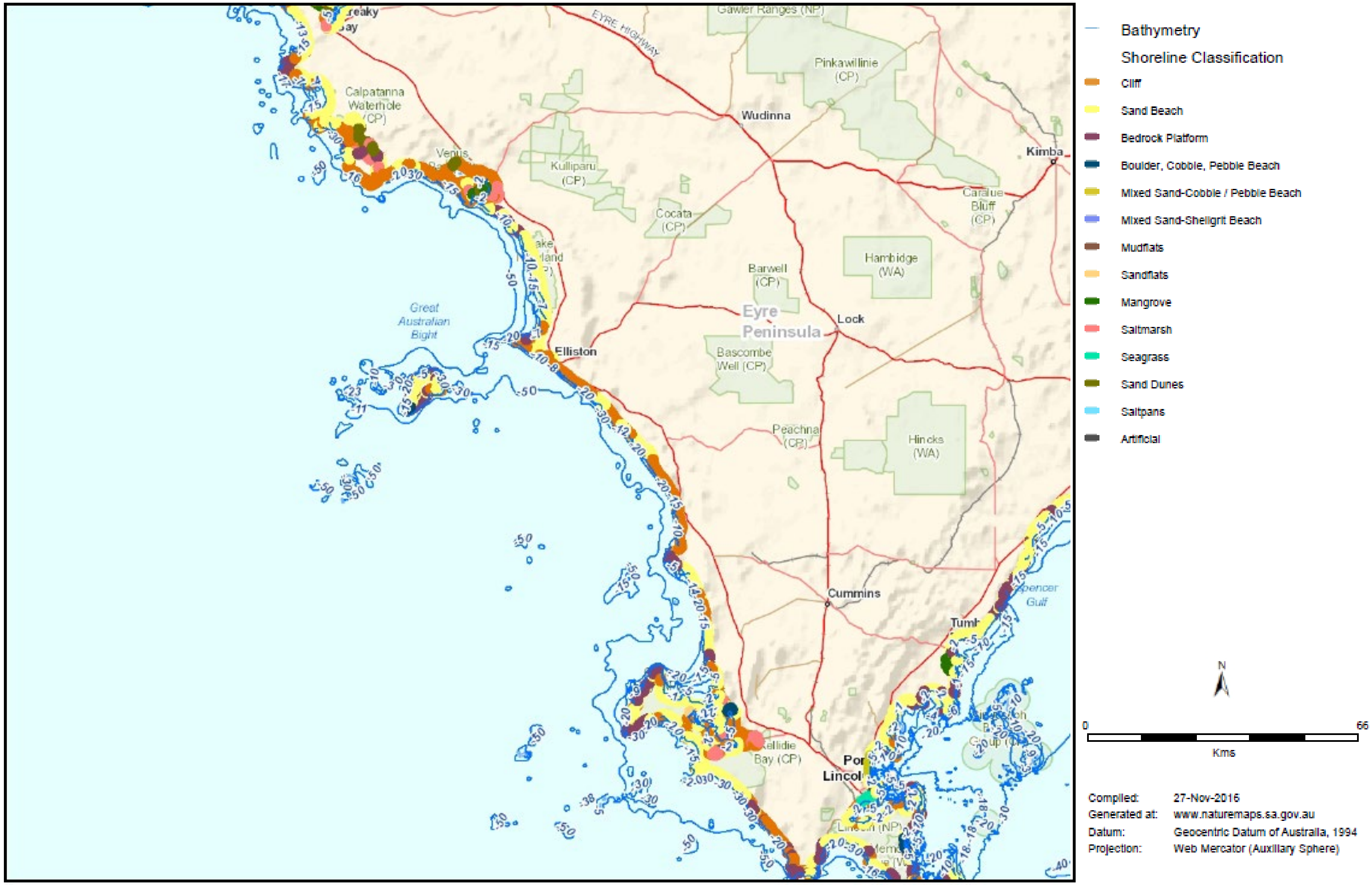
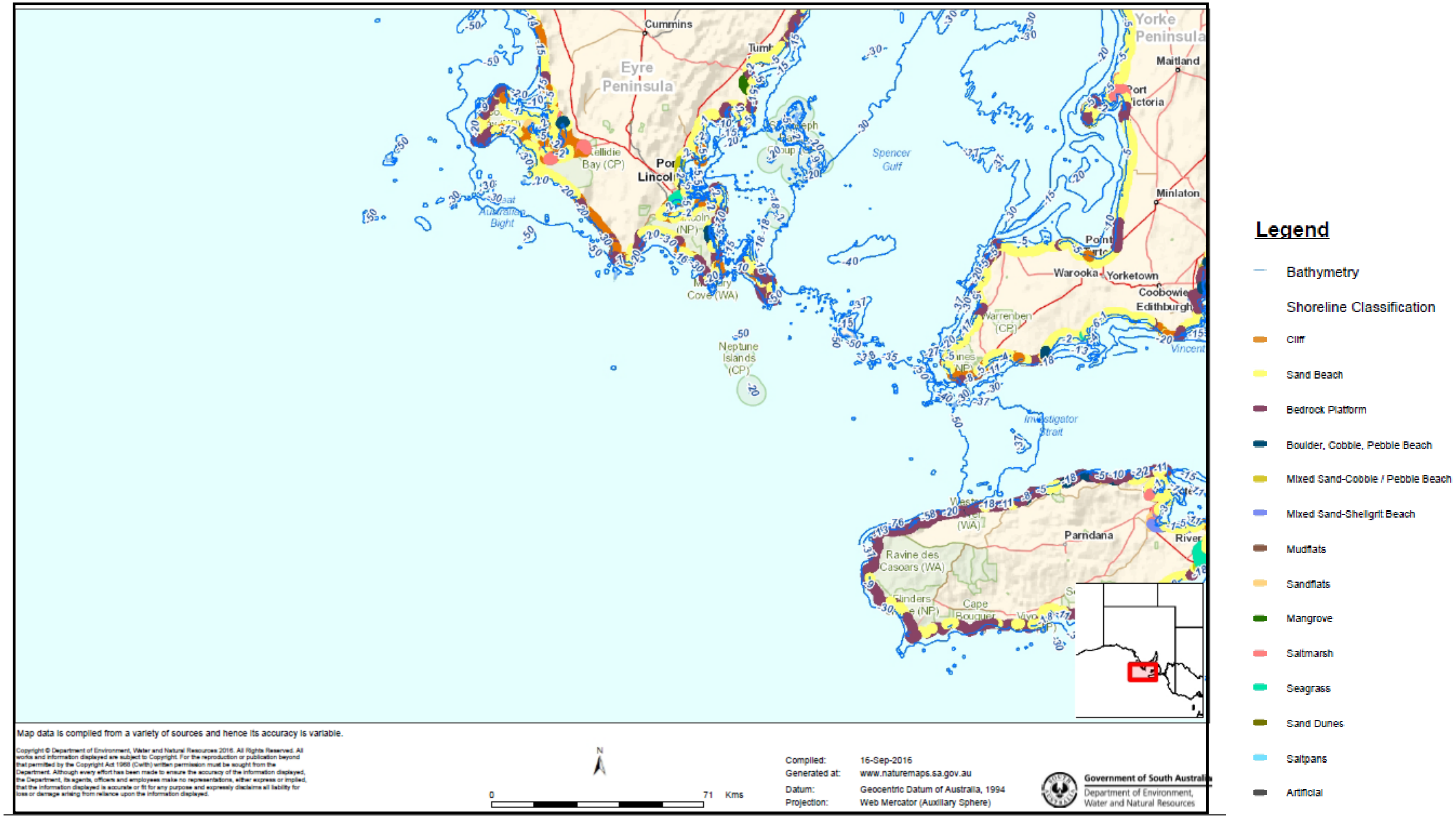


Figure 3-22: Shoreline classification adjacent to Duntroon OA (Lower Eyre Peninsula to Kangaroo Island)



3.7 Biological Environment

The EPBC Act 1999 lists both threatened and migratory species protected under Commonwealth legislation and various international conventions and treaties. A search of the EPBC Act Protected Matters Database (DoEE, 2017a) lists 28 threatened species and 33 migratory species that may be present in the Duntroon OA. These species are described in this section.

The Protected Matters Database search output for the Duntroon OA and the Duntroon EMBA are provided in **Appendix A**.

3.7.1 Benthic habitats and species assemblages

The GAB is one of the world's most diverse soft sediment ecosystems. Recent sampling studies revealing 360 different species of sponge, 138 species of ascidians and 93 species of bryozoans, many of which were newly discovered species (DEWHA, 2007). Ward et al. (2006), in surveys undertaken into epi-faunal assemblages of the continental shelf in the eastern GAB[12], established:

- Poriforans were the dominant taxa in terms of biomass accounting for 69% of total weight. Ascidians, bryozoans, echinoderms and cnidarians were also well represented and comprised approximately 23%, 5%, 2% and 1% of the total biomass respectively. Other taxa collected including molluscs, crustaceans, annelids, brachiopods and nemerteans comprised <0.5% of the total biomass sampled;
- Poriforans were the best represented taxa accounting for more than 45% of the species collected. Ascidians, bryozoans, cnidarians, echinoderms and molluscs accounted for 17%, 12%, 8%, 6% and 6% of the total species collected respectively. Most other taxa collected including crustaceans, annelids, brachiopods and nemerteans were relatively less diverse and represented fewer than 5% of total species collected;
- Bryozoans and poriforans were the most widely distributed taxa and occurred at 89% and 88% of the sampling sites respectively.

Suspension-feeding organisms (primarily porifora, ascidians and bryozoans) dominate the epibenthic assemblages and account for more than 98% of the total biomass and 86% of the species richness. All other feeding guilds (scavengers, predators, deposit-feeders and grazers) were rare by comparison and individually comprised less than 1% of the total biomass and 9% of the total species collected (Ward et al. 2006).

Species biomass and richness were highly correlated. The highest biomasses were found in the inner-shelf waters off the Eyre Peninsula and in waters near the Head of Bight. Biomass gradually declined between these two regions and decreased offshore. Biomass also declined significantly with depth and percentage mud. The large biomass and high species richness recorded at sites near the inner shelf of the Eyre Peninsula may reflect the coastal upwellings that enhance primary production along the coast and favour the filter-feeding poriferans and ascidians of the area. Figure 3-23 provides details of the overall community structures identified within the eastern GAB.

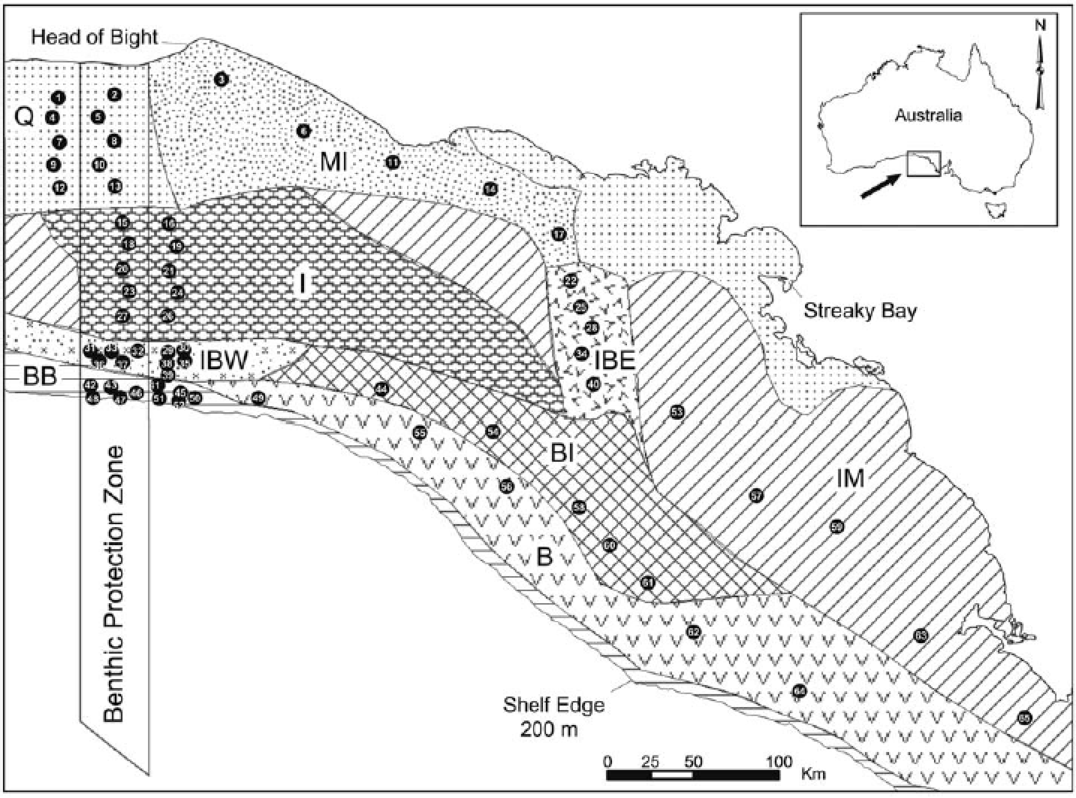
More specifically, review of the epibenthos in proximity to the OA (deep, outer-shelf group) found this area supported the lowest average biomass (0.7kg tow^{-1}) and second lowest species richness (11.2 species tow^{-1}) of any regional grouping with a high proportion of bryozoan species (42%). Most species (44 of 55 [80%]) were found elsewhere on the shelf. Additionally, 99.98% of species were sessile and suspension feeders in this area (Ward et al. 2006).

The Western Eyre CMP contains the benthic invertebrate community of the eastern GAB KEF (refer Section 3.3.4).

[12] This is defined in the study as extending from the Head of Bight to Cape Catastrophe. This overlaps the continental shelf component of the survey area.

Figure 3-23: Benthic communities within the Eastern GAB (Ward et al. 2005).

Duntroon multi-client survey area is in bottom right hand corner.



Note: Closed circles indicate the locations of sites sampled with the epibenthic sled. Alphabetic codes denoting nine sedimentary facies are as follows: B, Bryozoan; BB, Branching Bryozoan; BI, Bryozoan Intraclast; I, Intraclast; IBE, Intraclast Bryozoan East; IBW, Intraclast Bryozoan West; IM, Intraclast Mollusc; MI, Mollusc Intraclast; Q, Quartzose Skeletal

3.7.2 Plankton

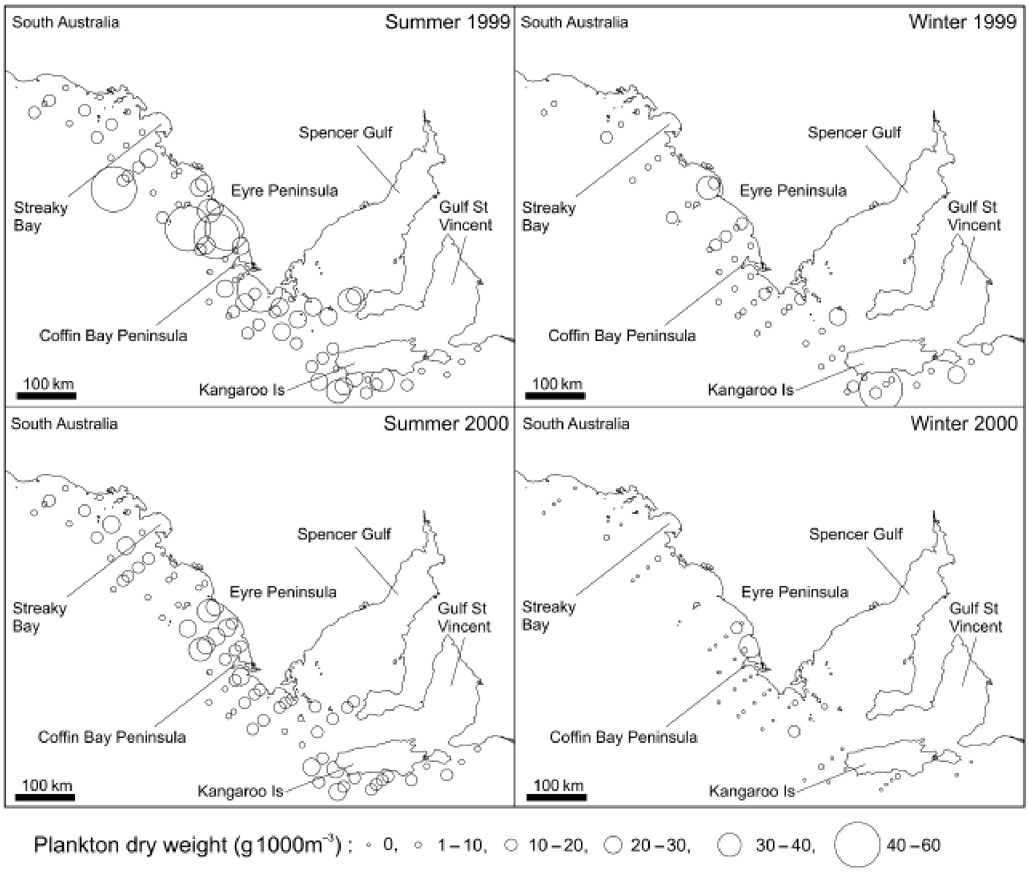
Plankton consists of microscopic organisms and includes phytoplankton (alga) and zooplankton (fauna including larvae). Plankton plays a major role in the trophic system with phytoplankton being a primary producer and zooplankton a primary consumer. Phytoplankton rapidly multiply in response to nutrient availability and are consumed by zooplankton that are in turn consumed by other fauna species.

Ward et al. (2006) assessed productivity in the eastern GAB to establish the effects of primary productivity (i.e. distribution and abundance of zooplankton), on secondary and tertiary production with the area. Previous studies undertaken by Young et al. (1999; cited in Ward et al. 2006) examined the biomass and composition of zooplankton along a north-south transect from the Head of Bight and concluded that the biomass of zooplankton was highest inshore and consisted of the salp, *Thalia democratica*, whereas the biomass of larger micro-nekton and crustaceans were highest offshore. Ward et al. (2006) established the following:

- During summer/autumn, sites with high levels of zooplankton biomass were located mainly in the shelf waters south of the Eyre Peninsula, whereas during winter sites with relatively high zooplankton density were sparsely scattered through the study area. While not statistically significant, the mean level of zooplankton biomass was considerably higher during summer/autumn (14.84 ± 0.86 SE g dry weight 1000m^{-3}) than during winter (8.14 ± 0.79 SE g dry weight 1000m^{-3}). Figure 3-24 provides details of the observed zooplankton mass in the eastern GAB during the summer-autumn and winter of 1999 and 2000.

- During summer/autumn surface concentrations of *chlorophyll a*[13] in offshore waters and outside the upwelling area were low (~0.2 mg m^{-3}). However, elevated levels of *chlorophyll a* (e.g. 4.5 mg m^{-3}) were recorded in upwelling areas along the western Eyre Peninsula and off Kangaroo Island. These levels are higher than in the western GAB or off the east and west coast of Australia, but fall within the lower portion of the ranges observed during upwelling events in the California and Humboldt current system (1-30 mg m^{-3}) (Small and Menzies, 1981; MacIsaac et al. 1985; Peterson et al. 1988: cited in Ward et al. 2006) and the Benguela current system (0.8-24 mg m^{-3}) (Brown, 1984: cited in Ward et al. 2006). These results suggest that during summer/autumn, the eastern GAB is moderately productive (Kampf et al. 2004; cited in Ward et al. 2006).

Figure 3-24: Relative zooplankton mass in the eastern GAB during the summer-autumn and winter of 1999 and 2000 (Ward et al. 2006).



Van Ruth (2009) studied the temporal variation in plankton abundance during the upwelling and down-welling seasons in 2004, and the upwelling seasons of 2005 and 2006 within the Kangaroo Island and Eyre Peninsula upwelling area. The results of this study identified the following:

- Productivity in the eastern GAB showed significant spatial and temporal variation reflecting regional and seasonal variation in meteorology and oceanography, and the water masses present in the region. The overall productivity of a summer/autumn upwelling season was highly dependent on within-season variations in wind strength and direction, which dictated the number, intensity and duration of upwelling events.

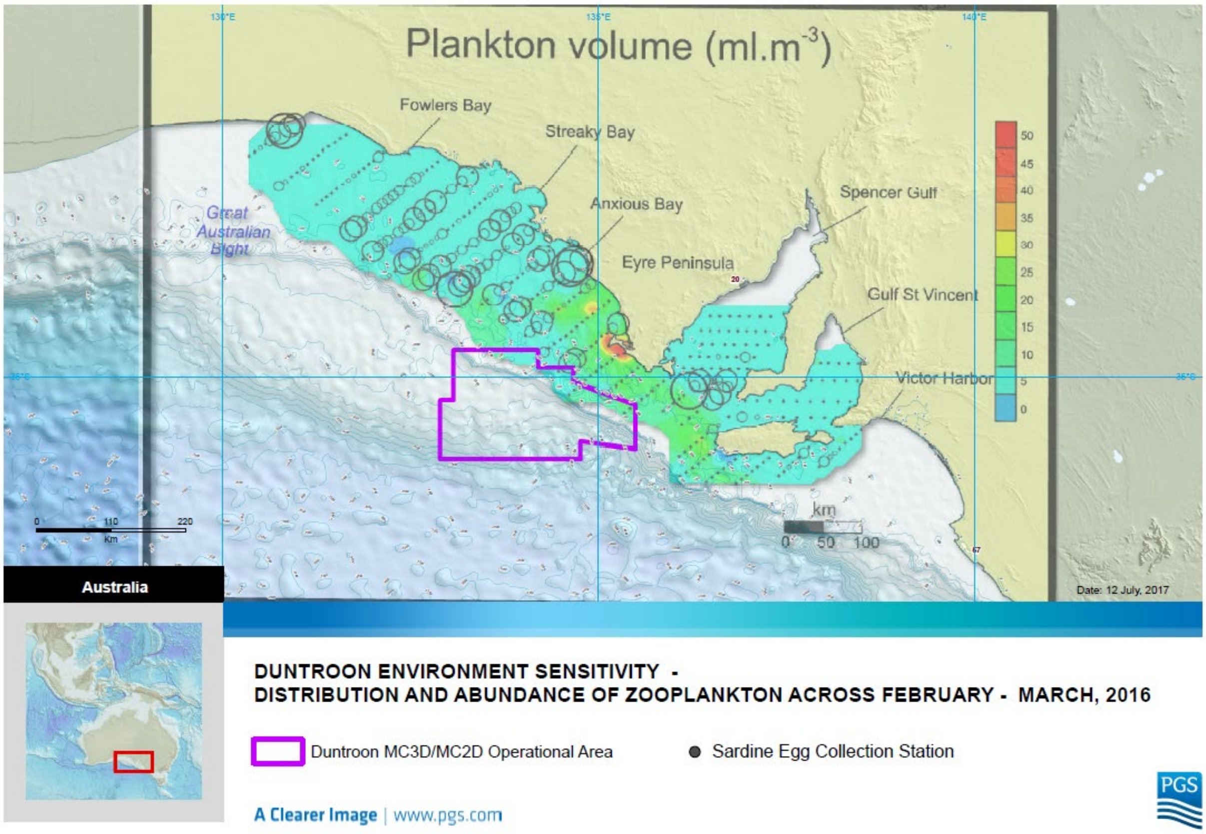
- Primary productivity and phytoplankton abundance were generally higher in near-shore waters (hotspots between 1600-3900 mg C m^{-2} d^{-1}) compared with mid-shelf/coastal waters (800-1600 mg C m^{-2} d^{-1}) and offshore waters (< 800 mg C m^{-2} d^{-1}); and also, during the summer/autumn upwelling season (February/March) compared with the winter/spring down-welling season (September).

[13] A measure of primary productivity.

- Three different phytoplankton communities were present during the study period. In summer/autumn, upwelled waters were characterised by high phytoplankton abundances (particularly diatoms) and larger average cell sizes, while the warmer high-nutrient, low-chlorophyll waters had lower phytoplankton abundances and smaller average cell sizes. The winter/spring community was made up of low abundance relatively large cells. In all seasons the phytoplankton community is dominated by diatoms with the highest mean phytoplankton abundance ~164,000 cells/litre in February/March 2004.
- Peak meso-zooplankton abundances and biomass occurred in the highly productive upwelling influenced nearshore waters of the eastern GAB. Abundances, however, were highly variable between regions and years reflecting the spatial and temporal variations in primary productivity. In offshore areas abundance levels were ~2,500 individuals m^{-3} (compared with peak abundances (nearshore) of approximately 20,000 individuals m^{-3}). Copepods and appendicularia species predominated in offshore zoo-plankton species.

Figure 3-25details measured plankton concentrations obtained as part of the sardine egg surveys in February-March by SARDI for 2016 (typical of other years) together with the spatial overlap of the Duntroon survey area. SARDI identified for all years recorded, zooplankton on the outer shelf comprised mostly salps, with the inshore areas containing the highest densities of small zooplankton taxa (Ward et al, 2009; Ward et al, 2011; Ward et al, 2013; Ward et al, 2014).

Figure 3-25: Distribution and Abundance of Zooplankton across February-March 2016



3.7.3 *Benthic fauna*

Benthic surveys taken on shelf waters representative of the survey area identified that porifera (63%), ascidians (28%) and bryozoans (5.5%) dominated (Ward et al. 2006). On a species diversity basis, bryozoans represented most species (23/55) (Ward et al. 2006). Characteristics (including spawning) for these fauna types are as follows:

- Porifera: Species identified in the area belonged to class *Demospongiae* (contains siliceous spicules) with smaller representation by class *calcarea* (contains calcareous spicules). Sponges are sessile, multicellular organisms that have bodies full of pores and channels for water to circulate allowing the species to obtain food and oxygen and remove wastes. They flourish in waters where water movement is strong (Butler et al. 2002). Sponges do not have nervous, digestive or circulatory systems and reproduce by asexual and sexual means. Increasing temperature is generally accepted as a major environmental factor regulating the onset of reproduction activity particularly in regions of large seasonal change (spring/summer) (Fromont, 1993). Sponges are efficient colonisers of marine hard surfaces although they will not typically colonise a newly cleared surface as rapidly as some other groups (e.g. bryozoans). Once established sponges are effective competitors in retaining living space through asexual reproduction and by using chemicals to deter competitors and predators (Butler et al, 2002).

- Ascidians: All ascidians (commonly known as sea squirts) are sessile, sac-like marine invertebrate filter feeders. The species has a digestive, circulatory and nervous system however lacks any special sensory organs. They are hermaphrodites and fertilisation can be external with development in the water column (solitary species) or internal with embryos brooded in the body (colonial species). Solitary larvae are free-swimming for periods of 1-24 hours and prior to hatching float free in the water for up to 3 days. Current dispersal contributes to gene flow and removes risks of isolation. The colonial species are seldom free swimming for more than an hour and attach to substrates rapidly (DoE, 2014). In temperate and cold seas, breeding is usually seasonal and restricted to warmer seasons but in tropical waters it may continue throughout the year (Shenkar, 2008).
- Bryozoans: Bryozoans are sessile, aquatic invertebrate filter feeding animals which attach to hard substrates and form lace-like colonies. They have no respiratory organs, heart, or blood vessels. Instead zooids absorb oxygen and eliminate carbon dioxide through the body wall. Colonies of bryozoans are started by a single individual that, after its larval existence, settles onto a substrate and begin to reproduce asexually (by budding). Bryozoans are hermaphrodites and fertilisation can be external in the water column or internal with embryos brooded in the body (as per ascidians) fertilised with sperm brought in on the feeding current. The larvae which are hatched are then released and swim but do not feed. They swim towards the light then after a few hours swim down to the sea floor to colonise. For species which do not brood but release eggs, fertilised eggs become part of the plankton stream for approximately 2 months until they are large enough to descend and start a new colony (Earthlife, 2014). Temperature controls all aspects of bryozoan life. In spring, rising water temperatures and increased intensity of light stimulate phytoplankton growth which initiates active budding in bryozoans and to some degree sexual reproduction (Smithsonian Institute, 2016).

The sediments of the continental slope are characterised by muddy oozes and contains large quantities of skeletal organic remains derived from the shelf including bryozoan and mollusc fragments. No published studies are available on the composition or distribution of benthic biota beyond the shelf-break in the south-west marine region.

3.7.4 Fish

The EPBC Act Protected Matters database search (DoEE, 2017a) for the Duntroon survey area identified one shark species as vulnerable, the great white shark (*Carcharodon carcharias)*; two shark species as migratory, the shortfin mako (*Isurus oxyrinchus*) and porbeagle (*Lamna nasus*); and 28 species of fish – namely pipefish, pipe-horse, sea-dragons and seahorse as possibly occurring in the survey area. Details of these fish species are discussed further in this section. Table 3-6 provides details of the species which are listed under the EPBC Act.

Other species present in the area are described in Section 3.7.4.5 and species of commercial significance are described in Section 3.8.3.

Table 3-6: EPBC Act – Listed fish species which may occur in or around the Duntroon survey area (DoEE, 2017a; 2018c)

Status:
E: Endangered
V: Vulnerable
M: Migratory
L: Listed

Likelihood of Occurrence:
LO: Species or species habitat likely to occur in area
MO: Species or species habitat may occur within area
FMO: Foraging/Feeding may occur within area
FKO: Foraging/Feeding known to occur in area
KO: Species or species habitat known to occur within area
FLO: Foraging/Feeding likely to occur in area
BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Sharks	Carcharodon carcharias	Great White Shark	V, M	FKO	✓	Foraging	✓	Foraging	✓ [Ref .1]
	Isurus oxyrinchus	Shortfin Mako	M	LO	✓	-	✓	-	-
	Lamna nasus	Porbeagle, Mackerel Shark	M	LO	✓	-	✓	-	-
Syngnathidae (pipefish, pipehorse, seadragons, seahorse)	Acentronura australe	Southern Pygmy Pipehorse	L	MO	✓	-	✓	-	-
	Campichthys galei	Gale's Pipefish	L	MO	✓	-	✓	-	-
	Campichthys tryoni	Tryon's Pipefish	L	MO		-	✓	-	-
	Filicampus tigris	Tiger Pipefish	L	MO	✓	-	✓	-	-
	Heraldia nocturna	Upside-down Pipefish	L	MO	✓	-	✓	-	-
	Hippocampus abdominalis	Big-belly Seahorse	L	MO	✓	-	✓	-	-
	Hippocampus breviceps	Short-head Seahorse	L	MO	✓	-	✓	-	-
	Histiogamphelus cristatus	Rhino Pipefish	L	MO	✓	-	✓	-	-
	Hypselognathus horridus	Shaggy Pipefish,	L	MO	✓	-	✓	-	-
	Hypselognathus rostratus	Knifesnout Pipefish	L	MO	✓	-	✓	-	-
	Kaupus costatus	Deepbody Pipefish,	L	MO	✓	-	✓	-	-
	Leptoichthys fistularius	Brushtail Pipefish	L	MO	✓	-	✓	-	-
	Lissocampus caudalis	Australian Smooth Pipefish	L	MO	✓	-	✓	-	-
	Lissocampus runa	Javelin Pipefish	L	MO	✓	-	✓	-	-
	Maroubra perserrata	Sawtooth Pipefish	L	MO	✓	-	✓	-	-
	Notiocampus ruber	Red Pipefish	L	MO	✓	-	✓	-	-
	Phycodurus eques	Leafy Seadragon	L	MO	✓	-	✓	-	-
	Phyllopteryx taeniolatus	Common Seadragon	L	MO	✓	-	✓	-	-
	Pugnaso curtirostris	Pugnose Pipefish	L	MO	✓	-	✓	-	-
	Solegnathus robustus	Robust Pipehorse	L	MO	✓	-	✓	-	-
	Solegnathus spinosissimus	Spiny Pipehorse	L	MO		-	✓	-	-

Status:
E: Endangered
V: Vulnerable
M: Migratory
L: Listed

Likelihood of Occurrence:
LO: Species or species habitat likely to occur in area
MO: Species or species habitat may occur within area
FMO: Foraging/Feeding may occur within area
FKO: Foraging/Feeding known to occur in area
KO: Species or species habitat known to occur within area
FLO: Foraging/Feeding likely to occur in area
BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Syngnathidae (Con't)	Stigmatopora argus	Spotted Pipefish	L	MO	✓	-	✓	-	-
	Stigmatopora nigra	Widebody Pipefish	L	MO	✓	-	✓	-	-
	Stigmatopora olivacea	a pipefish	L	MO	✓	-	✓	-	-
	Stipecampus cristatus	Ringback Pipefish	L	MO	✓	-	✓	-	-
	Urocampus carinirostris	Hairy Pipefish	L	MO	✓	-	✓	-	-
	Vanacampus margaritifer	Mother-of-pearl Pipefish	L	MO	✓	-	✓	-	-
	Vanacampus phillipi	Port Phillip Pipefish	L	MO	✓	-	✓	-	-
	Vanacampus poecilolaemus	Longsnout Pipefish	L	MO	✓	-	✓	-	-
	Vanacampus vercoi	Verco's Pipefish	L	MO	✓	-	✓	-	-

Definitions:

Listed threatened species:	A native species listed (L) under the Commonwealth EPBC Act (Section 178): critically endangered (CE), endangered (E), vulnerable (V)
Listed migratory species:	A migratory (M) species included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.
Listed marine species:	As listed in Section 248 of the EPBC Act.

References:

[1] Recovery Plan for the white shark (*Carcharodon carcharias)* (SEWPC, 2013)

3.7.4.1 Great white shark

The great white shark *(Carcharodon carcharias)*, a highly mobile migratory species listed as vulnerable, is widely distributed and present in low densities in coastal and offshore waters of most temperate and sub-tropical regions worldwide. It is primarily found in coastal and insular continental shelf waters and islands, however can be encountered in the open ocean (SEWPC, 2013c) and has been caught in varying depths up to 1280 m (EA, 2002). White sharks appear to occupy waters between the coast and the 100 m depth contour (DEWHA, 2007) with areas of frequent encounter around seal and sea lion colonies particularly when juveniles are present (SEWPC, 2013c). In South Australia, seal/sea lion colonies are known to occur at The Pages Islands (~ 250 km east); Dangerous Reef (~ 86 km NE); Seal Bay on Kangaroo Island (159 km ESE); West Waldegrave Island (~ 128 km north); and Olive Island (~ 210 km NNW) (SEWPC, 2011a). Large New Zealand fur seal colonies are found at the North and South Neptune Islands (~48 km ENE), Kangaroo Island (~ 90 km east) and Linguanea Island (SA) (~ 43 km north) (DEWHA, 2007). New Zealand fur seals pup in early December with the adults/pups most vulnerable between mid-January and April (Bruce & Bradford, 2008). White sharks are regularly observed at Neptune Islands and Dangerous Reef (SA) (DEWHA, 2007).

Great white sharks do not prey exclusively on pinnipeds also feeding on small cetaceans, finfish (e.g. snapper), other sharks, reptiles and seabirds (EA, 2002).

The location of white shark pupping areas in Australia is not known, however juveniles aggregate seasonally in certain areas such as Goolwa (SA) (~ 290 km east), Corner Inlet-Lakes Entrance (Vic) (summer-autumn), Newcastle-Foster (NSW) (late winter-spring), Fraser Island (Qld) and Portland (Vic) (SEWPC, 2012c). Pupping is believed to occur in spring through summer (SEWPC, 2012c). The Spencer Gulf and Gulf of St Vincent are considered important feeding grounds for sub-adult white sharks targeting dolphins, finfish and other shark species (DEWHA, 2007). Resident juvenile white sharks restrict their movement between shore and the 150 m depth contour (Bruce & Bradford, 2008).

The periods of residency of white sharks at pinniped colonies are variable ranging from days to months. Individuals may return on an annual or more frequent basis after spending considerable intervening periods away from these sites focusing on other sources of prey. White sharks commonly make extensive migrations over thousands of kilometres between visits to pinniped colonies and can spend considerable periods in the open ocean (Bruce & Bradford, 2011).

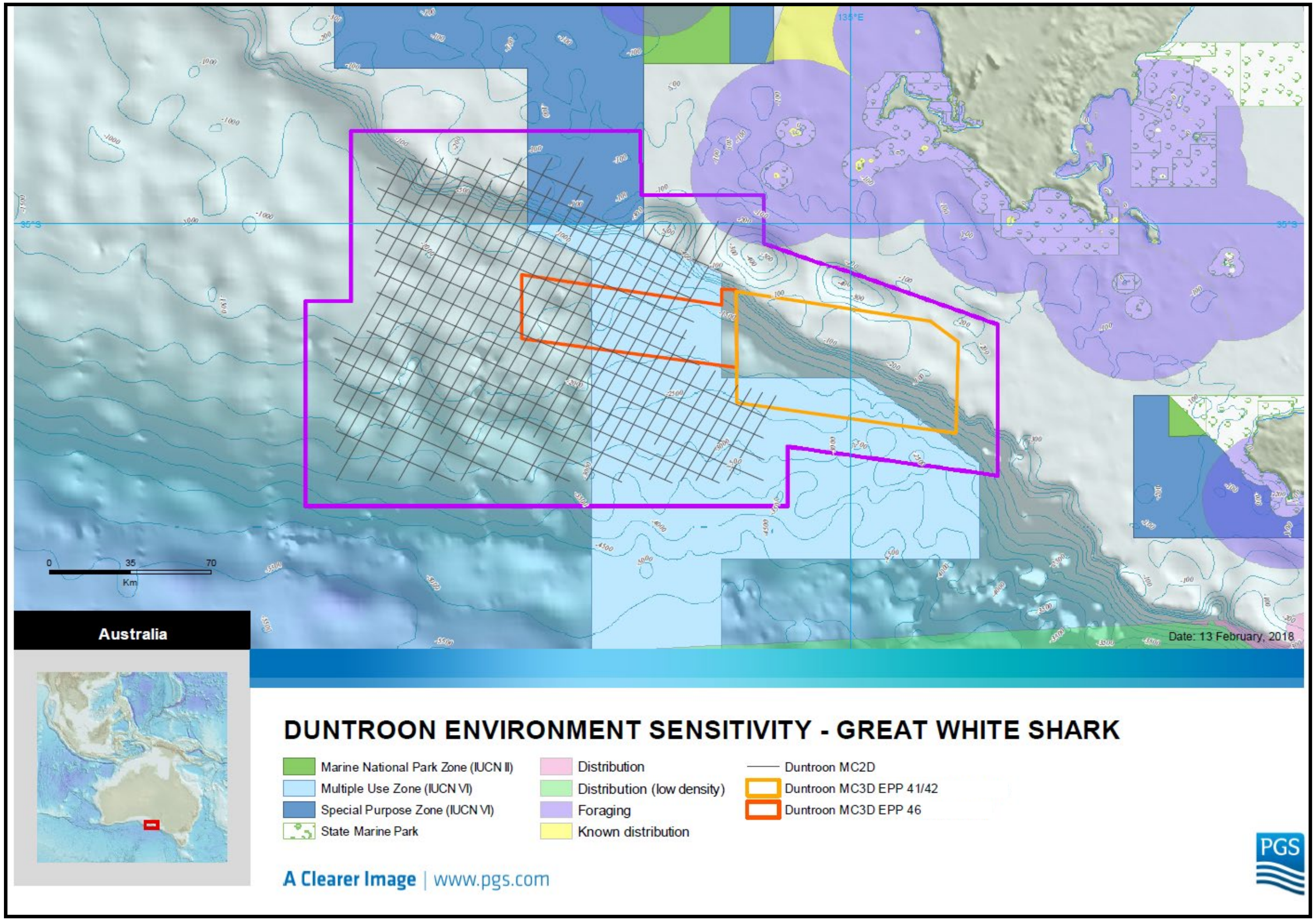
Acoustic monitoring studies undertaken by Bruce & Bradford (2011) at the Neptune Islands between December 2009 and April 2011 identified that residency periods of the white shark within the Neptune Islands system ranged from 1 to 92 days with the number of visits ranging from one to five. Most tagged sharks recorded multiple residency periods with periods separated by 6-10 days. All tagged sharks were detected at North Neptune Island, with detections lowest on the island's western side and highest on the eastern side. Only a portion of these sharks were also detected on South Neptune Island (9 of 21 sharks). Sharks routinely transited between the two islands with typical transit durations of 20 hrs. Sharks tagged at the Neptune Islands have been tracked moving primarily west into the GAB and WA waters.

The National Conservation Values Atlas (NCVA) identifies both a foraging BIA and known distribution BIA for the species in the region. The known distribution BIA reflects areas used by white sharks as they move between nursery areas particularly for juvenile white sharks (DoEE, 2017b). As identified in Figure 3-26, a small portion of the Duntroon OA coincides with the BIA (foraging) in the north of the OA where the survey boundary lies within 10 km of Rocky (south) Island, a known breeding area for the Australian sea lion. The white shark may transit the survey area to these foraging locations.

<u>Recovery Plan for White Shark:</u>

The Recovery Plan for the white shark (*Carcharodon carcharias)* (SEWPC, 2013) has been reviewed for threats posed by survey activities. No threats have been identified which are considered relevant for impacts which may be expected from the Duntroon survey activity. Sound is not identified as a threat to species recovery.

Figure 3-26: Duntroon Survey and White Shark BIAs in the eastern GAB (DoEE, 2017b)



3.7.4.2 Shortfin mako shark

The shortfin mako shark (*Isurus oxyrinchus*) listed as migratory, is found worldwide in tropical and temperate waters. It is usually found in coastal and oceanic waters in depths of 150 m, however can be found as deep as 740 m and is one of the most active (fast swimming) shark species. The species prefers temperatures above 16°C and feeds on schools of fish, cephalopods, billfish and small cetaceans (SEWPC, 2012e).

Reproduction is oophagous (embryos feed on eggs continuously ovulated by female). Average litter size is 12 with up to 16 recorded. Pups are born off NSW around November (Last & Stevens, 2009).

The species may be present in the area during the survey period however the NCVA does not identify that the survey OA is important biological habitat for the species (DoEE, 2017b).

3.7.4.3 Porbeagle (mackerel shark)

The porbeagle or mackerel shark (*Lamna nasus*) listed as migratory, is a pelagic oceanic fish that prefers cool waters (temperatures below 18ºC) and has a depth range of 715 m (Froese & Pauly, 2012). It is distributed from latitudes 76°N to 59°S and is abundant on continental shelves and has also been found well offshore. The mackerel shark feeds mainly on herring, mackerels; cod, white hake, red hake, haddock, cusk, and squid (WoRMs, 2011).

Reproduction is oophagous with 1-5 pups born in winter in the Australasian region (Last & Stevens, 2009).

The species may be present in the area during the survey period however the NCVA does not identify that the survey OA is important biological habitat for the species (DoEE, 2017b).

3.7.4.4 Syngnathidae species

The EPBC Act Protected Matters database lists 30 species of fish – namely pipefish, pipe-horse, sea-dragons and seahorse as possibly occurring in proximity to the survey OA. Available studies (Brown et al, 2008) identify these species exist over a broad geographical range, however within this range their distribution is limited to suitable habitats determined by the individual species' camouflage, size, food source, behaviour and reproduction requirements. Suitable habitats include seagrass and macro-algal habitat, reef and broken bottom habitats (described as a mixed mosaic of margins of seagrass meadows, shelly or rubbly bottom and sandy bottom with patchy seagrass or detritus, and disturbed areas). Many of the listed pipefish, seahorse and sea-dragon species have preferred habitat in shallow bays and coastal waters, especially seagrass beds, and on reefs covered with macro-algae where they are well camouflaged. In general, syngnathids are site associated in near-shore habitats (McClatchie et al. 2006) however pipe-horses usually occur in deeper continental shelf waters. Syngnathids utilise a swim bladder to control their depth within the water column.

For the three species of pipe-horse listed as possibly present in proximity to the survey OA (McClatchie et al. 2006):

- Southern Pygmy/Little Pipehorse (*Acentronura australe*): The species is known in the Southern Gulf of St Vincent but not commonly recorded and is assumed to live in red macro-algal habitats on semi-exposed coastal reefs. Specimens have typically been caught in depths less than 20 m;
- Robust Pipehorse (*Solegnathus robustus*): The species is common within its known depth range (42-68 m) and occurs in benthic habitats on the continental shelf; and
- Spiny pipe-horse (*Solegnathus spinosissimus*) lies in temperate waters. It is commonly trawled from water of 30 m to 230 m depth over muddy bottoms. It is known to occur in southern Queensland, NSW, Victoria, Tasmania and New Zealand. The species is not recorded in SA waters (Australian Museum, 2017).

As the depth range of the survey area lies in water depths of 100-3500 m and given the seabed sediment type on the continental shelf, these pipe-horse species are not expected to be present within the survey area.

3.7.4.5 *Other continental shelf fish (including small pelagic fisheries)*

General

Commercial fish landings taken from the shelf break and the upper/mid-slope include the orange roughy, blue grenadier, bight redfish, school shark, gummy shark, angel shark, gemfish, deep water flatheads, leatherjackets, latchets, stingrays and stingarees (DEWHA, 2007). These fish are prey to deep-diving toothed whales and dolphins including sperm whales, killer whales, seabirds, tunas and other large predatory fish. Sardines account for more than half of the prey species of juvenile southern blue-fin tuna (SBT) which also aggregate in the region (Ward et al. 2006; cited in Pattiaratchi, 2007).

There are also productive giant crab and lobster grounds along the shelf edge (DEWHA, 2007).

Fish species that utilise reefs and/or sand habitats along the western, north-western and/or south-western sides of Kangaroo Island include, but are not limited to, snapper (*Pagrus auratus*), West Australian salmon (*Arripis truttacea*), trevally (*Pseudocaranx dentex* and *Pseudocaranx wrighti*), flathead (*Platycephalus species*), ocean leatherjacket (*Meuschenia* sp), snook (*Sphyraena novaehollandiae*), western blue groper (*Achoerodus gouldii*), blue-throated wrasse (*Notolabrus tetricus*) and other wrasse species, sea sweep (*Scorpis* sp), blue morwong (*Nemadactylus valenciennesi*), redfish, silver drummer, tommy ruff (*Arripis georgianus*), yellow-eye mullet (*Mugilidae* sp), black bream (*Acanthopagrus species*), gummy shark (*Mustelus antarcticus*) and whaler shark (*Carcharhinidae* sp). Blue-eye trevalla (*Hyperglyphe antarctica*) hapuku, and blue warehou occur in deeper waters off southern Kangaroo Island, with at least blue warehou spawning in the region (Kangaroo Island Council, 2012).

The Spencer Gulf Shelf Province bioregion is regarded as a productive commercial fishing area in Australia, producing sardines and anchovies (finfish fishery) and for supporting migratory tuna (Ward et al. 2006; cited in Blue Whale Study Inc., 2012; Pattiaratchi, 2007). Peak spawning periods for sardines and anchovies in shelf waters is January to March which corresponds to peak upwelling periods (Dimmlich et al. 2004; cited in Pattiaratchi, 2007). Sardine and anchovy eggs and larvae are widely distributed in shelf waters with higher densities in areas of high zooplankton biomass (Dimmlich et al. 2004; cited in Pattiaratchi, 2007).

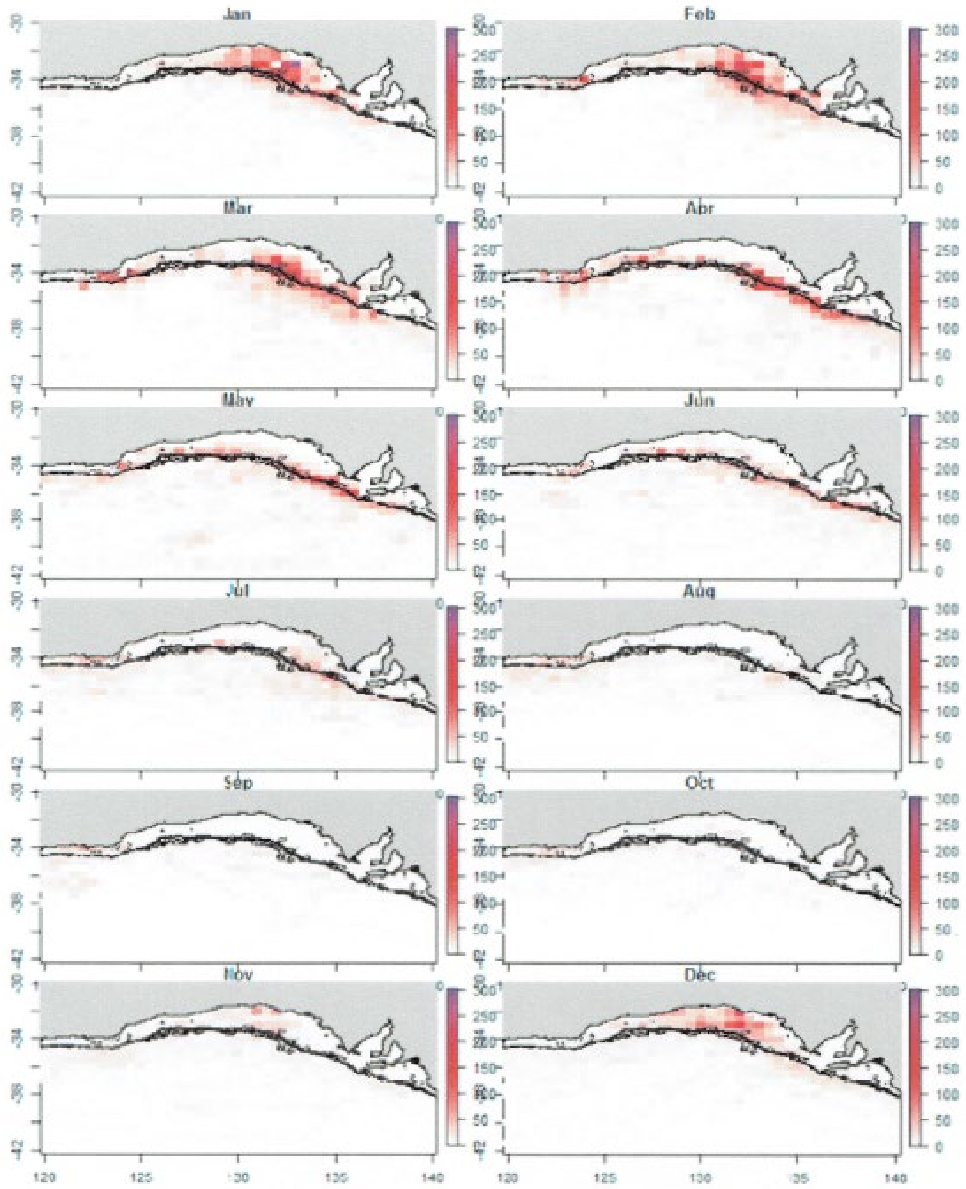
Anchovy larvae (>10 mm length) are found mainly in colder up-welling shelf waters (primarily close to shorelines) with larger larvae (>15 mm length) present in shelf waters adjacent to upwelling regions (Dimmlich et al. 2004; cited in Pattiaratchi, 2007).

Southern Bluefin Tuna

SBT spawn in tropical waters between Indonesia and North-west Australian (7ºS-20ºS) between September and March (Kailola et al. 1993). After spawning, SBT migrate south along the Western Australian coastline carried in part by the Leeuwin Current to, as far east as New Zealand and west to Southern Africa (DSE, 2003). Young fish are generally associated with coastal topographical features and continental shelf-waters, but by maturity, the SBT is oceanic and pelagic (Kailola et al. 1993) usually found seawards of the continental shelf (DSE, 2003). SBT appear off the southern WA coastline at approximately 12 months of age during spring-summer and inhabit in-shore waters up to the shelf-break (McClatchie et al. 2006). These fish move into the GAB where they aggregate over topographical features such as inshore reefs, islands and rises and the deeper half of the shelf particularly near the shelf-break (Cowling et al, 2002). At three years of age, juveniles are highly migratory making annual cyclical migrations between the inshore waters of the GAB (summer) and the waters of the Indian Ocean (winter). Individuals over 5 years have a circumglobal oceanic distribution and are rarely encountered in inshore waters (McClatchie et al. 2006).

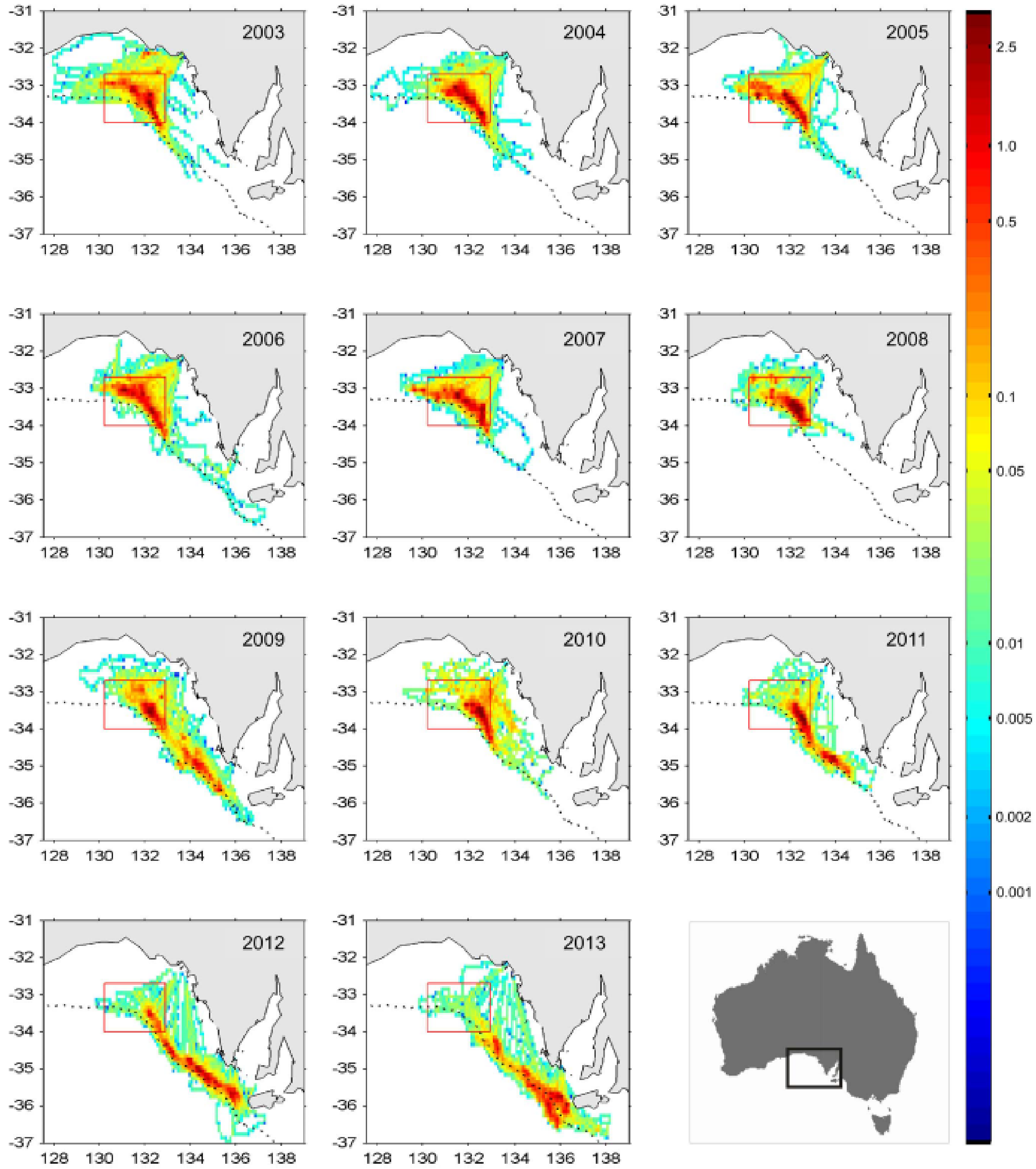
Data collected over almost 10 years has demonstrated that both the residence time and migration routes inshore and offshore across the continental shelf vary between years. Seasonal and inter-annual changes in the strength of the Leeuwin Current lead to thermal differences and potential changes in food availability between temperate and tropical waters. Juvenile SBT move in a broad area between 30-60ºS in the Indian Ocean and there does not appear to be specific or narrowly defined migratory routes (Basson et al., 2012). Movements of juvenile SBT into waters east of WA have been observed to increase as temperatures increase, with fish leaving the region when temperatures exceeded 20ºC. Movements are likely driven by change in prey availability resulting in changes in oceanographic conditions (Fujioka et al. 2012: cited in Kitagawa & Kimura, 2016) and productivity-related nutrition associated with key prey species (Ward et al, 2006). Nutritional analyses show that South Australian sardines have a relatively high lipid content (up to 6.8%) during summer-autumn, but that during the remainder of the year, when productivity levels are low and comparable with other parts of Australia, the lipid content is low, typically around 3% (D. Ellis, Australian Tuna Boat Owners Association, Adelaide, unpublished data; cited in Ward et al, 2006).Recent studies undertaken in the GAB, utilising electronic tagging of juvenile SBT (1998-2011) has identified that while migration timeframes vary year to year, SBT returning to the GAB start to rise in November, peak around December/January and continue through to as late as March. During summer (December to February) juvenile SBT are largely concentrated in inshore shelf waters or around the shelf-break in the western and central GAB (refer to Figure 3-27). During autumn (March – May) there is an apparent shift in preference for areas to the eastern side of the GAB with the northern, more coastal shelf waters of the GAB less frequented. The departure date of juvenile SBT from the GAB is highly variable but begins in February and extends into August with most fish having left the GAB by July (Evans et al, 2017). As evidenced in Figure 3-27, during the period September to November, the Duntroon MSS area, located in the *eastern GAB* does not carry large numbers of juvenile SBT. Juvenile SBT present in the GAB in November are primarily located in the western and central GAB regions.

Figure 3-27: Monthly aggregated counts of position estimates derived from juvenile southern bluefin tuna tagged with archival tags 1998-2011. Bathymetric contour lines associated with the shelf break are included as black lines (Evans et al, 2017)



SBT aggregate in large schools spending substantial time in the upper 100 m of the water column mostly during the day, and with deeper average depths during the night (Bestley et al. 2009). The GAB is the only area in the world where 1 to 5 year SBT are known to surface consistently (SEWPC, 2008). Juvenile SBT surfacing behaviours allow spotter planes to locate and target the species for commercial capture. Aerial and commercial fishing spotting data sets show that the highest densities of SBT schools are usually found in a band inside and parallel to the continental shelf break although this precise location varies. In recent years the areas of highest school density have moved from the central GAB (between ~130° and 133°E) to the east (~134°E) following the shelf break (Basson and Farley, 2014) although inshore areas around topographic features continue to be important for small/young SBT (refer Figure 3-28).

Figure 3-28: Distribution of SBT over GAB during Austral Summer (Jan-Mar) based on aerial survey data for 2003-2013 (Basson & Farley, 2014)



Individual SBT foraging success has been found to be highly variable with feeding predominantly occurring during the day particularly around dawn (Bestley et al, 2008). Whilst foraging in the GAB, juvenile SBT move rapidly between inshore and shelf-break habitats avoiding cooled upwelled water. Short movements between inshore topographic features are also common likely reflecting inshore foraging (Willis and Hobday 2007; cited in Kitagawa & Kimura, 2016). Migration from the GAB can begin in February extending into August (Cowling et al, 2017). There is a period of about 100 days from mid-April to mid-July when most departures occur (Basson et al. 2012) with the majority moving west into the Indian Ocean and the remainder moves east to the Tasman Sea (refer **Figure 3-29** and **Figure 3-31**).

Archival tag data from SBT often show distinctly shaped ascents and descents at dawn and dusk known as spike dives (Gunn and Block, 2001; Willis et al. 2009). Willis et al. (2009) recorded the depth of spike dives varied from 50-605 m. Sub-adult and adult SBT caught in the Tasman Sea demonstrate a preference for waters of 18-20°C and water depths < 250m, although spend time at depths >600 m and demonstrate diel variation in diving behaviour for periods of time (Patterson et al. 2008; cited in Kitagawa & Kimura, 2016). SBT are opportunistic and feed on cephalopods, crustaceans, fish and salps. Sharks, other tunas and fish, seabirds and killer whales are possible SBT predators at different stages of the SBT lifecycle (Kailola et al, 1993).

Song et al. (2006) examined the morphology of the inner ear of the Bluefin tuna (*Thunnus thynnus*) and hypothesised that the species probably does not detect sound much over 1 kHz. Other related species such as the yellowfin tuna (*T. albacares*) can detect sounds from 0.05 to 1.1 kHz with best sensitivity of 89 dB re 1µPa at 500 Hz (Iversen, 1967). Anatomical studies on the inner ear of several tuna species (Popper et al., 1981; Song et al., 2006) identified a lack of connection between the swim bladder and inner ear suggesting that tuna is primarily sensitive to the particle motion component of the sound field (Dale at al. (2015)). Dale et al., (2015) identified in the Pacific Bluefin Tuna, the best hearing was in the range 400-500 Hz with sharp decreases in sensitivity at higher and lower frequencies.

The IUCN lists the conservation status of the SBT as 'Critically Endangered' and SBT are recognised as being 'severely depleted'. This is a result of their slow-growing, late-maturing and long life-cycle which has led to overfishing by commercial fleets (Robins et al., 2000).

Figure 3-29: SBT spawning ground and migration pattern (Caton, 1991)

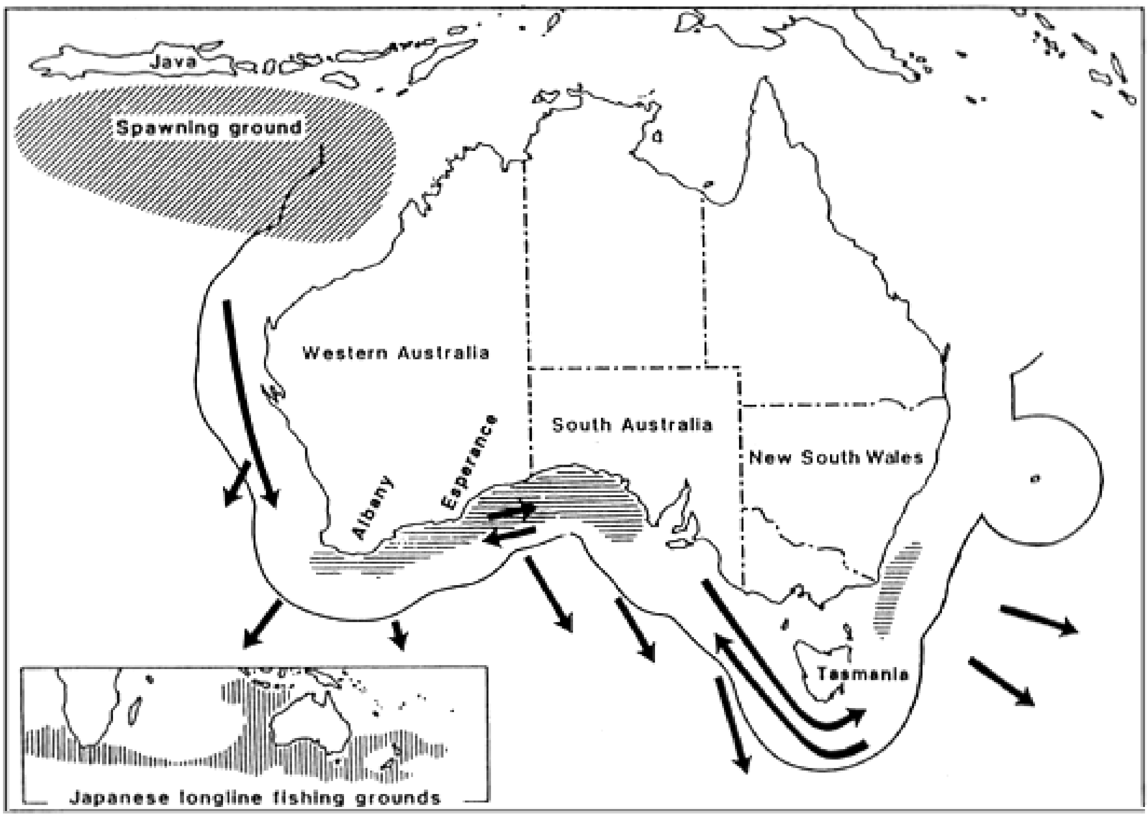
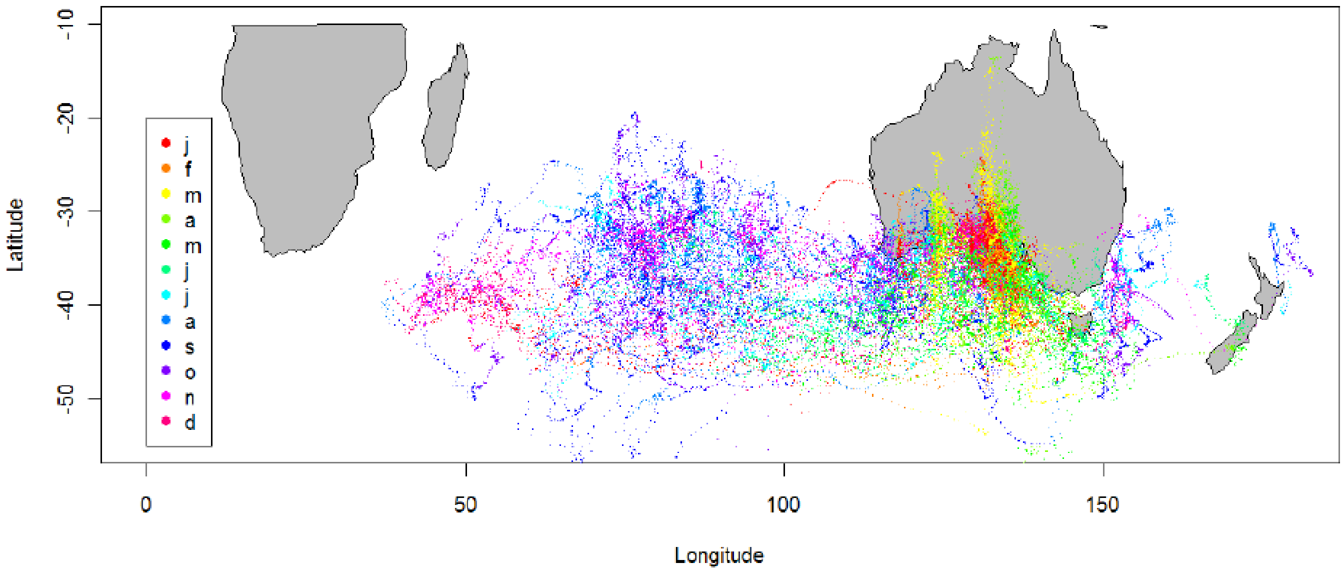


Figure 3-30: SBT Trackit estimates for location of 91 Archival Tags (1998-2008) (Basson et al, 2008)



Refer to Section 3.8.3 for further details on commercial fish species associated with specific commercial fisheries.

Small Pelagic Fish

Small pelagic fish inhabit a diverse range of marine environments, including inshore embayments, river-mouths and estuaries, the waters over the continental shelf and shelf-break. Population sizes fluctuate in response to environmental variability, inter-species competition, food availability, predation, recruitment variability and commercial fishing pressure. CSIRO (1998) identifies that the demersal fish resources in the GAB are small.

Small pelagic fish form schools that vary in size from several hundred individuals to immense aggregations of hundreds of tonnes. This schooling behaviour makes them particularly vulnerable to larger pelagic predators and to exploitation by fisheries for bait, mariculture fodder and human consumption (McClatchie et al, 2006).

The ‘small pelagic fishes’ species group consists of eleven key species belonging to six families. These families include Clupeidae, Engraulidae, Scombridae, Carangidae, Emmelichthyidae and Scomberesocidae. Members of family Clupeidae (herring-like fishes) are dominant and five species occur in the SW Region. Small pelagic fish species found in South Australia and Western Australia include sardine (pilchard) (*Sardinops sagax*), scaly mackerel (*Sardinella lemuru*), Australian anchovy (*Engraulis australis*), round herring (*Etrumeus teres*), sandy sprat (*Hyperlophus vittatus*), blue sprat (*Spratelloides spp*.), jack mackerel (yellowtail scad) (*Trachurus declivis* and *T. novaezelandiae*), blue or slimy mackerel (*Scomber australasicus*), redbait (Emmelichthys nitidus) and saury (*Scomberesox saurus*) (McClatchie et al, 2006).

Fluctuations in the abundance of small pelagic fishes have significant implications for the function of pelagic ecosystems. This species group represents a critical energy pathway between primary (phytoplankton) and secondary (zooplankton) producers and larger predatory fishes, sharks, seabirds, seals and cetaceans (McClatchie et al, 2006).

3.7.5 Cetaceans

The EPBC Act Protected Matters Search database (DOEE, 2017a) lists 32 cetacean species as possibly occurring in the survey area. Within the EMBA, 35 species may be present. Of these, five species are listed as threatened the Blue Whale (*Balaenoptera musculus*), Humpback Whale (*Megaptera novaeangliae*), Southern Right Whale (*Eubalaena australis),* Fin Whale (*Balaenoptera physalus*) and Sei Whale (*Balaenoptera borealis*); and 11 species are listed as migratory.

An additional marine mammal species is also listed as threatened, in or in proximity to the survey area is the Australian sea lion (*Neophoca cinerea*) (refer pinnipeds section).

Table 3-7 provides details of the species which are listed under the EPBC Act Protected Matters Database as present in the survey OA and EMBA. Details of those cetacean and other marine mammal species are discussed further in this section.

3.7.5.1 Humpback whale (baleen)

The humpback whale *(Megaptera novaeangliae)*, a migratory species listed as vulnerable under the EPBC Act, is found throughout Australian Antarctic waters and Commonwealth offshore waters (SEWPC, 2012f). Humpback whales feed on krill primarily during the summer months in Antarctic waters south of about 55°S (peak season mid-January to February) (SEWPC, 2012f). Some feeding has also been observed in Australia's coastal waters, but this is thought to be opportunistic and forms only a small portion of their nutritional requirements (SEWPC, 2012f). Two recognised populations exist in Australia, the western Australian population of humpbacks, which is a genetically distinct group from the eastern Australian group. The WA population of the species commences a northerly migration from Antarctic waters in May reaching southwest WA waters in early-mid June and the eastern Australian group reaches southeast Australia in April-May. The western population then migrates north along the WA coast to the north-west marine region (i.e. Camden Sound) where breeding/calving takes place between mid-August and early September; and the eastern population to the Great Barrier Reef (14ºS-27ºS) where breeding takes place, after which the southern migration commences (SEWPC, 2012f). Migratory humpbacks on their southern migration pathway are in southwest WA waters between mid-October to late November each year and in south-east Australian waters in November-December each year (DEH, 2005c). Migratory pathways are distinct along the eastern and western Australian coastlines with a lower presence in the GAB (DEH, 2005c).

Gill et al., (2015) assessed the cetacean presence over the continental shelf/slope waters between western Bass Strait to the eastern GAB from systematic aerial surveys between 2002 and 2013. There were ten sightings of humpback whale during this period with 18 individuals identified in a mean group size 1.8±1.0. These species were encountered most often between May and September despite low survey effort in those months. The mean depth of the species was observed to be 57 ± 31 m. Recorded encounter data for this period was (August to December):

- August – 0 whales sighted/1000 km survey distance;
- September – 0.35 whales sighted/1000 km survey distance;
- October – 0 whales sighted/1000 km survey distance;
- November – 0.05 whales sighted/1000 km survey distance; and
- December – 0.07 whales sighted/1000 km survey distance.

Note that survey effort was biased towards coverage of upwelling seasons (i.e. November to April; 103 of 123 surveys) and relatively little effort occurred during 2008-2011 (Gill et al, 2015). Observation data for humpback whale occurrence corresponds with the timing of migration to and from calving grounds off Northern Australia (Dawbin 1966; cited in Gill et al. 2015), and evidence of autumn feeding is consistent with opportunistic feeding observed in migration routes off eastern Australia (Stamation et al., 2007; cited in Gill et al., 2015).
Bilgmann et al (2014) observed in surveys located across coastal and shelf waters of the eastern GAB (coastline to 100 m depth contour) between Ceduna and Coffin Bay during July and August 2013, three humpback whales.

The NCVA records that the survey area does not lie in a BIA (breeding, feeding, resting or migration pathway) for the humpback whale. It is possible that this species may be encountered during survey activities, however based upon observation data, the timing of the survey is expected to avoid peak encounter periods and the potential for encounter is considered very low.

<u>Recovery Plan (Humpback Whale)</u>:

There is no recovery plan in place for the humpback whale (*Megaptera novaeangliae*). The recovery plan (DEH, 2005) ceased to be in effect from 1 October 2015.

Table 3-7: EPBC listed marine mammal species which may occur in or around the survey area (DoEE, 2017a; DoEE, 2018c)

Status:
E: Endangered
V: Vulnerable
M: Migratory
L: Listed

Likelihood of Occurrence:
LO: Species/ species habitat likely to occur in area
MO: Species/ species habitat may occur within area
FMO: Foraging/Feeding may occur within area
FKO: Foraging/Feeding known to occur in area
KO: Species/ species habitat known to occur within area
FLO: Foraging/Feeding likely to occur in area
BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Cetaceans	Balaenoptera acutorostrata	Minke Whale	L	MO	✓	-	✓	-	-
	Balaenoptera bonaerensis	Antarctic Minke Whale	M	LO	✓	-	✓	-	-
	Balaenoptera borealis	Sei Whale	V,M	FLO	✓	-	✓	-	✓ [1]
	Balaenoptera edeni	Bryde's Whale	M	MO	✓	-	✓	-	-
	Balaenoptera musculus	Blue Whale	E, M	FKO	✓	Foraging (abundant food source/annual high use) Known foraging area Distribution	✓	Foraging (abundant food source/annual high use) Known foraging area Distribution	✓ [2]
	Balaenoptera physalus	Fin Whale	V, M	FLO	✓	-	✓	-	✓ [3]
	Berardius arnuxii	Arnoux's Beaked Whale	L	MO	✓	-	✓	-	-
	Caperea marginata	Pygmy Right Whale	M	FLO	✓	-	✓	-	-
	Delphinus delphis	Common Dophin	L	MO	✓	-	✓	-	-
	Eubalaena australis	Southern Right Whale	E, M	KO	✓	-	✓	Calving Buffer Seasonal Calving Habitat	✓ [4]
	Feresa attenuata	Pygmy Killer Whale	L	MO	✓	-	✓	-	-
	Globicephala macrorhynchus	Short-finned Pilot Whale	L	MO	✓	-	✓	-	-
	Globicephala melas	Long-finned Pilot Whale	L	MO	✓	-	✓	-	-
	Grampus griseus	Risso's Dolphin	L	MO	✓	-	✓	-	-
	Hyperoodon planifrons	Southern Bottlenose Whale	L	MO	-	-	✓	-	-
	Kogia breviceps	Pygmy Sperm Whale	L	MO	✓	-	✓	-	-
	Kogia simus	Dwarf Sperm Whale	L	MO	✓	-	✓	-	-
	Lagrnorhynchus obscurus	Dusky Dolphin	M	LO	✓	-	✓	-	-

Status:
E: Endangered
V: Vulnerable
M: Migratory
L: Listed

Likelihood of Occurrence:
LO: Species/ species habitat likely to occur in area
MO: Species/ species habitat may occur within area
FMO: Foraging/Feeding may occur within area
FKO: Foraging/Feeding known to occur in area
KO: Species/ species habitat known to occur within area
FLO: Foraging/Feeding likely to occur in area
BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
	Lissodelphis peronii	Southern Right Whale Dolphin	L	MO	✓	-	✓	-	-
	Megaptera novaeangliae	Humpback Whale	V, M	LO	✓	-	✓	-	✓ [5]
	Mesoplodon bowdoini	Andrew's Beaked Whale	L	MO	✓	-	✓	-	-
	Mesoplodon densirostris	Blainville's Beaked Whale	L	MO	✓	-	✓	-	-
	Mesoplodon grayi	Gray's Beaked Whale	L	MO	✓	-	✓	-	-
	Mesoplodon hectori	Hector's Beaked Whale	L	MO	✓	-	✓	-	-
	Mesoplodon layardii	Strap-toothed Beaked Whale	L	MO	✓	-	✓	-	-
	Mesoplodon mirus	True's Beaked Whale	L	MO	✓	-	✓	-	-
	Mesoplodon ginkgodens	Ginko-toothed whale	L	MO	-	-	✓	-	-
	Orcinus orca	Killer Whale	M	MO	✓	-	✓	-	-
	Peponocephala electra	Melon-headed whalr	L	MO	✓	-	✓	-	-
	Physeter macrocephalus	Sperm Whale	M	FKO	✓	Foraging Likely	✓	Foraging Likely	-
	Pseudorca crassidens	False Killer Whale	L	MO	✓	-	✓	-	-
	Tasmacetus shepherdi	Sheperd's beaked whale	L	MO	-	-	✓	-	-
	Tursiops aduncus	Indian Ocean Bottlenose Dolphin	L	LO	✓	-	✓	-	-
	Tursiops truncatus s. str.	Bottlenose Dolphin	L	MO	✓	-	✓	-	-
	Ziphius cavirostris	Cuvier's Beaked Whale	L	MO	✓	-	✓	-	-
Other Mammals	Arctocephalus forsteri	New Zealand Fur Seal	L	LO	✓	-	✓	-	-
	Arctocephalus pusillus	Australian Fur Seal	L	MO	-	-	✓	-	-
	Neophoca cinerea	Australian Sea Lion	V	FLO	✓	Foraging (male)	✓	Foraging (male and female) Breeding Sites	✓ [6]

Definitions:

Listed threatened species:	A native species listed (L) under the Commonwealth EPBC Act (Section 178): critically endangered (CE), endangered (E), vulnerable (V)
Listed migratory species:	A migratory (M) species included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.
Listed marine species:	As listed in Section 248 of the EPBC Act.

References:

[1] Conservation advice for the Sei Whale (TSSC, 2015e)

[2] Blue Whale Conservation Management Plan (DoE, 2015)

[3] Conservation advice for the Fin whale (TSSC, 2015d)

[4] Conservation Management Plan for the southern right whale (SEWPC, 2012)

[5] Conservation advice for the Humpback Whale (TSSC, 2015c)

[6] Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (SEWPC, 2013)

Conservation Advice (Humpback Whale):

Information from the conservation advice for the Humpback whale (TSSC, 2015c) identifies the following threats to the species relevant to the Duntroon multi-client survey:

- Noise interference from anthropogenic noise sources including seismic exploration and shipping noise. The potential impacts of increasing noise can include hearing impairment, organ damage or mortality, mask vocalisations, change call frequency or amplitude and behavioural disturbance;
- Entanglement when the whale is caught in marine debris; and
- Vessel disturbance and strike.

Conservation and management actions detailed for these threats from the Conservation Advice are detailed in Table 3-8. Noise interference is discussed in Section 6.2, entanglement with marine debris in Section 6.13; and vessel disturbance and strike in Section 6.15.

Table 3-8: Conservation advice for the Humpback Whale (TSSC, 2015c) – Threats relevant to activity

Relevant Threat/ Objectives	Conservation and Management Action	Action taken within EP
Assessing and addressing anthropogenic noise; shipping, industrial and seismic surveys	All seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. Should a survey be undertaken in or near a calving, resting, foraging area, or a confined migratory pathway then Part B. Additional Management Procedures must also be applied.	Duntroon survey is not within a BIA (calving, resting, foraging or confined migratory pathway) for the Humpback whale. EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales will be applied.
	For actions involving acoustic impacts (example pile driving, explosives) on humpback whale calving, resting, feeding areas, or confined migratory pathways site specific acoustic modelling should be undertaken (including cumulative noise impacts).	Acoustic modelling has been undertaken for this survey. Survey area is not within recognised calving, resting, feeding or migratory pathways for the species.
	Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified a noise management plan should be developed.	Not applicable to Duntroon survey.
Entanglement – Marine Debris	-	Threat Abatement Plan (marine debris) isapplied within this EP.
Minimising Vessel Collisions	Maximise the likelihood that all vessel strike incidents are reported in the National Ship Strike Database. All cetaceans are protected in Commonwealth waters and, the EPBC Act requires that all collisions with whales in Commonwealth waters are reported. Vessel collisions can be submitted to the National Ship Strike Database at https://data.marinemammals.gov.au/report/shipstrike	Reporting requirement to be included within Section 6.15 (Cetacean collision with vessel)
	Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike.	Vessel strike risk assessment included in this EP (Section 6.15)

3.7.5.2 Blue whale (baleen)

The blue whale *(Balaenoptera musculus),* a migratory species listed as endangered, is present in waters of Australia's Antarctic Territory and is widespread in all Australian waters at various times of the year (SEWPC, 2012g). The species has a cosmopolitan distribution, oceanic and appears to undertake extensive migrations between warm water (low latitude) breeding, mating and calving areas during the winter and cold water (high latitude) feeding grounds during summer between approximately 20ºS and 60-70ºS (Bannister et al. 1996; DoE, 2015).

Subspecies of the blue whale which may occur in Australian waters includes the Antarctic blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda).* Australian blue whales are represented by the following sub-populations, namely (DoE, 2015; Garcia-Rojas et al, 2018):

- Antarctic blue whale population which consists of all Antarctic blue whales occupying or passing through Australian waters. This population has a circumpolar, but potentially patchy, distribution off Antarctica during the summer feeding season. Limited evidence suggests that some of the population migrate to sub-tropical latitudes of the Pacific and Indian Oceans to breed. Off WA this population has been detected off Cape Leeuwin from May to November; the Perth Canyon from May to October; and off the west and north coast of Tasmania predominantly from May to December. There is limited understanding of the movements of Antarctic blue whales around Antarctica or between Antarctica and breeding areas. However, based upon acoustic recordings off WA and Tasmania, these areas may form part of their migratory route between Antarctica and northern wintering grounds;
- Eastern Indian Ocean (Indonesian and Australian) pygmy blue whale population (*relevant to survey area*) which aggregates predictably during the austral summer and autumn to forage in the Perth Canyon (WA); the Bonney upwelling system; and adjacent waters off Victoria, South Australia and Tasmania.
- Tasman-Pacific blue whales which consist of all pygmy blue whales occupying or passing through waters in south-east Australia and the Pacific Ocean. The migratory routes off the east coast are not known. Acoustic loggers have detected pygmy blue whales in May-June indicative of animals heading east potentially foregoing low-latitude migration seeking alternative wintering grounds in temperate waters. Regular acoustic detections recorded along the east coast of Australia suggest that this population may utilise the Tasman Sea year-round.

Migration:

The pygmy blue whale does not migrate as far south (~55°S) compared with the Antarctic blue whale (Bannister et al. 1996). Antarctic blue whales appear to feed mainly, if not exclusively, in the Antarctic. Pygmy blues are not generally found in the Antarctic and appear to feed in more temperate latitudes (usually found north of 55°S) (DoE, 2015; Branch et al, 2007). It is therefore likely that records of blue whales feeding in Australian waters between late spring-autumn are pygmy blue whales (DEH, 2005d) (*hereafter referred to as blue whales*). The blue whale distribution around Australia is provided in **Figure 3-31** and migration pathways are provided in Figure 3-32.

Photo-identification has confirmed within and between season movement of pygmy blue whales between the Bonney upwelling and Perth Canyon feeding areas (Garcia-Rojas et al, 2018). Satellite tagged individuals have been tracked migrating north from the Perth Canyon to Indonesian waters almost to the equator, the likely breeding area for this population (Branch et al, 2007; Gales et al, 2010; Double et al, 2014: cited in Garcia-Rojas et al, 2018). While migratory pathways require further delineation, satellite tagging undertaken has established the following (refer Figure 3-33):

- For one whale tagged in Geographe Bay (WA), migration into the Southern Ocean 775 km southeast of Cape Leeuwin between 4 December 2002 and late January 2003 (Garcia-Rojas et al, 2018); and
- For four adult pygmy blue whales tagged in April 2005 in Discovery Bay (VIC), three whales moved along the continental shelf before tagging transmissions ceased. The fourth whale subsequently moved northwest along the continental shelf, then tracked back 80 km to the southeast along the shelf, and then tracked due south reaching the Subtropical Convergence Zone (STC). During its presence at the STC, the whale slowed its travel speed and limited its movements to an area less than 10, 000 km^2. This whale was also a resight of a whale previously photo-identified in February 2004 in the Perth Canyon (Garcia-Rojas et al, 2018).

The Subtropical Front (confluence of sub-tropical and sub-antarctic waters between 40-45°S) is likely to be a large-scale feeding area (Mikhalev, 2000; cited in DoEE, 2018d). Satellite tagging has shown rapid movement from western and eastern Australia to the Subtropical Front – an area targeted by Soviet whalers during the 1960s (Mikhalev, 2000; cited in DoEE, 2018d). Additional studies involving long-term (3 year) acoustic data collection over the Southern Ocean (between Australia and the Antarctic continent) found peak acoustic presence of the pygmy blue whale occurred between March-May and at more northerly recording sites compared with the Antarctic blue whale acoustic presence (May to August) (Gedamke et al, 2007; cited in DoEE, 2018d).

Foraging Areas:

Key foraging aggregation areas within Australian waters for the blue whale are the Bonney upwelling system and adjacent water off South Australia and Victoria, and the Perth Canyon (WA). According to the NCVA (DoEE, 2018b), the eastern GAB is a recognised blue whale BIA - a known distribution area, seasonally high foraging area (abundant food source, known foraging area) and possible weaning area for calves. While the area has high usage, there is variation between and within seasons dependent on the prevailing local environmental conditions that are favourable to krill (DoE, 2015; Branch et al, 2007). **Figure 3-35** details the Duntroon survey area relative to the recognised BIAs for the pygmy blue whale. The MC3D survey area spatially overlaps approximately 3326 km^2 (8.7% of the blue whale BIA (high abundant food source) and BIA (known foraging area) BIA [Note these BIAs are coincident[14]]. The MC2D survey area spatially overlaps 477 km^2 of the (1.2% known foraging area + high abundant food source) BIA.

According to the NCVA (DoEE, 2018b; DoE, 2015), blue whales forage in the eastern GAB adjacent to the Kangaroo Island canyons (i.e., area west of the Bonney Upwelling System) from November to May *with data to date suggesting peak use in December and limited evidence of later use (i.e. single sighting in April 2007*)'. Branch et al (2007), based upon blue whale records for historic catch, sightings, strandings, mark-recapture movement studies and acoustic detections (period 1950-2007), established a low seasonal presence between June and October with increased sightings in November.

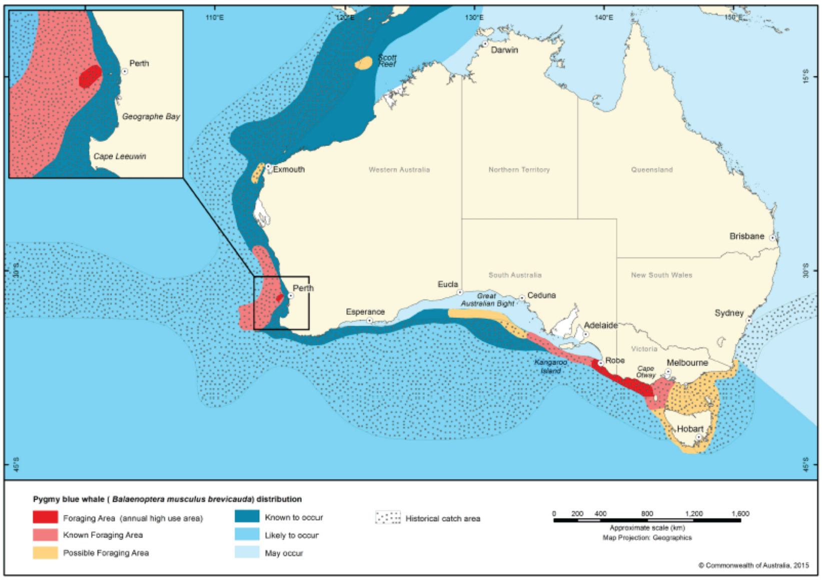
Surveys undertaken in 2003-04 found up to 30 blue whales foraging along the shelf break to the west and south of Kangaroo Island (Morrice et al, 2004), but subsequent surveys have shown that that relative abundance in this area is highly variable. All 2003 observations were located within 15 km of the 200 m depth contour, with most whales concentrated inshore of the steep slope canyon features (Morrice et al. 2004; cited in Pattiaratchi, 2007). In the Bonney Upwelling, approximately 300 km to the southeast, the earliest sighting in any season to date was 8 November (in 2004) and the latest that the blue whale has been acoustically detected was 29 May (in 2001). Recent correspondence from the Blue Whale Study (BWS) [**Stakeholder Record 26**] has indicated that blue whales have recently been spotted off Portland in October (no other details provided).

Aerial surveys (1998-2001) have not sighted blue whales during June-October (Gill, 2002; cited in Gill et al, 2011). Non-systematic surveys conducted between June and October have found no whales, nor have any been reported from other sources (Thiele 2005; cited in DoEE, 2018d).Gill (2018) has identified that blue whales have been sighted off Portland in October and November in the recent past (**Stakeholder Record 29**).

In feeding and foraging grounds, the pygmy blue whale typically occurs as individuals or in groups of two. This may minimise the potential for competition of small patches of krill (DoE, 2015). In the Bonney Upwelling, the blue whale frequently lunge forage at or near the surface; but at other times, they may also dive to varying depths to forage (Gill 2004; Gill & Morrice 2003).

[14] Total area of the Foraging (abundant food source) and Known foraging area BIAs is 37,986 km^2.

Figure 3-31: Pygmy blue whale distribution around Australia (DoE, 2015)



Foraging Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis	Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons	Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
Possible Foraging Area	Evidence for feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity of whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route	May occur	Evidence for the presence of blue whales through strandings or rare observations
		Historical catch area	Blue whales were caught during the whaling period based on whaling data

Figure 3-32: Pygmy blue whale migration routes (DoE, 2015)

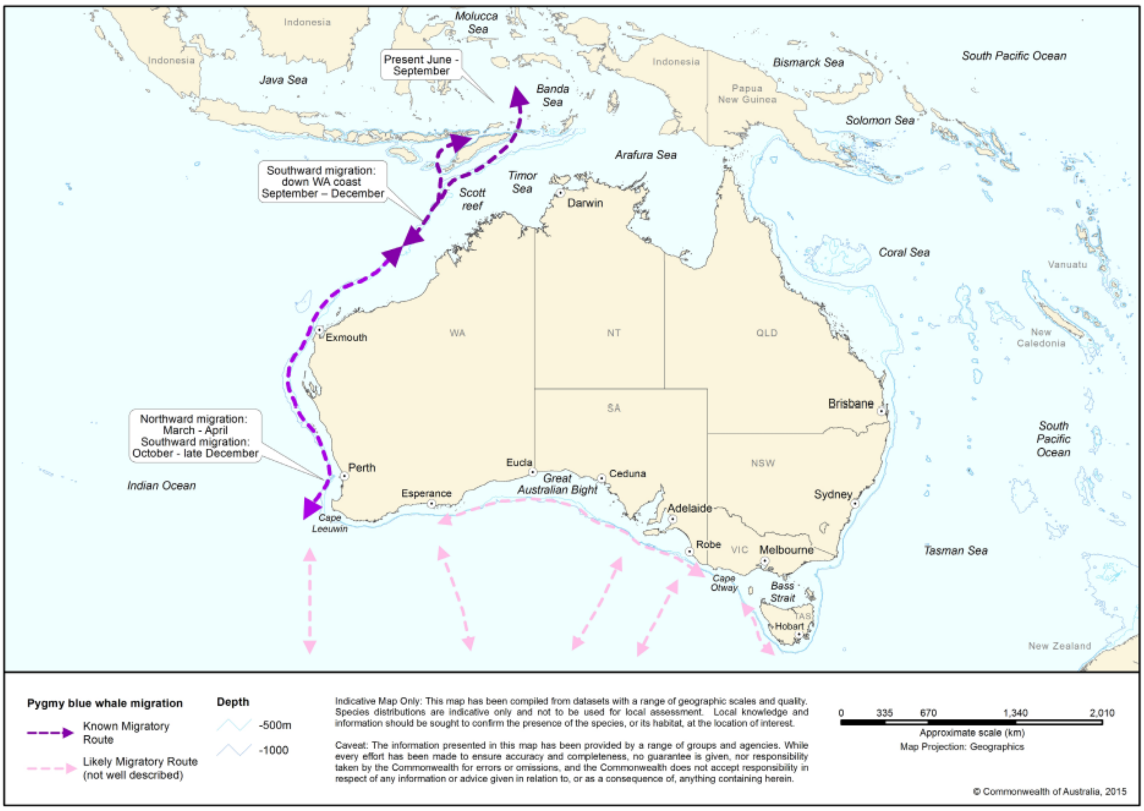
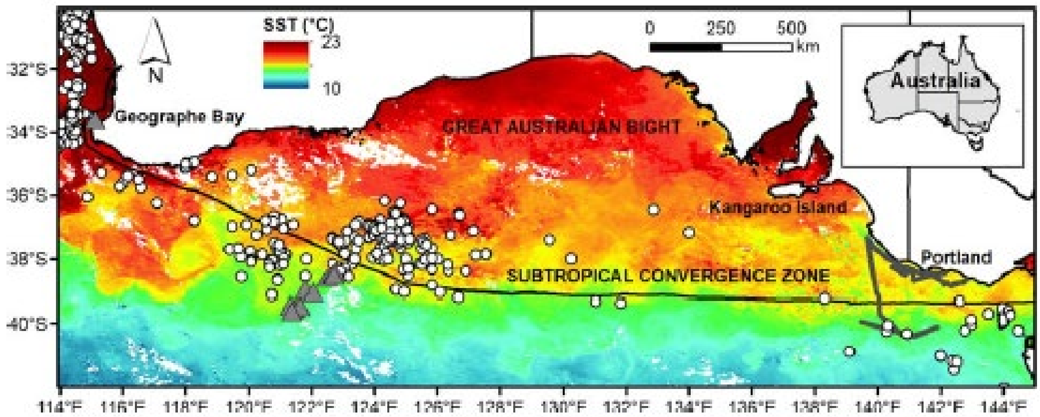


Figure 3-33: Satellite Tracking of pygmy blue whale individuals in the Subtropical Convergence Zone south of Australia (STC) between 4 December 2002-31 January 2003 (grey triangles) and 5-18 April 2005 (grey line). Hictorical Soviet whaling catches of pygmy blue whales are indicated by the white circles) (Garcia-Rojas et al, 2018).



Croll et al., (2001) studied the diving behaviours for blue and fin whales during migration and foraging. Foraging dives in both species were deeper, longer in duration and distinguished by a series of vertical excursions where lunge feeding presumably occurred. On average, blue whales dive to 140.0 (±46.01) m and for 7.8 (±1.89) min when foraging, and 67.6 (±51.46) m and for 4.9 (±2.53) min when not foraging. Similarly, Goldbogen et al., (2011) studied foraging dives for 265 blue whales and identified the maximum foraging depth was 290 m and a maximum dive duration of 12.8 mins.

In accordance with the *Conservation Management Plan for the Blue Whale* (DoE, 2015), foraging BIAs are important to the survival of blue whales upon which significant whale aggregations rely (DoE, 2015).

Aerial surveys in eastern GAB:

Gill et al. (2011) undertook 69 aerial surveys between January 2002 and May 2007 to establish the spatial and temporal variation of abundance and distribution of blue whales in the area extending from west of Kangaroo Island (~134ºE) to Cape Otway (Vic) (~143º30'E). These surveys were conducted during six upwelling seasons each defined as the period between November and May. **Figure 3.34** provides the aggregation areas in November and December on the outer shelf in the western zone in two clusters, south and west of Kangaroo Island. Survey effort was concentrated on the outer shelf and upper continental slope where whales were detected during initial surveys (refer Figure 3-34). Gill et al (2011) qualify these survey results by identifying that there was little survey coverage of this area in subsequent months and sighting effort in the 'western zone' of the survey (i.e., west of Eyre Peninsula to Cape Jaffa) was concentrated in the 2003-04, 2004-05 and 2005-06 seasons.

Foraging was observed in 23% of sightings; and in 48% of sightings euphausiid surface swarms were within ~ 2 km of the whales. At times where no surface swarms were sighted (i.e. 52% of sightings), the likely presence of submerged prey swarms was often indicated by blue whales diving steeply and resurfacing nearby, with partly open mouths and distended throat pouches (Gill et al, 2011). The depth distribution of blue whales in the western region is provided in Figure 3-36 (Gill et al. 2011).

Figure 3-34: Blue whale sightings for December 2003, 2004 and 2005 (pooled all seasons) for western zone overlain on gridded aerial survey effort (10km x 10km squares) and 50% and 95% probability contours for blue whale distribution from density kernels (Gill et al. 2011)

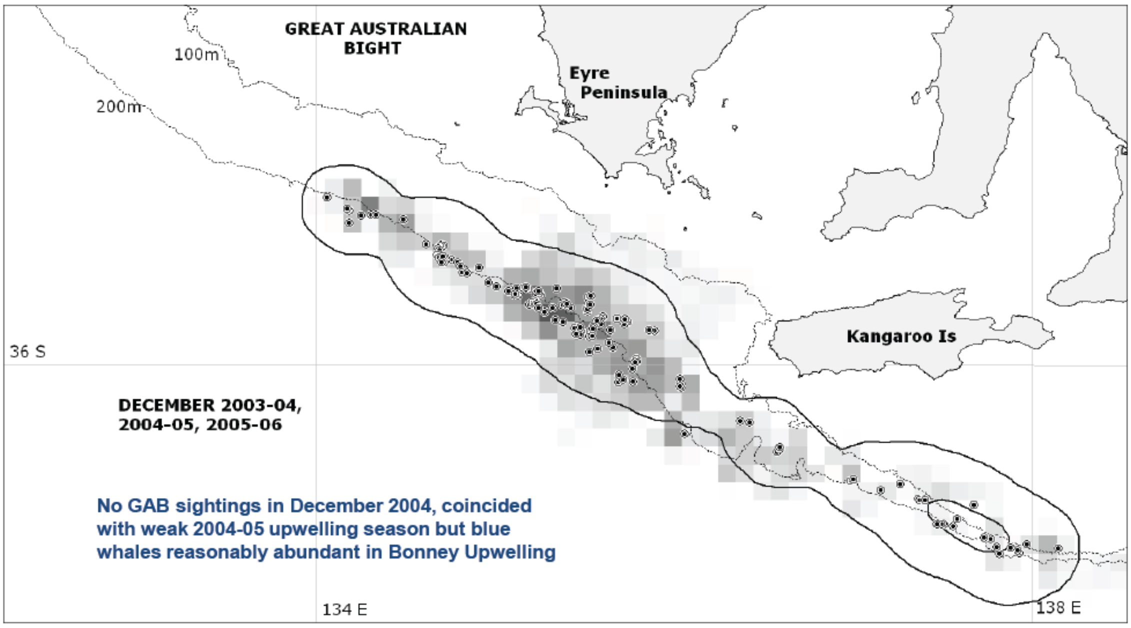


Figure 3-35: Duntroon Survey OA relative to Pygmy Blue Whale BIAs in Eastern GAB (DoEE, 2017b)

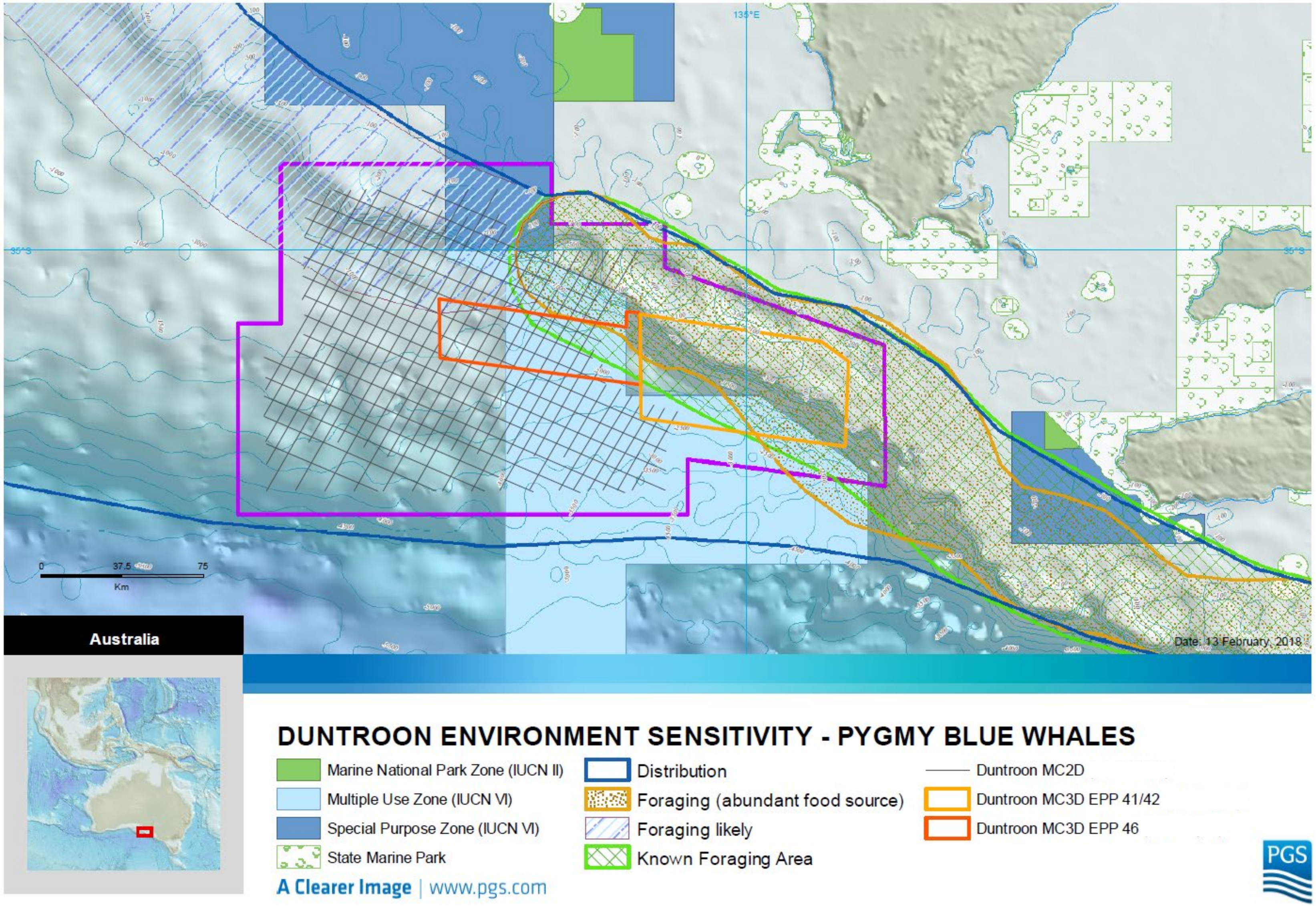
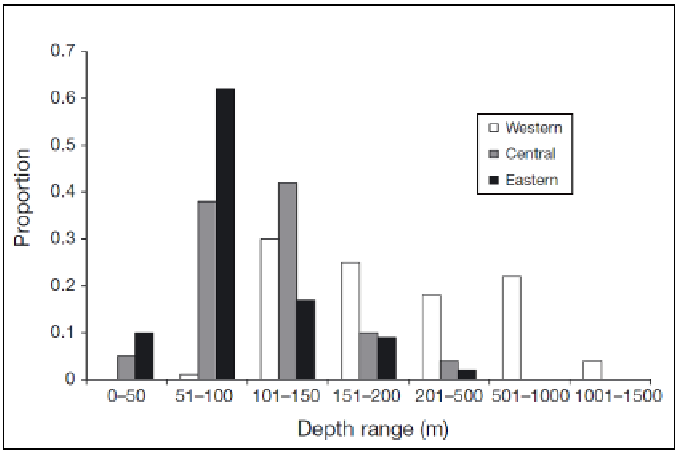


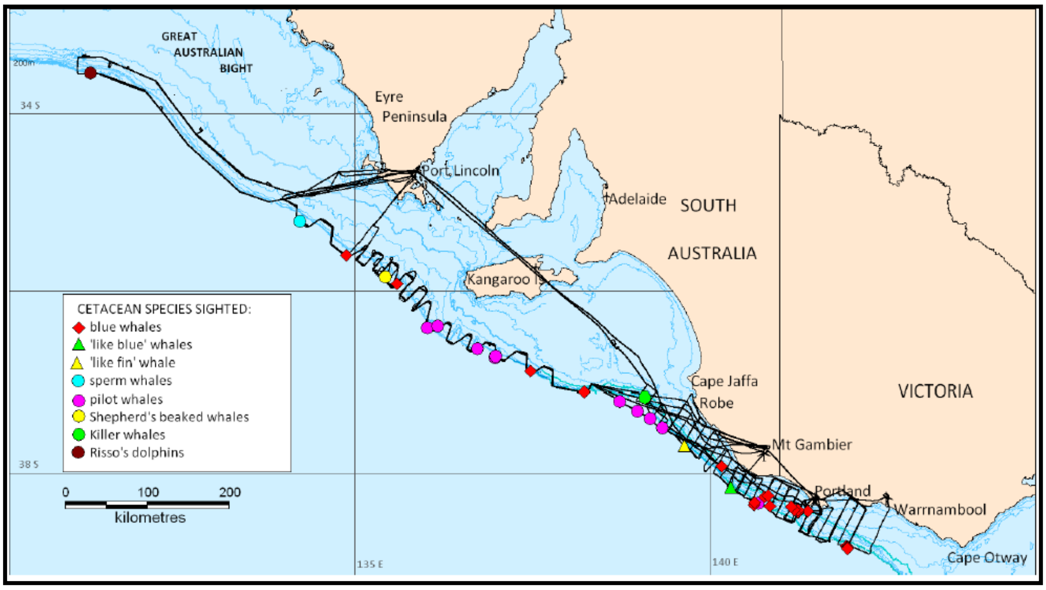
Figure 3-36: Sighting depth distributions in the three zones (Gill et al. 2011)



Other observation data obtained from GAB surveys includes:

- An aerial survey monitoring programme undertaken by Blue Whale Study Inc. on behalf of Bight Petroleum, for the 2011-2012 season (November-March) where blue whales were sighted in December (only) in proximity to the survey area (Blue Whale Study Inc., 2012) (refer Figure 3-37).

Figure 3-37: Cetacean Survey (November 2011-March 2012) for East GAB (Blue Whale Study, Inc.)



- PGS's Ceduna 3D MSS, which was located approximately 200 km to the west of the Duntroon OA and carried out between November 2011 and May 2012 reported 12 sightings of pygmy blue whale in November only (TGS, 2014).

- The International Fund for Animal Welfare (IFAW) conducted a vessel-based survey between 26th April and 8th May 2013 to look at the diversity, distribution and presence of whales and dolphins in the area to the west of Kangaroo Island using visual and acoustic techniques. Data collected identified several groups of dolphins, pods of bottlenose dolphins, a number of fur seals, pilot whales, sperm whales and Shephard's beaked whales (IFAW, 2013). There were no reported encounters of blue or southern right whales during the survey.

- Bilgmann et al. (2014) undertook aerial surveys in the eastern GAB via north-south transects between Ceduna and Coffin Bay extending from the coast to the continental shelf between 23 July and 8 August 2013. No blue whales were sighted during this survey.

- TGS's Nerites MC3D MSS (Phase 1), located west of the proposed Duntroon OA, was undertaken from January to June 2014. Throughout this survey only one pygmy blue whale was sighted in May (TGS, 2014).
- Gill (2016) in three aerial surveys of the western Otway coastline and eastern/central GAB in December 2015 and January and March 2016, identified a total of 58 cetaceans. No blue whales were sighted in the eastern GAB during the survey. Anecdotal records provided in the survey report identified a group of 25 blue whales around the Murray and Sprigg canyons south of Kangaroo Island during late November-early December 2015 (not present on 9 December during aerial survey) and in mid-December 2014 tuna spotting pilots reported a group of 25-30 blue whales in a small area west of Kangaroo Island.

Factors affecting blue whale distribution:

Branch et al (2007) collated based upon all available worldwide records of blue whale presence (i.e. historic catches, sightings, strandings, mark-recapture movement studies and acoustic detections) an update to blue whale distribution, densities and migration theory. The study identified that blue whale distribution is linked to areas with known or inferred high densities of *euphausiids*. Branch et al (2007) identified at the largest scale, blue whales occurred in regions where there were high phytoplankton densities (Antarctic/Sub-antarctic waters, Arabian Sea and west coasts of South America and Africa), however also identified that annual mean *chlorophyll-a* levels were intermediate to low south of Madagascar and around Australia where blue whale sightings were numerous. This observation was attributed to seasonal blooming and under-representation in the annual mean. Blue whales were virtually absent year-round from the mid-lattitude central gyres with the lowest *chlorophyll-a* concentrations.

In the Bonney Upwelling, the major prey of the blue whale is the krill *Nyctiphanes australis* (Gill & Morrice 2003). Relative abundance of *N. australis* appears to be linked to the timing of the Bonney Upwelling, which is active between November and May (Gill 2004). Other crustacean species have been identified in plankton samples and it may be that the blue whale feeds opportunistically on more than one species in this region. Whales almost certainly consume quantities of copepods (crustacean) and possibly salps (free-swimming organisms) as bycatch when feeding on other target species (Morrice 2004; cited in DoEE, 2018d).

Gill et al (2011) found a statistically significant correlation between blue whale encounter and sea surface temperature (SST) and sea surface chlorophyll (SSC), closely followed by water depth. In the western zone of the study area, blue whales were distributed west of Kangaroo Island with a mean SST of 19.2ºC ± 0.77 ºC, and to the south of Kangaroo Island with a mean SST of 18ºC ± 1.02ºC. For the western zone, blue whales were distributed west of Kangaroo Island with a mean SSC of 0.101 mg/m^3 ± 0.014 mg/m^3 and south of Kangaroo Island with a mean SSC of 0.171 mg/m^3 ± 0.022 mg/m^3. While the study identified a positive distribution relationship with SST at the scale of the upwelling system it did not preclude cold water surface plumes being a significant predictor of blue whale distribution over the wider oceanic domains. Ecologically, SST is likely to be a significant predictor on a broad scale because of its relationship with upwelled nutrients and the effect on primary and secondary production (Gremillet et al, 2008; Whitehead et al, 2010; cited in Gill et al, 2011).

Garcia-Rojas et al (2018) studied blue whale foraging within the STC and found a statistically significant relationship between whale occurrence and areas of enhanced SSC and SST (17.5-18ºC), however also identified that while SSC was < 1.5 mg/m^3, subsurface concentrations reached 8 mg/m^3 (~45 m deep). Other studies undertaken in the North Pacific, conducted on broader spatial and temporal scales than those in Australian waters found statistically significant correlation between blue whales and SST (Moore et al, 2002; Stafford et al, 2009; Forney et al, 2012; Hazen et al, 2017). A study, undertaken by Buchan and Quinones (2016), assessed the oceanographic characteristics providing suitable foraging conditions for blue whales in northern Chilean Patagonia over three austral summers (2011-2013) finding a statistically significant correlation between blue whale presence and SSC, surface salinity and euphausiids.

Gill et al (2011) identifies a key determinant of blue whale distribution is likely to be the distribution of their euphausiid prey (N. *australis).* The optimal temperature range for *N. australis* is 12 to 18°C (Blackburn 1980; cited in Gill et al, 2011), and vertical migration by *Nyctiphanes* spp. is not generally constrained by thermoclines (Williams & Fragopolou 1985, Lavaniegos 1996; cited in Gill et al, 2011). In the Kahurangi Point-Cape Farewell Upwelling, New Zealand, *N. australis* were found in a range of depths and were thought to position themselves on the shelf by vertical migration into water strata that were either upwelling inshore, or advecting offshore (Bradford & Chapman 1988, Bradford-Grieve et al. 1993; cited in Gill et al, 2011). Gill et al (2011) identifies that poorly understood sub-surface processes (van Ruth, 2009) not measured in the Bonney upwelling study are likely to prevail in the western (van Ruth 2009) zone of the study area.

In upwelling systems elsewhere, peak primary production is displaced ‘downstream’ and offshore from upwelling centres by wind-forced alongshore advection of upwelled water over distances of 15 to 30 km (Wieters et al. 2003, Broitman & Kinlan 2006; cited in Gill et al, 2011). In the Kahurangi Point-Cape Farewell Upwelling, *N. australis* were scarce near the upwelling source and most abundant at the distal end of the upwelling plume (Bradford & Chapman 1988). In Gill et al (2011), euphausiid surface swarms were never sighted in coastal upwelling centres. It is also possible there is spatial mismatch (Grémillet et al. 2008; cited in Gill et al, 2011) between trophic levels, i.e. primary and secondary production. Ritz et al. (1990; cited in Gill et al, 2011) calculated that only 25% of *N. australis* carbon requirements off southern Tasmania were obtained from phytoplankton, suggesting significant predation on smaller zooplankton. It is possible another trophic level is within the food chain topped by blue whales, which could contribute to further physical displacement of sightings from areas of SSC maxima.

Encounter Rates:

It is possible that the blue whale may be encountered during the survey period. The Duntroon survey period (September to November) is temporally positioned to avoid overlap with biologically important timeframes where the blue whale is present in the eastern GAB, however due to potential upwelling commencement in November, it is possible that that the blue whale may be encountered in the region during that month.

<u>Conservation Management Plan (Blue Whale):</u>

The Blue Whale Conservation Management Plan (DoE, 2015) identifies noise interference and vessel disturbance as threats which are relevant to the Duntroon survey (refer Table 3-9). Noise interference is addressed in Section 6.2 and vessel interference is addressed in Section 6.15.

Table 3-9: Conservation Management Plan for the Blue Whale (DoE, 2015) – Threats relevant to Duntroon Survey Activity

Relevant Threat	Action Objective	Action within EP
Noise Interference	Anthropogenic noise in BIAs will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area.	On a temporal basis position survey period to not overlap biologically important times in the eastern GAB. For periods of greater upwelling potential, undertake surveillance of upwelling and primary productivity conditions in the eastern GAB and prevent spatial overlap with blue whale presence.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales is applied to all sesimic surveys.	Implement EPBC Policy Guideline 2.1 for survey activities.
Vessel Strikes	Ensure all vessel strike incidents are reported on the National Ship Strike database.	Report all vessel strike incidents on the National Ship Strike Database
	Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented.	Implement requirements of the draft Stragey for mitigating vessel strikes of marine megafauna.

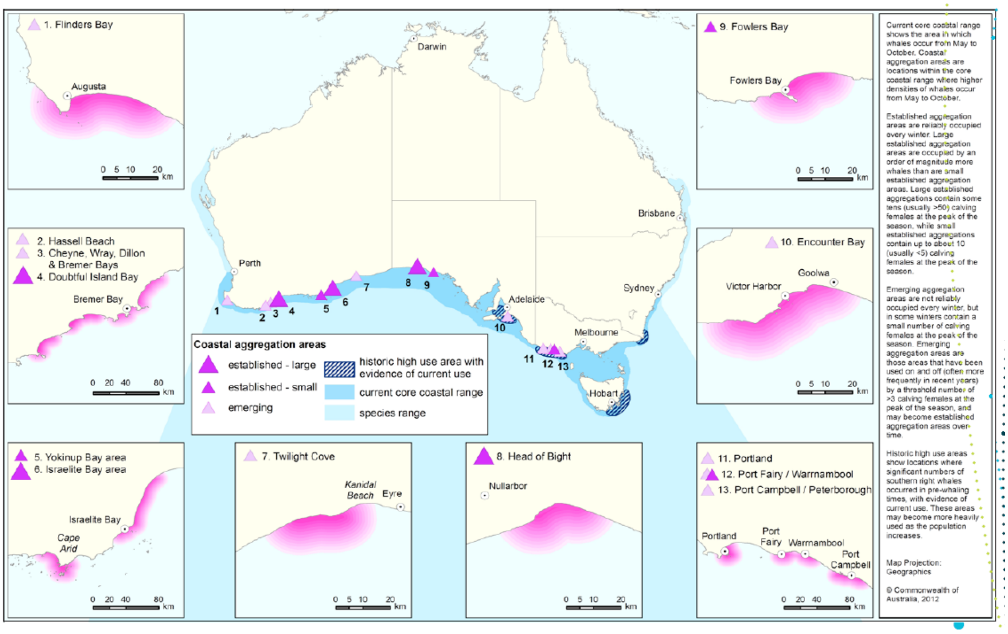
3.7.5.3 *Southern right whale (baleen)*

The southern right whale *(Eubalaena australis)* a migratory species listed as endangered, is seasonally present on the Australian coast between May (earliest late April) and early November (SEWPC, 2012r) and is distributed between 16ºS and 65ºS (SEWPC, 2012r). The species is pelagic in summer foraging in the open Southern Ocean (Bannister et al. 1996) between 40° and 65°S (SEWPC, 2012r) and migrates to southern Australian coastal waters to breed (Mustoe & Ross, 2004). Pregnant females generally arrive during late May and early June and depart with calves in September-October (~2 to 3 months) however the general time of arrivals and departures varies on an inter-annual basis. Calving females are known to have high site fidelity and a 3 to 4-year calving interval. Other population classes stay for shorter and variable periods undertaking coastal movements and departing the coast earlier than female-calf pairs (SEWPC, 2015r).

Southern right whales until recently have been thought to be one population, however it is possible two populations exist – the south-east SRW population (Ceduna to Sydney including Tasmania) which is demographically separate to the south-western SRW population (located between Cape Leeuwin, WA and Ceduna) (SEWPC, 2012r). In terms of spatial recovery, the south-west population is recovering moderately well with three well established calving areas and evidence of a number of smaller and emerging calving areas being regularly but variably occupied. The south-east population is not showing the same spatial recovery with very low regular habitat occupancy, particularly when considered in relation to historic ecology (SEWPC, 2012r). Aerial surveys undertaken on the abundance of SRWs between Ceduna and Coffin Bay during the peak period of presence along the SA coastline (July/August 2013) identified a low presence of the SRWs. Coastal transects were flown one nautical mile from the coastline, a location where SRW cows about to give birth or with newborn calves are frequently seen close to shore (Bannister et al, 2011; cited in Bilgmann et al, 2014) and a second transect followed the 40 m bathymetry representing deeper waters utilised by SRW to travel from offshore feeding grounds to calving grounds at the HOB (Bilgmann et al, 2014). Oceanic transets were aligned north-south from the coastline to the 100m depth contour (extending a maximum of 136 nm over the continental shelf) between Ceduna and Coffin Bay. The survey observed a relatively low number of SRW (3 sightings) suggesting the surveyed region did not represent a core area for use of the species at that time. Data indicates that some SRW may use the eastern GAB for transiting from feeding grounds to coastal aggregation sites at the HOB or Fowlers Bay (Bilgmann et al, 2014). A similar study (Watson et al, 2014; cited in Bilgmann et al, 2014) in late August detected eight SRW between Ceduna and Coffin Bay, suggesting the region maybe utilised by the SRW towards the start and end of the peak season when whales transit to/from the aggregation sites.

Established breeding areas within the GAB where a high density of calving occurs includes Doubtful Island Bay (~ 1200 km west), Israelite Bay (~ 850 km west) and Head of Bight (~ 380 km NNW) (SEWPC, 2011r) (refer Figure 3-38). Other areas along the GAB coastline provide seasonal calving habitat (SEWPC, 2011r). In coastal habitats whales are generally within two kilometres of the shore with calving occurring in waters less than 10 m deep (SEWPC, 2012r). The closest calving area to the survey area is Encounter Bay (SEWPC, 2012r) ~ 300 km east. Incidental sighting records suggest additional BIAs for the south-eastern population of SRWs are emerging, mostly within historic, high use areas. These are areas of importance where small but growing numbers of non-calving SRWs aggregate for short periods of time (SEWPC, 2012r). This includes Sleaford Bay at the southern end of the Eyre Peninsula ~ 51 km NNE.

Figure 3-38: Coastal aggregation areas for southern right whales (SEWPC, 2012r)

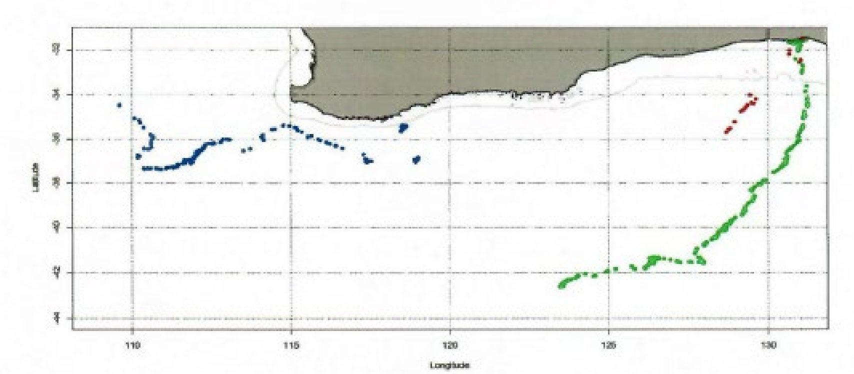


Foraging ecology for the species is poorly understood and observations of feeding are rare (SEWPC, 2012r). Species have been observed feeding in the region of the Sub-Tropical Front (41-44°S) in January and December. In that region copepods are mainly consumed, whereas at higher latitudes krill is the main prey item. Coastal Australian waters are not generally used for feeding (SEWPC, 2012r).

Individuals of the species are known to migrate within widely separated coastal waters (200-1500 km apart) within a season, indicating substantial coast-wide movements (Kemper et al. 1997; SEWPC, 2012r; Burnell, 2001: cited in Charlton et al. 2014). The longest movements are undertaken by non-calving whales, though calving whales have also been recorded to move up to 700 km in a single season. Connectivity of coastal habitat is essential for the species (SEWPC, 2012r; Charlton et al. 2014).

Migration pathways between coastal Australian waters and offshore feeding grounds are not well defined (Gill et al. 2015; SEWPC, 2015r). Data was obtained on the migratory movements of three adult females (accompanied by calves) implanted with satellite telemetry devices at the Head of Bight (HOB) during September 2014 by Mackay et al. (2015). Two whales migrated directly south from the HOB, while one, after a period without data transmissions, moved west from Albany, Western Australia, into the Naturaliste Plateau (refer **Figure 3-39**) but none moved east (Bilgmann et al, 2014). All whales had begun migration away from the HOB by the 6th October 2014.

Figure 3-39: Movement of three southern right whales tracked from Head of Bight South Australia [Tag 120944 (Blue); Tag 120949 (Red) and Tag 120 945 (Green)] (Mackay et al. 2015)



BIAs for the species are present at established and emerging aggregation areas used for calving and nursing and coastal connecting habitat (coastal waters). As identified in **Figure 3-40**, the NCVA (DoEE, 2017b) shows a BIA for seasonal calving approximately 1.5 km from the coastline (Ceduna to Port Lincoln and gulf regions) which is used infrequently with suitable habitat occurring in pockets around Streaky Bay, Coffin Bay and Port Lincoln during late autumn, winter and spring; a seasonal calving habitat at Sleaford Bay (low level use with infrequent/occasional sightings); and a calving buffer zone which applies from late autumn to spring and extends approximately 24 km from the coastline between Encounter Bay in the east to north of Perth (WA). The DoEE has advised that the intention of the buffer was to be consistent with the management approach used in the *Former Great Australian Bight Marine Park – Marine Mammal Protection zone*. This zone extends from 3 nautical miles for approximately 12 nautical miles offshore and was primarily intended to provide for the undisturbed calving of the southern right whale (pers.com. P. Benson DoEE, 2017).

Gill et al. (2015) has assessed the presence of cetacean species over the continental shelf/slope waters between western Bass Strait to the eastern GAB from systematic aerial surveys between 2002 and 2013. These surveys were undertaken across all months with the highest seasonal effort from November to April. There were twelve sightings of southern right whale most often between May and September, with 52 individuals identified in a mean group size 4.2±4.2. Recorded encounter data for the period the southern right whale was observed is as follows:

- May - 0 whales sighted/1000 km survey distance;
- June – 0.8 whales sighted/1000 km survey distance;
- July – 3.1 whales sighted/1000 km survey distance;
- August – 6.8 whales sighted/1000 km survey distance;
- September – 8.8 whales sighted/1000 km survey distance;

- October – 0 whales sighted/1000 km survey distance;
- November – 0 whales sighted/1000 km survey distance.

Additional survey encounter data includes:

- Based upon 16 seismic surveys completed or partially acquired during the April to July period (2000-2012) between the GAB and Western Tasmania, the likelihood of southern right whale encounter is considered very low. The encounter rate during the total of 31,867 km of seismic acquired over a cumulative period of 475 days was 1 whale per 79 days, ranging from 1 whale in 135 days in April; 1 whale in 52 days in May; and 1 whale in 99 days in June with no encounter during July. It is not known whether this low encounter rate is due to whales not being in the area or due to 'avoidance' of acoustic sources (Bight Petroleum, 2013).
- IFAW conducted a vessel-based survey between 26th April and 8th May 2013 to look at the diversity, distribution and presence of whales and dolphins in an area to the west of Kangaroo Island using visual and acoustic techniques. Data collected identified several groups of dolphins, pods of bottlenose dolphins, a number of fur seals, pilot whales, sperm whales and Shephard's beaked whales (IFAW, 2013). Here were no reported encounters of blue or southern right whales during the survey.
- TGS's Nerites MC3D MSS (Phase 1), located adjacent to the proposed Duntroon OA undertaken from January to June 2014 did not encounter any southern right whales in the operational area over the survey period (TGS, 2014).

The survey area is not located within any BIAs for the southern right whale however lies adjacent to BIA areas (DoEE, 2017b). As this species is seasonally present in coastal waters between late April and early November the species may be encountered in the Duntroon OA during the proposed survey period (late April-May).

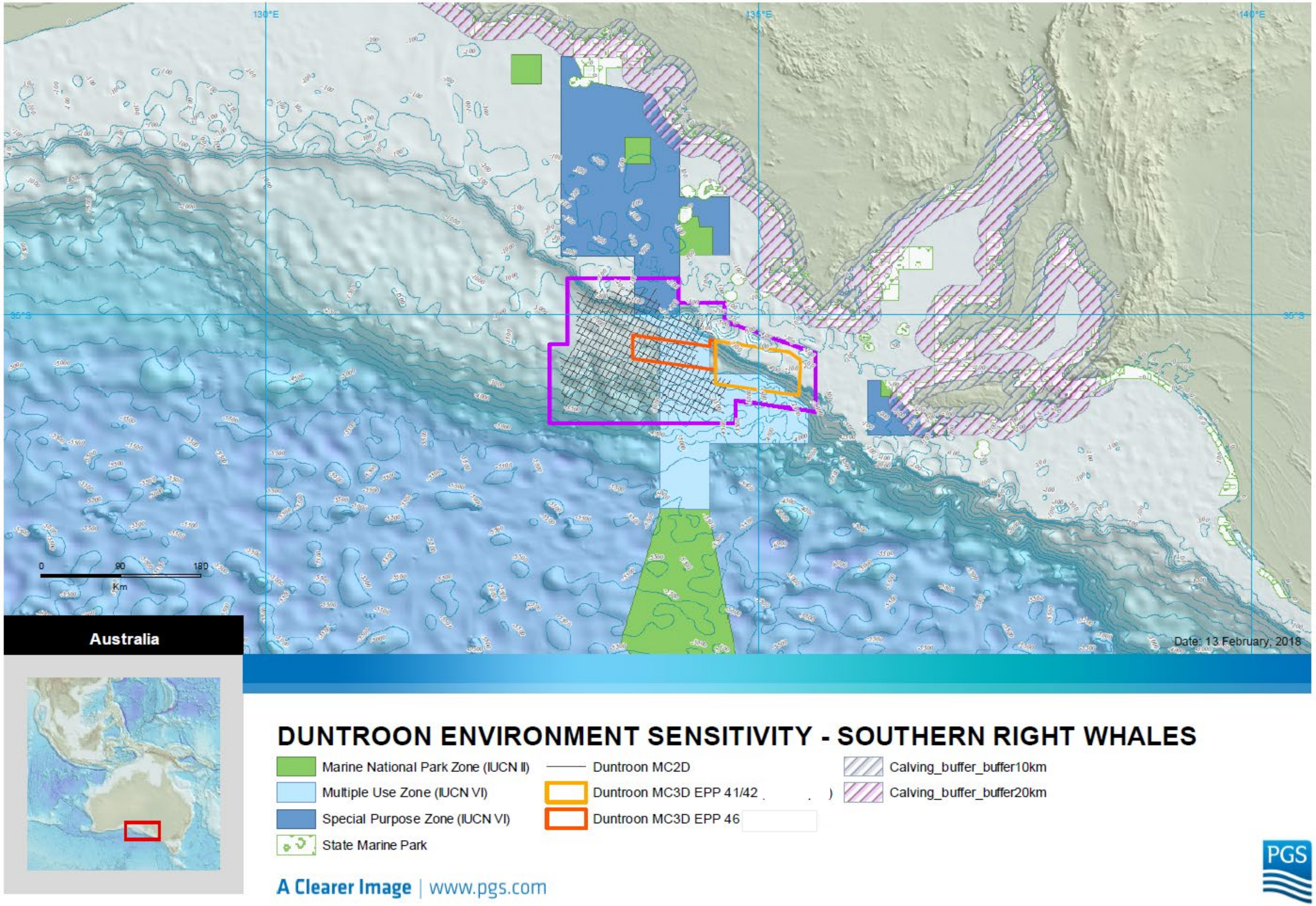
<u>Conservation Management Plan (Southern right whale):</u>

The Conservation Management Plan for the southern right whale (SEWPC, 2012) identifies noise interference and vessel disturbance as threats which are relevant to the Duntroon survey (refer **Table 3.10**). Noise interference is addressed in Section 6.2 and vessel interference is addressed in Section 6.15.

Table 3-10: Conservation Management Plan for the southern right whale (SEWPC, 2012) – Threats relevant to activity

Relevant Threat	Action Objective	Relevant Actions
Noise Interference	Management practices included in the Seismic Guidelines (EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales) focus on the prevention of temporary or permanent injuries to the hearing of large baleen whales. In respect to behavioural impacts, rather than specific management practices, the seismic guidelines advise that seismic surveys should be undertaken outside of biologically important areas at biologically important times, otherwise they may require further assessment under the EPBC Act.	Implement requirements of the Management practices included in the Seismic Guidelines (EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales)
Vessel Collisions	Develop a national ship strike strategy (draft currently available) that quantifies vessel movements within the distribution ranges of southern right whales and outlines appropriate mitigation measures that reduce impacts from vessel collisions.	Implement requirements of the draft Strategy for mitigating vessel strikes of marine megafauna.

Figure 3-40: Duntroon Survey in relation to Southern Right Whale BIAs in the Eastern GAB (DoEE, 2017b)



3.7.5.4 *Fin Whale (baleen)*

The fin whale (*Balaenoptera physalus*), a migratory species listed as vulnerable, is a cosmopolitan species and occurs from polar to tropical waters but is rarely sighted in inshore waters. Fin whales show well defined migratory movements between polar, temperate and tropical waters which are essentially north–south with little longitudinal dispersion. Fin whales regularly enter polar water however unlike blue whales and minke whales, fin whales are rarely seen close to ice (DoEE, 2017h). It is likely that fin whales migrate between Australian waters and the following external waters: Antarctic feeding areas (the Southern Ocean); Subantarctic feeding areas (the Southern Subtropical Front); and tropical breeding areas (Indonesia, the northern Indian Ocean and south-west South Pacific Ocean waters) (DoEE, 2017h).

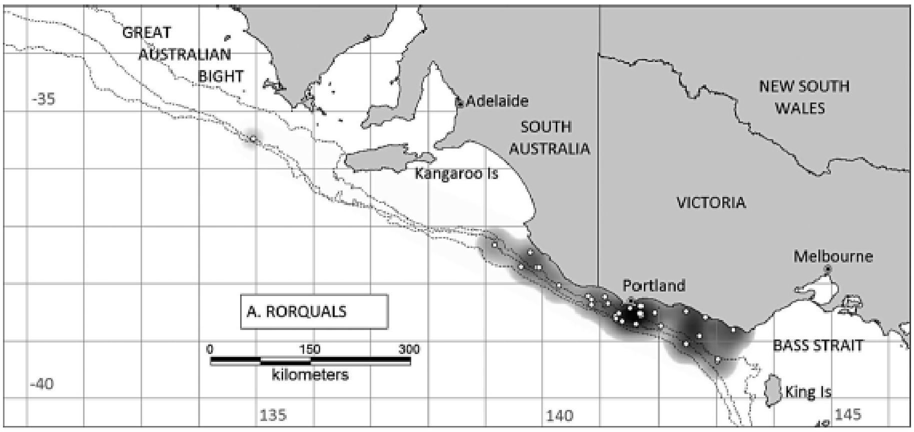
Breeding occurs between May-July and there is no known mating or calving areas in Australia waters (SEWPC, 2012w). While Australian Antarctic waters are important feeding grounds for fin whales, the species also feeds in the Bonney upwelling during summer/autumn (November to May) sometimes in the company of blue and sei whales (DoEE, 2017h). Areas of upwelling and interfaces with mixed and stratified waters may be an important feature of fin whale feeding habitat (DEH, 2005c) with the species feeding on planktonic crustacea, krill, some fish and cephalopods (DoEE, 2017h). Fin whales frequently lunge or skim feed at or near the surface and they are known to dive to 230 m to feed (DoEE, 2017h).

The NCVA does not identify any BIA for the fin whale within Australian waters (DoEE, 2017b).

Gill et al. (2015) reported 8 individual fin whales in 7 sightings for surveys undertaken during the period 2002 to 2013. The mean group size was 1.1 ± 0.4 individuals and the mean depth distribution in shelf waters of 162 ± 90 m. The species was observed to be feeding indicating the region is used at least opportunistically. Figure 3-41 provides density kernels and point sightings for rorquals during this survey period. Recorded encounter data for the months in which the fin whale was observed is as follows (August to December):

- August – 0 whales sighted/ 1000 km survey distance;
- September – 0 whales sighted/1000 km survey distance;
- October – 0 whales sighted/ 1000 km survey distance;
- November – 0.1 whales sighted/1000 km survey distance; and
- December – 0.14 whales sighted/1000 km survey distance.

Figure 3-41: Density kernels and point sightings (white dots) for rorqual cetacean group in southern Australia 2002-2013. Kernel shading indicates the relative probability of encountering a rorqual species at a given point (black is highest density). The 100m, 200m and 1000m isobaths (dashed lines) are provided to indicate shelf and slope depth (Gill et al. 2015)



It is possible this species may be encountered during the proposed survey activities.

Recovery Plan (Fin whale):

There is no recovery plan in place for the fin whale (*Balaenoptera physalus*). The recovery plan (DEH, 2005) ceased to be in effect from 1 October 2015.

Conservation Advice (Fin Whale):

Information from the conservation advice for the Fin whale (TSSC, 2015d) identifies the following threats as relevant to the Duntroon survey:

- Anthropogenic noise and acoustic disturbance;
- Vessel strike.

Conservation and management actions identified for these threats from the Conservation Advice are detailed in **Table 3-11**. Noise interference is discussed in Section 6.2 and vessel disturbance and strike in Section 6.15.

Table 3-11: Conservation advice for the Fin Whale (TSSC, 2015d) – Threats relevant to activity

Relevant Threat/ Objectives	Conservation and Management Action	Action taken within EP
Assessing and addressing anthropogenic noise	Once the spatial and temporal distribution (including biologically important areas) of fin whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development) should be undertaken on this species. If required, additional management measures should be developed and implemented to ensure the ongoing recovery of fin whales.	Duntroon survey has considered the presence of Fin Whales. EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales will be applied.
Minimising Vessel Collisions	Develop a national vessel strike strategy that investigates the risk of vessel strikes on fin whales and also identifies potential mitigation measures. Ensure all vessel strike incidents are reported in the National Vessel Strike Database	Reporting requirement to be included within Section 6.15 of this EP. (Cetacean collision with vessel)

3.7.5.5 Sei whale (baleen)

The sei whale (*Balaenoptera borealis*), a migratory species listed as vulnerable, is considered a cosmopolitan species, ranging from polar to tropical waters, but tend to be found more offshore than other species of large whales. They show well defined migratory movements between polar, temperate and tropical waters (Mackintosh 1965; cited in DoEE, 2017i) with migration movements essentially north-south with little longitudinal dispersion (DoEE, 2017i). Sei whales move between Australian waters and Antarctic feeding areas; Subantarctic feeding areas (e.g. Subtropical Front); and tropical and subtropical breeding areas (DoEE, 2017i).

The species feeds on planktonic crustacea, particularly copepods and amphipods. Below the Antarctic convergence sei whales feed exclusively upon krill (*Euphausia superba*) though, as a proportion of their diet, krill makes up a much smaller component of diet than the other rorquals. Sei whales feed by swimming horizontally near the surface skimming pelagic crustaceans and will feed on concentrations of food that are thought inadequate for other rorquals. Sei whales sink rather than dive and tend to be shallow swimmers with their heads seldom emerging and with no positive arching when diving (DoEE, 2017i).

There is no known mating or calving areas in Australian waters (DoEE, 2017i).

Sei whales have been sighted 20–60 km offshore on the continental shelf in the Bonney Upwelling opportunistically feeding (Gill et al. 2015) and have also been reported 200 nautical miles south-west of Port Lincoln (Dec. 1995) (DoEE, 2017i). Gill et al. (2015) observed 14 individual whales in 12 sightings for surveys undertaken between 2002 to 2013. The mean group size was 1.3 ± 0.5 individuals and the mean depth distribution in shelf waters was 160 ± 137 m. The species was observed to be feeding during the surveys indicating the region is used at least opportunistically. Figure 3-41 provides density kernels and point sightings for rorquals during this survey period. Recorded encounter data, for the months the sei whale was observed (August to December), is as follows:

- August – 0 whales sighted/1000 km survey distance;
- September – 0 whales sighted/1000 km survey distance;
- October – 0 whales sighted/1000 km survey distance;

- November – 0.25 whales sighted/1000 km survey distance; and
- December – 0.07 whales sighted/1000 km survey distance.
-

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

It is possible that this species may be encountered during the proposed survey activities.

Recovery Plan (Sei whale):

There is no recovery plan in place for the sei whale (*Balaenoptera borealis*). The recovery plan (DEH, 2005) ceased to be in effect from 1 October 2015.

Conservation Advice (Sei Whale):

Information from the conservation advice for the sei whale (TSSC, 2015e) identifies the following threats as relevant to the Duntroon multi-client survey:

- Anthropogenic noise and acoustic disturbance;
- Vessel strike.

Conservation and management actions detailed for these threats from the Conservation Advice are detailed in **Table 3-12.** Noise interference is discussed in Section 6.2 and vessel disturbance and strike in Section 6.15.

Table 3-12: Conservation advice for the sei whale (TSSC, 2015e) – Threats relevant to activity

Relevant Threat/ Objectives	Conservation and Management Action	Action taken within EP
Assessing and addressing anthropogenic noise	Once the spatial and temporal distribution (including biologically important areas) of fin whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development) should be undertaken on this species. If required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.	Duntroon survey has considered the presence of Sei Whales. EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales will be applied.
Minimising Vessel Collisions	Develop a national vessel strike strategy that investigates the risk of vessel strikes on sei whales and also identifies potential mitigation measures. Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	Reporting requirement to be included within Section 6.15 of this EP. (Cetacean collision with vessel)

3.7.5.6 *Other migratory cetacean species*

Brydes' whale (baleen): Brydes' whale *(Balaenoptera edeni)* classified as migratory, has been recorded in all Australian states except the Northern Territory, and is present in temperate and tropical waters bounded by latitudes 40°N/S in waters exceeding 16.3°C but generally the 20°C isotherm (DoEE, 2017j).

No sub-species are recognised for Bryde's whale, but there are two distinct forms in South Africa and Japan: a coastal form that appears restricted to the 200m isobath moving along the coast in response to available prey and an offshore form found in deeper water (500-1000 m) which undergoes extensive migrations. Dive times are relatively short, averaging 1.27 minutes but potentially lasting 9 minutes suggesting that Bryde's Whales use the upper layers of the ocean, and can therefore be considered pelagic (DoEE, 2017j). The species is an opportunistic feeder readily consuming shoaling prey available (DoEE, 2017j).

Species inhabiting inshore, coastal locations appear to breed and give birth throughout the year while the offshore form appears to have a protracted breeding and calving season over several months during winter.

Insufficient information is available on specific Australian feeding or breeding grounds for this species. No feeding or breeding grounds have been discovered in Australia (DoEE, 2017j). Population surveys in the eastern GAB (Gill et al. (2015); IFAW, 2013; Bilgmann et al. 2014; Bight Petroleum, 2012) have not observed this species.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Based upon available survey data, the potential for encounter of this species during the survey period is low.

Antarctic minke whale (baleen): The Antarctic minke whale (*Balaenoptera bonaerensis*) has been found in all Australian states except the Northern Territory (NT) and occupies offshore and pelagic habitats within cold temperate to Antarctic waters between 20ºS to 65°S (Bannister et al. 1996). In summer the species is found in pelagic waters from 55°S to the Antarctic ice edge. During winter this species retreats to breeding grounds between 10-30ºS occupying oceanic waters which exceed 600 m depth and beyond the continental shelf break (SEWPC, 2012i). Mating occurs from June through December, with a peak in August and September, and calving peaks occur during late May and early June in warmer waters north of the Antarctic Convergence (SEWPC, 2012i).

Gill et al. (2015) reported one sighting of an Antarctic minke whale for surveys undertaken in the period 2002 to 2013. The depth of the species in shelf waters was 93 ± 79 m. Bilgmann et al. (2014) also reported one minke whale (sp. not identified) in shelf waters in July/August 2013. Surveys undertaken by Bight Petroleum (2012) and IFAW (2013) did not observe minke whales in the area.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

It is possible that this species may be encountered during the survey activities, however based upon available observation data the potential for encounter is considered low.

Pygmy right whale (baleen): The pygmy right whale *(Caperea marginata)* is found in temperate and subantarctic waters between 19º and 52ºS preferring water temperatures between 5ºC and 20ºC. Records for the species in Australian waters indicate a distribution between 32ºS and 47ºS, but sightings are not uniformly spread around the coast. The species is found close to coastal upwellings and further offshore it appears that the subtropical convergence may be an important area for regulating distribution (Bannister et al. 1996). There is no evidence of large-scale movements of pygmy right whales, with coastal strandings recorded throughout the year on the Australian coastline (SEWPC, 2012j). Concentrations of stranded animals have occurred at the entrance of the South Australian gulfs, however live sightings have predominated in the area (SEWPC, 2012j). The species do not appear to be deep divers as recorded dive times are short implying that they primarily inhabit the pelagic zone of oceanic waters (SEWPC, 2012j).

The species have primarily been recorded in areas associated with upwellings and with high zooplankton abundance, particularly copepods and small euphausiids which constitute their main prey (SEWPC, 2012j. Key locations for the species include Kangaroo Island (SA) and southern Eyre Peninsula (SA) close to habitats rich in marine life and possibly the zooplankton upon which it feeds (Bannister et al. 1996).

Gill et al. (2015) reported a single pod of pygmy right whales with 100 individuals for surveys undertaken during the period 2002 to 2013. This single observation occurred during June (19.8 whales sighted per 1000 km of survey distance). Other population surveys in the eastern GAB (IFAW, 2013; Bilgmann et al. 2014; Bight Petroleum, 2012) did not observed this species.

The NCVA does not identify any BIAs for this species within Australian waters (DoEE, 2017b).

It is possible that this species may be encountered during the proposed survey as it is present in Australian waters on a year-round basis.

Killer whale (odontocete): The killer whale *(Orcinus orca)*, a migratory species, is the most cosmopolitan of all cetaceans and is seen in many marine regions. The species has a distribution from polar to equatorial regions and has been recorded in all Australian states except Northern Territory with frequent sightings in South Australia, Tasmania and Victoria.

The preferred habitat of the Killer whale included oceanic, pelagic and neritic regions in both warm and cold waters. In Australia, this species is often seen along the continental slope and shelf particularly near seal colonies. Although groups of up to several hundred individuals have been observed, group size is usually less than 30, and several studies outside Australian waters have reported mean pod sizes of less than 10 (DoE, 2016j). The specific diet of the killer whale is not known, but they are top-level carnivores and there are reports of attacks on dolphins, young humpback whales, blue whales, sperm whales, Australian sea lions and great white sharks (Bannister et al. 1996; Bruce & Bradford, 2011).

Killer whales are known to make seasonal movements, and probably follow regular migratory routes. It is probable they move latitudinally with changing ice conditions and seasonally to areas of food supply (Bannister et al, 1996), however, no information is available for Australian killer whales (DoE, 2016j). No key localities are known for the killer whale within continental Australian waters, however, the Australian sub-Antarctic territory, Macquarie Island, may be a key locality as there are regular sightings at that location (Bannister et al. 1996).

This species has been observed during population surveys in the Eastern GAB (Bight Petroleum, 2012). Two killer whales were observed west of Robe (approx. 200 km south-east of Kangaroo Island) during late March (Blue Whale Study Inc., 2012). Gill et al. (2015) reported for aerial survey events (2002 to 2013) six pods of the species (21 individuals). The mean group size was 3.5 ± 2.8 individuals which were located predominantly on the shelf close to the shelf break at a mean water depth of 171 ± 135 m. Recorded encounter data for the species is as follows (months not listed had a zero-encounter rate):

- December – 0.19 whales sighted/1000 km survey distance;
- March – 5.0 whales sighted/1000 km survey distance;
- May – 6.0 whales sighted/1000 km survey distance; and
- July – 0.68 whales sighted/1000 km survey distance.

Other surveys undertaken in the region (Bilgmann et al. 2014; IFAW, 2013) did not observe the species.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

As pinniped colonies can be found in the coastal waters adjacent to the survey area and given the observed presence of the species in the Duntroon OA, encounter is possible.

Sperm whale (odontocete): The sperm whale (*Physeter macrocephalus*), a migratory mid-frequency cetacean, is cosmopolitan with a worldwide distribution; has been recorded in all Australian states; and is a pelagic species usually found in deep water off the continental shelf. Sperm whales inhabit water depths of 600 m or more and are uncommon in waters of depth less than 300 m. The species is usually present in waters where sea surface temperatures are greater than 15°C (SEWPC, 2012l). Female sperm whales are generally found in deep waters (at least 1000 m deep) with females and young males appearing to be restricted to warmer waters (i.e. north of 45°S) and likely to be resident in tropical and sub-tropical waters year-round. Adult males are found in colder waters to the edge of the Antarctic pack ice.

Sperm whales are found where seabeds rise steeply from a great depth with concentrations of food such as cephalopods (Bannister et al. 1996). This species also feeds on medium and large size demersal fish including rays, sharks and teleost fish. The species are prolonged and deep divers often diving for over 60 minutes (Bannister et al. 1996). However other studies have observed that sperm whales do rest at, or just below, surface for extended periods (> 1hr) (Gannier et al., 2002). Female and juvenile sperm whales in temperate waters have been observed to spend several hours a day at surface resting or socialising (Hastie et al., 2003).

Mating occurs from July to March, peaking in September and December. Calving in tropical or temperate waters occurs between November and March (Bannister et al. 1996). There is generalised movement of sperm whales south in summer and movement north in winter particularly for males (Whitehead, 2002a; cited in DoEE, 2017b).

In Australian waters, sperm whales appear concentrated in a narrow area only a few miles wide at the shelf edge particularly off Albany, Western Australia, moving westwards through the year (Bannister et al. 1996). In the open ocean, there is generalised movement of sperm whale southwards in summer, and corresponding movement northwards in winter, particularly for males (Whitehead 2002a; in SEWPC, 2012l).

Sperm whales are known to forage and concentrate at the shelf break south and south-west of Kangaroo Island in the canyons; and deep waters off the Tasmanian west and south coasts (SEWPC, 2012u). The NCVA identifies that the survey area is coincident with two BIA areas for the species (DoEE, 2017b):

- MC2D Survey: “Slope off the GAB” BIA where foraging is likely to occur due to abundant food sources. The presence of the species is listed as year- round but most abundant in August and September. The spatial overlap with this BIA is ~5000 km^2 (or 11.1% of the BIA of 44,930 km^2);

- MC3D Survey: "Kangaroo Island Canyons (west)" where foraging is likely due to abundant food sources and is based upon one sighting and proximity to many strandings. The spatial overlap with this BIA is ~4675 km^2 (or 37.5% of the BIA of 12,520 km^2).

The survey area is not coincident with the sperm whale "Kangaroo Island canyons (south) BIA" however this area does lie within the Duntroon EMBA. Figure 3-42 details the overlap of the Duntroon OA together with the BIAs for the sperm whale.

The following population survey data is available for the sperm whale in the eastern GAB:

- Aerial surveys undertaken in December 2003 identified seven sperm whales south-west of Kangaroo Island in deep waters (1000-2000 m).
- Aerial surveys undertaken for the upwelling season 2011-2012 (November-March) identified four Sperm whales during November (only) to the west of Port Lincoln (Blue Whale Study Inc., 2012).
- IFAW (2013) in their vessel-based visual and acoustic surveys over EPP 41 and EPP 42 (west of Kangaroo Island) during April and May 2013 detected sperm whales acoustically, usually in waters deeper than 1,000 m although there were no sightings during vessel surveys. Aerial surveys conducted of the same area reported two sightings of three individual sperm whales (TGS, 2014).
- Gill et al. (2015) reported for aerial surveys (2002 to 2013) 34 pods of the species (66 individuals). The mean group size was 1.9 ± 2.2 individuals located predominantly on the lower continental slope at a mean depth of 1,221 ± 628 m. Observations did not record calves which may indicate that the area is not important breeding or for rearing young. Of the sightings made, 68% were solitary males, and the remainder were groups of 2-12 similarly sized animals, possibly bachelor schools. Recorded encounter data[15] is as follows (all months not listed had a zero-encounter rate):
    - October – 1.7 whales sighted/1000 km survey distance;
    - November – 1.2 whales sighted/1000 km survey distance;
    - December – 0.23 whales sighted/1000 km survey distance;
    - January – 0.53 whales sighted/1000 km survey distance;
    - February – 0.08 whales sighted/1000 km survey distance; and
    - March – 0.13 whales sighted/1000 km survey distance; and
    - April – 0.75 whales sighted/1000 km survey distance; and
    - May – 0.85 whales sighted/1000 km survey distance.
- Bilgmann et al (2014) did not observe sperm whale presence during July/August, however this survey was located on the continental shelf.
- Phase I of the Nerites MC3D MSS, four sperm whales were sighted in March 2014 (TGS, 2014).
- Mackey et al (cited in Goldsworthy et al, 2017) undertook visual and acoustic surveys during the period 22 April and 1 May 2015 along the shelf-break and slope area of the eastern GAB (Longitude 131ºE-136ºE). Two visual sightings of sperm whales (1.4 individuals per 1000 km) and four occasions of acoustic detection (0.21 individuals per 1000 km) were obtained during that survey.

The South-west Bioregional Plan documents peak sighting periods of August and September as referenced in the NCVA (DoEE, 2017). Given the species year-round presence and observation data, encounter with the species is possible during the survey period.

Dusky dolphin: The dusky dolphin *(Lagenorhynchus obscurus)* a migratory species, occurs in the southern hemisphere between latitudes 26-55ºS and across southern Australia from Western Australia to Tasmania (SEWPC, 2012k). The species inhabits temperate and subantarctic zones primarily in inshore locations but is pelagic at times. The species is anticipated to be resident inshore for much of the year and seeks out colder

[15] Note the period of highest seasonal effort during the period was November to April.

water (<18°C) as inshore temperatures rise in summer (Bannister et al. 1996). The species undertakes seasonal movements in Australia which may be linked to the position of the subtropical convergence and with El Niño Southern Oscillation (ENSO) events, which expands the extent of cold waters (SEWPC, 2012k).

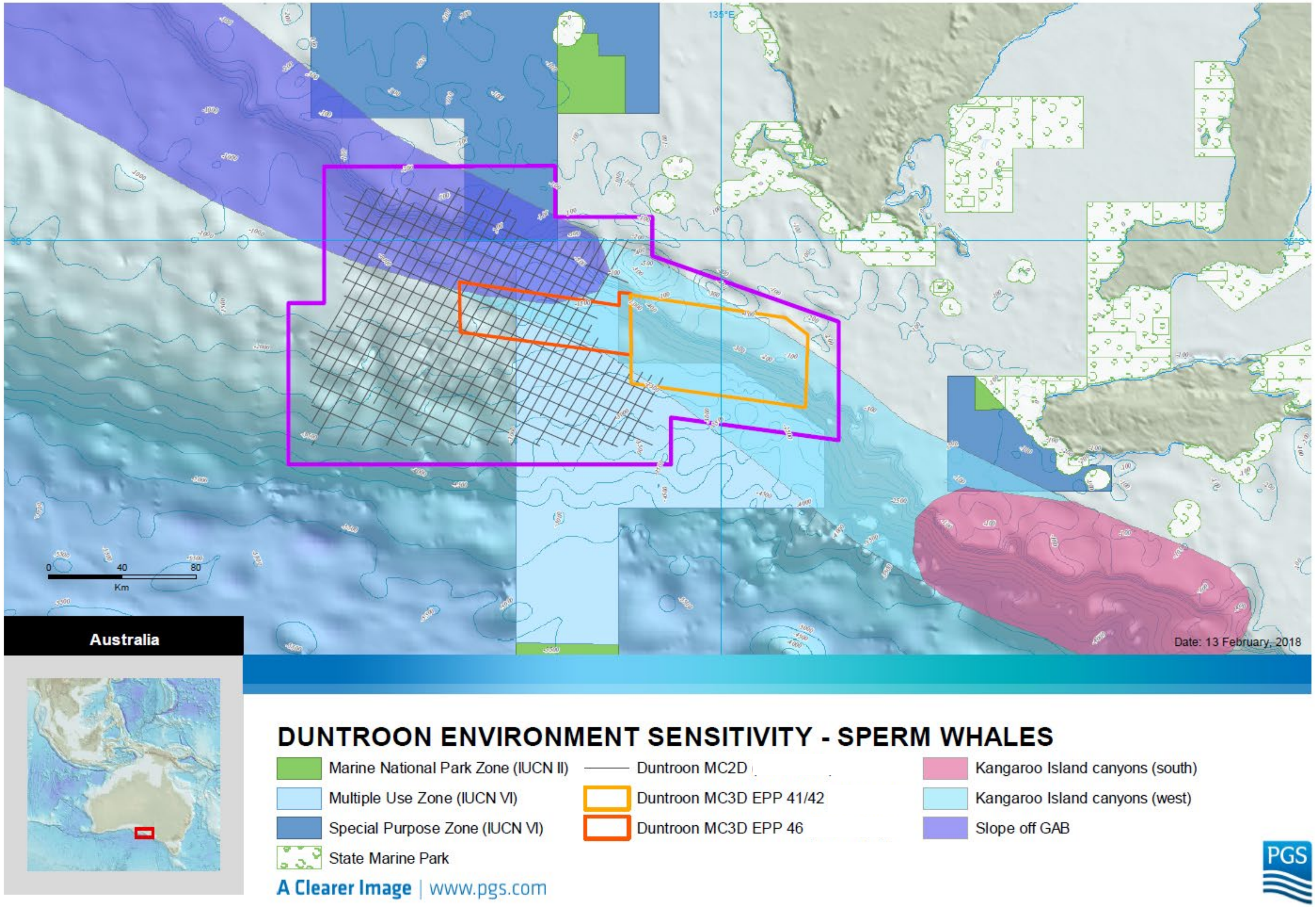
Calves are born mainly in summer although no calving areas have been identified in Australian waters (SEWPC, 2012k).

Dusky dolphins eat a diversity of prey, including schooling fish (especially anchovy) and mid-water/benthic prey such as squid and lantern fish. This species is a surface feeder but have been known to dive to depths of 150 m off New Zealand (SEWPC, 2012k).

Population survey data for this species within the area include the following:

- Gill et al. (2015) did not explicitly identify the dusky dolphin during the aerial surveys of 2002-2013 however 384 sightings of unidentified dolphins were recorded (22169 individuals). Dolphin species were sighted most consistently over the years and were observed to be widely distributed in shelf waters with a greater probability of occurrence inshore along the shelf (mean depth 134 ± 197 m). Figure 3-43 provides density kernels and point sightings for all dolphin species observed during the surveys and Figure 3-44 provides the depth range for dolphin species observed. Dolphins were often observed feeding, either on baitfish schools or in krill surface swarms.
- Bilgmann et al. (2014) did not observe dusky dolphin species during surveys in July/August 2013, however many other dolphin species (common and bottlenose) were encountered in shelf waters;
- Bight Petroleum (2012) did not observe dusky dolphins during survey activities of 2011-12; and
- IFAW (2013) did not observe dusky dolphins during survey activities.

Figure 3-42: Duntroon Survey Area and BIAs for Sperm Whales in the eastern GAB



The NCVA does not identify any BIA for this species in Australian waters. Given the species wide distribution within Australian waters and their year-round presence, it is possible the species may be encountered during the survey period, particularly over shelf areas.

Figure 3-43: Density kernels and point sightings (white dots) for dolphins in southern Australia 2002-2013. Kernel shading indicates the relative probability of encountering a dolphin species at a given point (black is highest density). The 100m, 200m and 1000m isobaths (dashed lines) are provided to indicate shelf and slope depth (Gill et al. 2015)

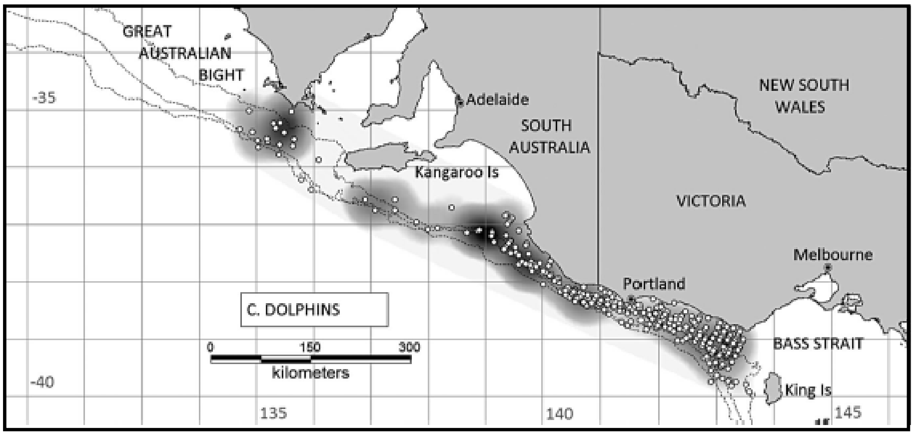
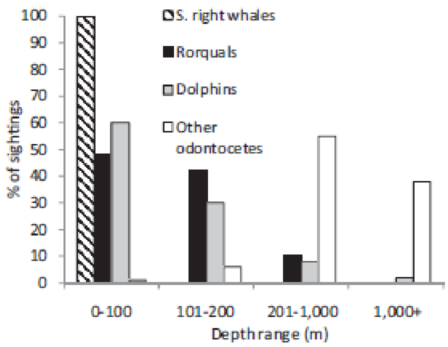


Figure 3-44: Depth range by cetacean species group in southern Australia (2002-2013) (Gill et al. 2015)



3.7.5.7 *Other listed cetacean species*

Minke whale (baleen) *(balaenoptera acutorostrata)*: Minkes are the only baleen whale species still common in Antarctic waters (AAD, 2016) and relatively common in Australian waters (Bannister et al. 1996). Like the blue whales, minkes feed almost exclusively on Antarctic krill while in Antarctic waters. The species usually feeds in groups and may form a large group of many hundreds if there is sufficient food present (AAD, 2016).

The species is oceanic but not restricted to deep water. It has extensive migrations between cold water feeding and warm water breeding grounds, however the location of breeding grounds are unknown. Calving is thought to occur between May and July (Banister et al. 1995).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

As the species is widespread in in Australian waters, it is possible, that the species may be encountered during the survey period.

Pygmy killer whale: In Australia, pygmy killer whales are known from strandings in NSW and Western Australia reported during August through to February. The whale is a tropical and subtropical species that inhabits oceanic waters, generally 18ºC or warmer, around the globe, generally not ranging north of 40° N or south of 35° S. No population estimates are available for pygmy killer whales in Australian waters, however, they are generally considered to be in relatively low abundance and occur in group sizes less than 50 individuals. Prey includes sardines, squid and dolphins (DoEE, 2016).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

It is possible this species will be encountered in during the survey period.

False killer whale (odontocete) (*Pseudorca crassidens*): The species is found worldwide in deep tropical or temperate waters (10 to 32ºC). They are distributed circumglobally between 45ºN and 45ºS and widely recorded in all Australian states from available stranding data (Bannister et al. 1996). Records identify stranding events are more common along the western and eastern coasts of Australia (DoE, 2014r). No population estimates occur in Australian waters however the species is thought to occur in low abundance (DoE, 2014r).

The species prefers deep, offshore waters and sometimes deep coastal waters. They approach land only where the continental shelf is narrow, possibly attracted to enhanced prey abundance (fish and cephalopods) along the continental slope (Bannister et al. 1996). The movement pattern of false killer whales, inferred from stranding data, is that a seasonal movement inshore or along the continental shelf of the southern and southeast coast occurs between May and September. They appear to be opportunistic feeders (DoE, 2014r). No calving areas are known in Australian waters and mating/calving occurs throughout the year with no seasonal pattern (Bannister et al. 1996).

Population surveys conducted in the eastern GAB (Gill et al. 2015; IFAW, 2013; Bilgmann et al. 2014; Bight Petroleum, 2012) have not observed this species.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Given the species has a low abundance in Australian waters and population surveys undertaken in the eastern GAB have not sighted the species, encounter with the species during survey activities is unlikely.

Pygmy sperm whale (*Kogia breviceps*) (Odontocete): The species is considered to have a worldwide cosmopolitan, oceanic distribution in temperate to tropical waters. It is not known to have strong seasonal changes in distribution, migration or exhibit strong regional movements (Bannister et al. 1996). The species has been recorded in all Australian states except the Northern Territory however no key localities have been identified in Australia (Bannister et al, 1996). The species has been observed in water depths of 400 – 600 m in the North-Central Gulf of Mexico (DoE, 2016k).

Pygmy sperm whales consume deep-water cephalopods and less often deep-sea fish and shrimp (DoE, 2016k). Calving season is reported as spring with no known calving areas identified, however the location is expected to be oceanic in temperate and tropical seas (Bannister et al, 1996). The species communicates at frequencies between 60 and 200 kHz (Simmonds et al. 2004).

Population surveys undertaken in the eastern GAB (Gill et al. 2015; IFAW, 2013; Bilgmann et al. 2014; Bight Petroleum, 2012) have not observed this species.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Encounter with this species during survey activities is possible in the deeper areas of the OA, however given the sighting data, is not expected.

Dwarf sperm whale (*Kogia simus*) (odontocete): This species has habitat, feeding and reproduction characteristics like the pygmy sperm whale however the dwarf sperm whale prefers warmer waters and approaches the coast more often than the pygmy sperm whale (Bannister et al. 1996). The species is not considered abundant in Australian waters as sightings and strandings are rare, however dwarf sperm whales are difficult to detect due to their propensity to spend little time at the surface. When they are at the surface, they are slow moving and have an inconspicuous movement style (DoE, 2016l).

Surveys undertaken in the eastern GAB (Gill et al. 2015; IFAW, 2013; Bilgmann et al. 2014; Bight Petroleum, 2012) have not observed this species.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Encounter with the species during survey activities is possible but not expected given observation data available.

Beaked whales (odontocetes)

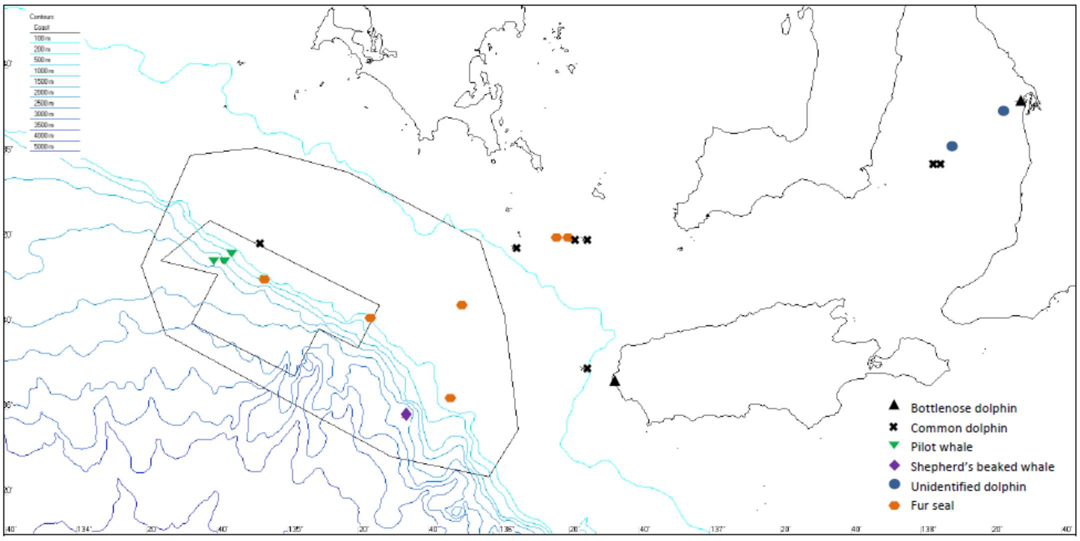
Beaked whales are distinguished by a 'beak' similar to dolphin species. The species is highly specialised to dive to great depths and remain submerged for prolonged periods – 20 to 30 minutes are common. Southall et al., (2007) classifies beaked whales as mid-frequency cetaceans with an estimated auditory bandwidth of 150 Hz to 160 kHz.

Beaked whales are not well studied and are considered rare in Australian waters although they are known to have circum-global/circumpolar distributions. All species identified by the Protected Matters Search as possibly present in the survey area are known to be deep diving oceanic species and occur close to undersea features such as submarine escarpments and sea mounts which are areas of increased productivity including food sources such as cephalopods and fish. Beaked whale presence is identified as occurring in continental slope/abyssal plain habitats along much of Australia's coastline (DoE, 2014b; DoE, 2014c; DoE, 2014c; DoE, 2014e; DoE, 2014f; DoE, 2014g; DoE, 2014h; DoE, 2014i; DoE, 2014j). In the eastern tropical Pacific beaked whales are generally sighted, on average, 1000 km offshore with a range of 40-3750 km (DoE, 2014e).

Population surveys undertaken in the eastern GAB (Gill et al. 2015; IFAW, 2013; Bilgmann et al. 2014; Bight Petroleum, 2012) have not observed the presence of beaked whales with the following exceptions:

- Gill et al. (2015) identified one sighting of a pod of 'unidentified beak whales' (20 individuals) during the 2002-2013 survey period (December);
- Bight Petroleum (2012) surveys observed one pod of Shepherd's beaked whale (6 individuals) during February 2012 (also contained in Gill et al (2015) observation data); and
- IFAW (2013) (April/May) had one sighting of a group of three Shepherd's beaked whales in 2000-2500m water depths (refer Figure 3-45).

Figure 3-45: Marine mammal sightings during EPP-41 and EPP-42 IFAW survey (April-May 2013) (IFAW, 2013)



The following beaked whale species are listed as possibly having habitat in the Duntroon OA and EMBA (DoEE, 2017a):

- **Arnoux's beaked whale** (*Berardius arnuxii*): Species is only known in Australia from five stranded specimens (South Australia, south-west Western Australia (two), Tasmania and the sub-Antarctic) and possible species sightings made inshore off the SA and NSW South Coasts. Confirmed sightings have been made in Antarctic territorial waters and most sightings have been in the Tasman Sea and around the East Pacific rise. Sightings are rare and are seldom seen over continental shelves. No key localities have been identified in Australian waters (DoE, 2014b).

  This species is circum-global from approximately 34°S to the Antarctic ice (DoE, 2014b) and common in deep oceanic waters particularly close to regions which carry higher prey densities such as sea mounts and submarine escarpments (DoE, 2014b). Little is known about the species diet although one New Zealand specimen contained a large quantity of cephalopod beaks (DoE, 2014b). The species is presumed to dive to 1000 m for periods of 15-30 minutes in pursuit of prey, but their capture method is unknown (Bannister et al. 1996). There are no known calving areas in Australia (Banister et al. 1996) and the species is not a common stranding species (Bannister et al. 1996).

Cetacean surveys undertaken in the eastern GAB have not observed this species (Gill et al. 2015; IFAW, 2013; Bilgmann et al. 2014; Bight Petroleum, 2012).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Based on this information, given the presence of canyons in the deeper sections of the OA it is possible this species may be encountered however this is considered unlikely.

- **Andrew's Beaked Whale** (*Mesoplodon bowdoini):* Species is known in Australia from sightings and strandings in Western Australia, Victoria, Tasmania and NSW. The species is considered to have a southern circumpolar distribution north of the Antarctic convergence between 32ºS and 54º30'S and appears to prefer deep oceanic temperate waters between 10–20 °C. No information on habitat is available, although these whales are presumed to feed at depth on mid- and deep-water squid and fish (DoE, 2014c).

  In Australia, the species is not considered abundant as sightings and strandings are rare (Bannister et al. 1996). There are no key localities for the species identified in Australia (DoE, 2014c). The breeding areas and habitats for the species are not known, however may move inshore in spring and summer (i.e. periods when most sightings have been made) possibly for calving and mating (DoE, 2014c).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  There is no recorded stranding data observed in South Australia. On this basis, encounter with the species during survey activities is not expected.

- **Blainville's Beaked Whale** *(Mesoplodon densirostris)*: Australian strandings have been reported from Western Australia (1), Victoria (1), Tasmania (1), NSW (1), Queensland (7) and Lord Howe Island (1) (DoE, 2014d). The species is considered to have an oceanic and circum-global distribution in low-mid latitudes in both hemispheres preferring tropical/warm temperate waters (~ 10-32ºC water temperatures). The species prefers deep water (700-5000 m) but often adjacent to much deeper waters of 5000 m (Bannister et al. 1996). Diving durations of 20-40 minutes are expected (DoE, 2014d). Off Australia, this species is not considered abundant as sightings and strandings are rare in Australia compared with other areas in its range (e.g. South Africa) (DoE, 2014d).

  There are no known calving areas in Australia, however calving is thought to occur during summer (Bannister et al, 1996) and presumed to be oceanic (DoE, 2014d). Little is known about the species diet, but it is assumed to consist of mid- and deep-water squid and fish (Bannister et al. 1996).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  There is no recorded stranding data observed in SA. On this basis, encounter with the species during survey activities is not expected.

- **Gray's beaked whale** *(Mesoplodon grayi)*: Gray's beaked whale is known from 48 strandings along the Australian coast, including 16 from southern WA, eight from SA, three from Victoria, 14 from Tasmania, and seven from NSW (DoE, 2014e). This species is the second most commonly stranded beaked whale in Australia after the strap-toothed beaked whale (63 events), however are not considered abundant as sightings/strandings are still considered rare (Bannister et al. 1996). The majority of Australian strandings have occurred from December to April, suggesting a seasonal movement inshore (and possibly to lower latitudes) during summer (DoE, 2014e). The presence of many mature females with calves in these summer strandings suggests that Gray's beaked whales may use waters over the continental shelf for breeding & calving purposes. However, the lack of sightings implies they do not normally come close to shore (Dalebout et al. 2004; cited in DoE, 2014e).

  The species appears to occupy circumpolar waters between 30-50ºS, in temperate (10–20 °C) to subantarctic (1–8 °C) regions (Pittman 2002; Ross 2006; cited in DoE, 2014e). No information on habitat is available, although these whales are presumed to feed at depth on mid- and deep-water squid (DoE, 2014e).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Given the observed stranding data in South Australian waters and proximity of the survey area to canyon systems, encounter with the species during survey activities in the deeper sections of the survey area, is possible.

- **Hector's beaked whale** (*Mesoplodon hectori)*: Only a small number of the species have been recorded in Australia (in Tasmania (2), SA (1) and WA (1)). The species occurs south of the Tropic of Capricorn and is distributed circum-globally between about 35-55ºS. It is considered rare in Australia based upon sighting and stranding data. The species is thought to prefer deep oceanic waters of cool temperate (water temperatures between 10–20 °C) to sub-Antarctic (water temperatures between 1–8 °C) regions rarely venturing into continental seas. The diet of Hector's beaked whale is presumed to be mainly mid- and deep-water squid and some fish (DoE, 2014f).

  No known breeding or calving areas occur in Australia and not much is known about reproductive behaviours (DoE, 2014f).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Given the limited stranding data in South Australian waters, encounter with the species during survey activities is not expected.

- **Strap-toothed Beak Whale** *(Mesoplodon layardii)*: This species is the most commonly stranded beaked whale in Australia with 64 events to 1994 (in WA (5), SA (27), Victorian (5), Tasmania (13), NSW (14) and Queensland (4)) and appears to be one of the more widespread and common beaked whales in the Southern Ocean between 30ºS and the Antarctic convergence. Strap-toothed beaked whales are thought to occur south of 38° S throughout the year. In contrast, their occurrence north of 38°S appears to be seasonal, suggesting that the species may undergo some limited migration to lower latitudes during local winters (Pitman 2002; cited in DoE, 2014g). Insufficient data exists as to the proportion of the population undergoing this seasonal movement, and whether this would constitute an extreme fluctuation in numbers.

  The species preferentially feeds on squid species (DoE, 2014g).

  In Australia, the majority of strandings occur from January to April, indicating a seasonal influx during mid- to late summer (Bannister et al., 1996) and given the frequency of strandings suggesting that the Strap-toothed beaked whale may be seasonally common off southern Australia. This might be possibly related to a movement onto the continental shelf edge to feed, and/or to mate and calve in the warmer coastal waters (Bannister et al. 1996).

  Breeding areas and habitats are unknown but are presumed to be oceanic (DoE, 2014g). Mating is thought to occur in summer and, after an inferred gestation period of between nine to 12 months, calves are born from summer through autumn (Ross 2006; cited in DoE, 2014g). No calving areas are known for Australian waters (Bannister et al., 1996), although the possible inshore movement of Strap-toothed beaked whales in summer and autumn may be associated with breeding.

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Given the observed stranding data in South Australian waters, encounter with the species in the deeper waters of the survey area is possible.

- **True's beaked whale** (*Mesoplodon mirus*): Only a small number of this species has been recorded in Australia based upon stranding data to 1994 (WA (2), Victoria (1) and Tasmania (1)) and there are no known key localities for the species in Australian waters. Distribution is expected between 30-50ºS in deep oceanic waters of cool temperate (10–20 °C) regions rarely venturing into continental seas. In Australian waters, the species is not considered abundant as sightings/standings are rare (DoE, 2014h). Confirmed sightings of this species travelling parallel to a steep subsea drop-off between 1000-1800 m have been observed (DoE, 2014h).

  Little is known on the reproductive behaviours of the species (DoE, 2014h).

  The diet of True's beaked whale is presumed to be mid- and deep-water squid and some fish although some common inshore squid in the stomach of a stranded adult female from South Africa has been observed (DoE, 2014h).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

There is no recorded stranding data observed in SA. On this basis, encounter with the species during survey activities is not expected.

- **Cuvier's beaked whale** (*Ziphius cavirostris*): Cuvier's Beaked Whale is known in Australian waters from 31 strandings (to 1994), mostly from January to July, suggesting some seasonality of occurrence (Ross 2006; cited in DoE, 2014i). Records of Cuvier's beaked whale include strandings in Western Australia (5), South Australia (2), Victoria (3), Tasmania (13), NSW (2), Queensland (3), Northern Territory (1), and two at Macquarie Island (Bannister et al*.* 1996).

  The species has a worldwide distribution in all temperate and tropical waters from 60°N to 55°S. The species is not considered abundant in Australia as sightings and stranding are rare events (DoE, 2014i).

  Off Japan, whaling records indicate that Cuvier's beaked whales are most commonly found in waters deeper than 1000 m (Heyning 1989; cited in DoE, 2014i) and is mostly an oceanic species confined to waters within the 10° C isotherm and the 1000 m bathymetric contour (DoE, 2015i). Cuvier's beaked whales are rarely found close to mainland shores, except in submarine canyons or in areas where the continental shelf is narrow and coastal waters are deep (Carwardine 1995; cited in DoE, 2014i).

  Their diet is primarily of cephalopods, with some oceanic fish and crustaceans depending on feeding depth. Limited data from Japanese fisheries indicate squid comprised the bulk of the diet for species taken in waters slightly less than 1000 m. For deep-water species fish predominated (Nishiwaki & Oguro, 1972; cited in DoE, 2014i). Decapod and mysid shrimps were also recorded (DoE, 2014i).

  Mating and calving is inferred to be all year round as no seasonal pattern is evident. No carving areas are known in Australian waters (DoE, 2014i).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Given the observed stranding data in SA waters, encounter with the species in the deeper waters of the survey area is possible but not expected.

- **Shepherd's beaked whale** (*Tasmacetus shepherdi*): In Australia, Shepherd's beaked whales are known from only three stranded specimens (SA and WA) and an unconfirmed sighting of a group of three in WA (Bannister et al., 1996). This species apparently prefers subantarctic (1–8 °C) and adjacent temperate (10–20 °C) deep oceanic waters and is therefore only likely to be present in the offshore Australian Exclusive Economic Zone (EEZ) waters between 33° S and 50° S (Ross, 2006). No key localities are known in Australian waters (Bannister et al., 1996).

  The species is not considered abundant in Australian waters as sightings and strandings are rare (predominantly in WA in areas related to deep trenches/canyons allowing the species to come closer to land). Diet details are poorly known but thought to consist of fish (DoE, 2014j). The species is expected to dive deeply in pursuit of prey.

  There is no information on breeding and calving habitats or life-cycle data for the species (DoE, 2014j).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Cetacean surveys undertaken in the eastern GAB have identified this species in the months of February (Gill et al, 2015) and April/May. As such, encounter with the species during survey activities in the deeper waters of the survey area is possible but not expected.

Dolphins (Odontocetes)

Dolphin species typically communicate at frequencies between 0.2 and 325 kHz (Simmonds et al., 2004). Surveys undertaken in the eastern GAB have observed significant numbers of dolphin species. This included:

- Gill et al., (2015)[16] sighted a pod (40 individuals) of Risso's dolphins during February; a pod of Southern right whale dolphins (120 individuals) during November; four sightings of Bottlenose dolphins (363 individuals; mean group size 90.8 ± 140.1) during November, December and

[16] This includes the observation data of the 2011-2012 Bight Petroleum cetacean surveys.

September; and 384 'aggregated' sightings of dolphin (22,169 individuals; mean group size 58 ± 129.6) during October to June. The latter was aggregated due to the difficulty in identifying individual species.

- IFAW (2013) during their survey in April/May 2013 observed that the most common species encountered was the short-beaked common dolphin in waters less than 200 m; and
- Bilgmann et al., (2014) in their survey of continental shelf waters to the 100 m isobath in July/August 2013 observed approximately 71 schools of short-beaked common dolphin (722 individuals) and 14 schools of bottlenose dolphins (107 individuals).

The following dolphin species are listed as having a possible presence in the Duntroon MSS EMBA (DoEE, 2017a):

- **Risso's dolphin** (*Grampus griseus*): Risso's Dolphin inhabits tropical, subtropical, temperate and subantarctic waters between 60° N and 60° S. The species has been sighted both inshore and well offshore and is generally considered pelagic and oceanic. The species is present mainly on steep sections of the upper continental slope usually in waters deeper than 1000 m (DoE, 2014k), however the species has been observed to come into shallower water when the continental shelf is close to shore (Bannister et al. 1996). Sea temperatures in these areas range from 15–30 °C (DoE, 2014k). Risso's dolphin is regularly seen with other oceanic cetaceans particularly pilot whales (DoE, 2014k).

  This species has been recorded in all Australia states except Tasmania and Northern Territory (DoE, 2014k). Stranding records range from about 23° S to 39° S and while no estimates of abundance are available, it is believed this species is reasonably abundant throughout its range in depths from 180 m to 1500 m based on limited sight data (Corkeron & Bryden 1992; cited in DoE, 2014k).

  No calving areas are known in Australian waters and the calving/mating season is unknown (DoE, 2014k).

  Risso's dolphin feeds primarily on squid, some octopus and possibly fish. Squid species taken by Risso's dolphin are both pelagic and neritic (Bannister et al., 1996).

  The species was observed in February (1.7 species/1000 km survey distance) in aerial surveys from November 2002 to March 2013 (Gill et al, 2015).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Based upon available survey data, this species may be encountered in the survey area during the survey period.

- **Common dolphin** (*Delphinus delphis*): Species are found in offshore waters (shallow and deep) on the continental shelf and have been recorded in all Australian states and territories but rarely seen in northern waters (prefers water temperatures 10-20°C). Common dolphins appear in two locations around Australia, one cluster in the southern south-eastern Indian Ocean and another in the Tasman Sea (DoE, 2014l). A genetically distinct common dolphin population is regionally distributed in coastal and shelf waters of the GAB separate to adjacent populations to the west (Esparence, WA) and east (Eyre Peninsula SA to Wilsons Promontory VIC) (Bilgmann et al., 2014).

  Globally, the species is found in tropical, subtropical and temperate waters of the Atlantic, Pacific and Indian Oceans in both shallow and deep offshore waters (DoE, 2014l). Common dolphins occur mainly in medium water depths over the continental shelf, however they have been observed to travel over specific oceanic features such as seamounts, ridges and escarpments and in habitats which contain small epipelagic fish such as anchovies and sardines (DoE, 2014l).

  Their diet consists of epipelagic/mesopelagic fish and squid, cephalopods and crustaceans. Reproduction, based upon data obtained from outside Australia, indicates that calving occurs year-round with peaks in spring and autumn. No specific calving areas are known in Australia (DoE, 2014l).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Based upon available survey data, this species may be encountered in the survey area during the survey period.

- **Southern right whale dolphin** (*Lissodelphis peronnii*): Southern right whale dolphins are found only in the southern hemisphere, where their distribution is circumpolar and generally between 30–65°S (DoE, 2014m). The species is pelagic generally in deep water or on the outer edges of the continental shelf between the sub-tropical and sub-Antarctic convergence (DoE, 2014m). They are usually found offshore but when inshore are usually in deep water, or on the outer edges of the continental shelf (DoE, 2014m). No key localities are known is Australian waters, but the preferred water temperature range is approximately 2-20ºC (DoE, 2014m).

  The species has been recorded as feeding on mesopelagic fish, squid and crustaceans; and euphausiids are also thought to be potential prey (Chou et al. 1995; cited in DoE, 2014m). It is unknown whether the southern right whale dolphin is a surface or deep-layer feeder (Bannister et al. 1996).

  Calving areas are not known, however there is evidence that the calving season is November to April (DoE, 2014m).

  The species was observed in November (59.6 species/1000 km survey distance) in aerial surveys from November 2002 to March 2013 (Gill et al, 2015).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Based upon available survey data, this species may be encountered in the survey area during the survey period.

- **Indian Bottlenose Dolphin** (*Tursiops aduncus*): Indian Ocean bottlenose dolphins are found in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean. The species is distributed continuously around the Australian coastline restricted to inshore areas such as bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters including coastal areas around oceanic islands (< 20 m depth). The total population of Indian Ocean bottlenose dolphin is unknown. However, it is likely that this species is common in inshore and nearshore waters of eastern, western and northern Australia (Ross 2006; cited in DoE, 2014n). Four main regions have been identified around Australia – Eastern Indian Ocean, Tasman Sea, Coral Sea and Arafura/Timor Seas (DoE, 2014n). Local population estimates suggest that 102 individuals occur in Jervis Bay, 140 in Port Stephens (Möller et al. 2002; cited in DoE, 2014n), about 350 in Moreton Bay (Corkeron 1990; cited in DoE, 2014n), 900 in coastal waters off North Stradbroke Island (Chilvers & Corkeron 2003; cited in DoE, 2014n), and about 1800–2400 in Shark Bay, Western Australia (Preen et al. 1997; cited in DoE, 2014n).

  The species feeds predominantly on fish and cephalopods. Calving season is summer and mating time coincides with peak calving time in each location. No calving areas have been identified in Australian waters (Bannister et al, 1996).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Based upon survey observation data, geographic range and preferred habitat, this species is not expected to be encountered during the survey activities.

- **Bottlenose Dolphin** (*Tursiops truncatus):* Bottlenose Dolphins are found in all temperate and tropical waters, in both coastal (inshore and nearshore) and offshore waters. They are usually found in latitudes lower than 45° in both hemispheres, but in the North Atlantic they can reach about 65° N (DoE, 2014o).

  The species population size is not known but it is likely to be common in offshore waters of south-eastern and southern Australia. The species has been recorded in Queensland, NSW, Tasmania, SA and SW Western Australia inhabiting inshore areas (bays, lagoons, estuaries), nearshore (open coast) and offshore environments. There appears to be two main locations for the species in Australia – South Pacific Ocean and Southern Indian Ocean (DoE, 2014o).

  Inshore animals feed on fish and invertebrates from the littoral zone while offshore animals feed on mesopelagic fish and oceanic squid (DoE, 2014o).

  Calving season is diffuse but expected to be in summer with no known calving areas in Australia (Bannister et al. 1996).

The species was observed in November (1.5 species/1000 km survey distance) and December (7.7 species/1000 km survey distance) in aerial surveys from November 2002 to March 2013 (Gill et al, 2015).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Based upon available survey data, this species may be encountered in the survey area during the survey period.

Pilot whales (odontocetes)

Pilot whale species typically communicate at frequencies between 1 and 18 kHz (Simmonds et al. 2004).

Surveys undertaken in the eastern GAB have observed significant numbers of pilot whales. This includes:

- Gill et al. (2015)[17] recorded 40 sightings (1853 individuals; mean group size 46.3 ± 46.7) of long-finned pilot whales from November to May. This species was located on the upper slope (close to the shelf break) in mean water depths of 634 ± 494 m; and
- IFAW (2013) during their survey in April/June 2013 observed pilot whales within the survey area over the continental slope.

The following pilot whale species are listed as having a possible presence in the Duntroon MSS EMBA (DoEE, 2017a):

- **Long-finned Pilot Whale** (*Globicephala melas*): Species is distributed throughout the northern and southern hemisphere in circumpolar oceanic temperate and sub-Antarctic waters. In the southern hemisphere this is generally between 27°S and 62°S.

  The long-finned pilot whale is widely recorded in waters off southern Australia, and at Macquarie and Heard Island (Bannister et al. 1996). Eighteen sightings and 55 strandings have been recorded in Australian territories (for South Australia 15 strandings) (DoE, 2014p). Mass strandings of long-finned pilot whales on Australian coasts have occurred on average once per year since 1970. All but three events have occurred between September and March, with 60% occurring from December to March (Ross 2006; cited in DoE, 2014p). This implies there may be extreme fluctuations in the species numbers within Australian territorial waters, possibly due to seasonal onshore movements (Bannister et al. 1996). No population estimates are available for the species in Australian waters, however, they are generally considered to be in relatively high abundance (DoE, 2014p).

  Long-finned pilot whales inhabit temperate (10–20°C) and subantarctic (1-8°C) deep oceanic waters and zones of higher productivity along the continental slope, apparently venturing into shallower shelf waters (<200 m) in pursuit of prey species (squid and fish). There is some (in-conclusive) evidence that the species moves along the edge of the continental shelf in southern Australian waters (Bannister et al. 1996) in response to prey abundance at bathymetric upper slopes and canyons (DoE, 2014p).

  Tasmanian records indicate mating occurs in spring and summer with 85% of calves born between September and March although births do occur throughout the year. No calving areas are known in Australian waters (DoE, 2014p).

  The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

  Based upon available survey data, this species may be encountered in the survey area during the survey period.

- **Short-finned Pilot Whale** (*Globicephala macrorhynchus)*: This species is circum-global between 45°N and 41°S in tropical and temperate waters. Their distribution includes oceanic waters (edge of continental shelf and over deep submarine canyons) and continental seas with possible offshore-inshore movement responding to spawning prey abundance (squid, cuttlefish, octopus and some fish) (Bannister et al, 1996).

[17] This includes the observation data of the 2011-2012 Bight Petroleum cetacean surveys.

Relatively few stranding events have occurred in Australia however strandings have been recorded from all states and the Northern Territory (until 1994). One stranding each has occurred in Victoria and Tasmania, two in WA and the Northern Territory, three in both Queensland and NSW and eight in SA (Bannister et al. 1996). No population estimates are available for the species in Australian waters, although they are generally considered to be in relatively high abundance (DoE, 2014q).

Short-finned pilot whales feed mainly on squid, cuttlefish, octopus and some fish. It has been hypothesised that the species undertaken deep dives (~600-800 m for a maximum of 27 minutes) at dusk and dawn following prey migration and near-surface (~100 m) foraging at night (DoE, 2014q).

Calving season is diffuse peaking in July and August however there are no known calving localities in Australia.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

This species may be encountered in the area during the survey period.

3.7.6 Other marine mammals

3.7.6.1 Australian Sea Lion

The Australian sea lion (*Neophoca cinerea*), listed as vulnerable, is present along the Australian coastline from the Houtman Abrolhos Islands (WA) to the Pages Island, east of Kangaroo Island (SA) (SEWPC, 2012m). The species hauls-out (or rests) and breeds on rocky platforms, low lying limestone islands and sandy beaches on sheltered sides of islands on the Australian mainland (DEWHA, 2007) avoiding exposed rocky headlands. Sea lion colonies are present on coastlines adjacent to the survey area (SEWPC, 2011a). Female sea lions show strong affinity to breeding sites (DEWHA, 2007). **Figure 3-47** identifies breeding locations in proximity to the survey area. Breeding details at locations within the Duntroon EMBA are provided in **Table 3-13**.

Figure 3-46: Australian sea lion breeding locations (Goldsworthy et al., 2015)

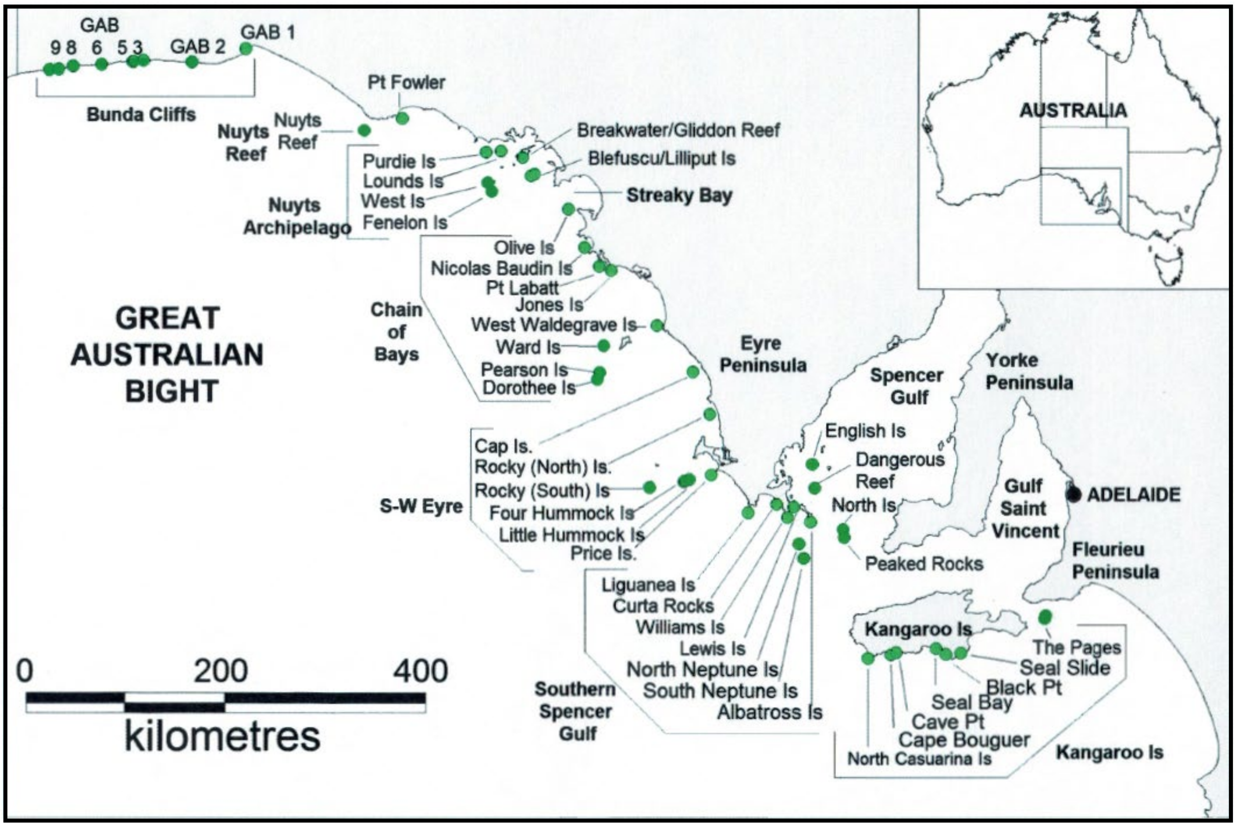
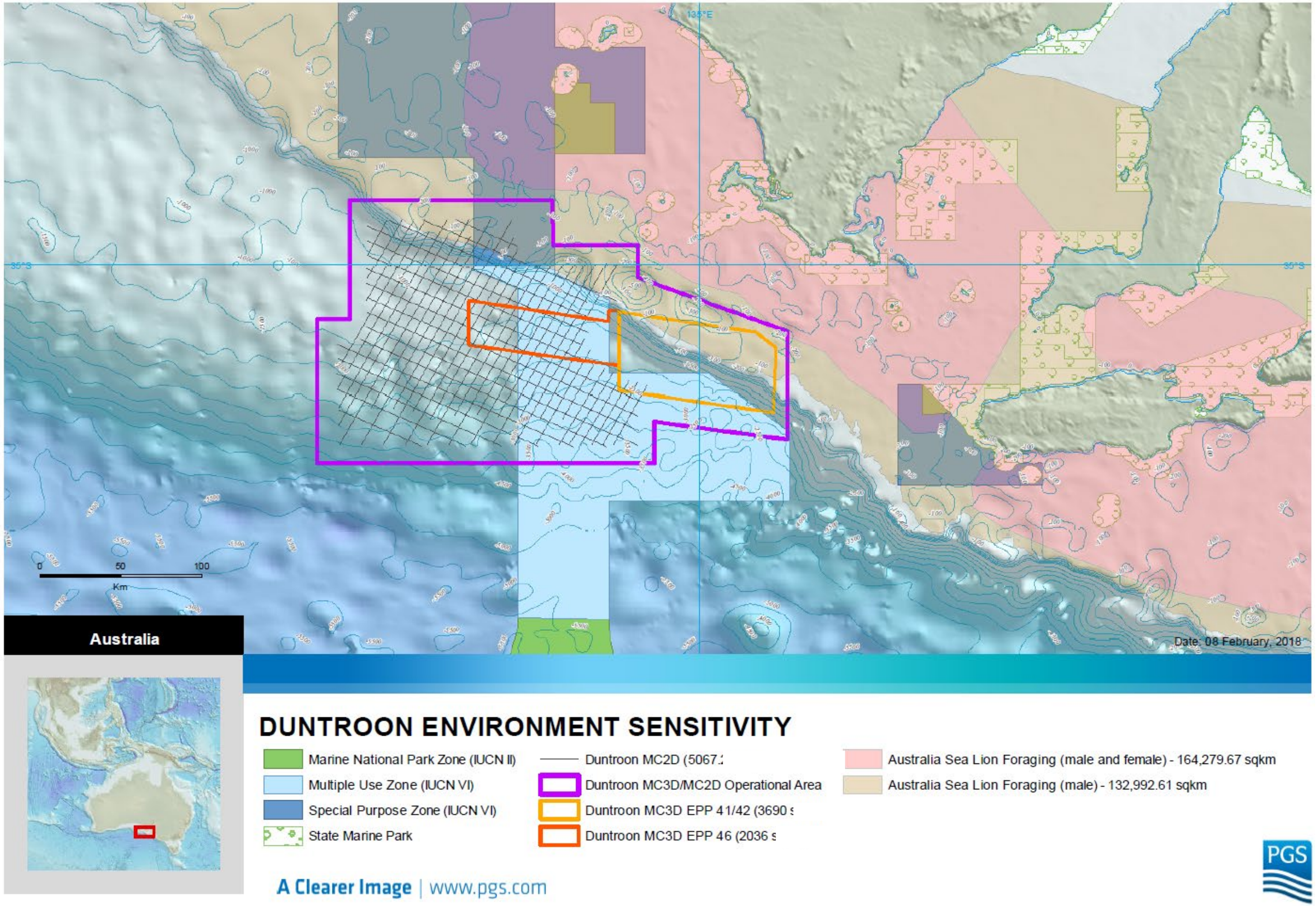


Table 3-13: Breeding Seasons at Australian sea lion breeding sites (adapted from Goldsworthy et al. 2015)

Name	Pups Surveyed	Year
Ward Island	44	2015
Pearson Island	30	2015
Dorothee Island	0	2013
West Waldegrave Island	80	2015
Cap Island	31	2014
Rocky (North) Is.	35	2014
Rocky (South) Is.	11	2014
Four Hummock Island	6	2014
Little Hummock Island	4	2014
Price Island	32	2014
Liguanea Island	25	2015
Curta Rocks	7	2014
Williams Island	5	2014
Lewis Island	82	2014
North Neptune Island	9	2014
South Neptune Island	7	2014
Albatross Island	95	2011
English Island	64	2011
Dangerous Reef	485	2014
North Island	32	2011
Peaked Rocks	17	2011
North Casuarina Island (KI)	11	2014
Cape Bouger (KI)	9	2014
Cave Point (KI)	0	2014
Seal Bay (KI)	259	2013
Black Point (KI)	0	2002
Seal Slide (KI)	8	2015

Figure 3-47: Duntroon Survey Area and BIAs for Australian sea lion in the eastern GAB (DoEE, 2017b).



Breeding colonies for the Australian sea lion are found only in South Australian and Western Australian waters (SEWPC, 2013). Most of the Australian sea lion population occurs in South Australia with an estimated 40% of the population found in the three largest colonies located at the eastern end of its range (refer Table 3-13). The NCVA (DoEE, 2017b) nominates the following critical breeding locations for the Australian sea lion within the EMBA:

- Seal Slide (Kangaroo Island) – 176 km east from survey OA;
- Seal Bay (Kangaroo Island) - 159 km east from survey OA;
- Peaked Rocks - 85 km ENE from survey OA;
- North Island – 87 km ENE from survey OA;
- Albatross island - 68 km ENE from survey OA;
- Lewis Island - 61 km NE from survey OA;
- Dangerous Reef - 86 km NE from survey OA;
- English Island - 101 km NE from survey OA;
- North Neptune Island – 48 km ENE from survey OA;
- South Neptune Island – 49 km ENE from survey OA;
- Liguanea island - 43 km north from survey OA;
- Price Island - 60 km ENE from survey OA;
- Four Hummocks (North) Island – 36 km ENE km from survey OA;
- Rocky Island North – 90 km NE from survey OA;
- Pearson Island – 73 km north from survey OA;
- Ward Island – 95 km north from survey OA; and
- West Waldegrave Island - 128 km north from survey OA.

The large colonies are found at The Pages Islands (~ 250 km east), Dangerous Reef and Seal Bay at Kangaroo Island (SEWPC, 2012m). It should be noted that all these major colonies do not have direct aspects onto the survey area and are protected[18] from sound propagation associated with the survey activities. During the Duntroon survey period, breeding will be occurring at West Waldegrave Island (Oct-Nov); Rocky Island South (Sep); Four Hummock Island (Sept-Nov); Little Hummock Island ((Sept); Price Island (Sept-Nov); Curta Rocks (Sept); Williams Island (Sept); Lewis Island (Sept-Oct); Dangerous Reef (Sept); Seal Bay (Nov) and Seal Slide (Nov). .

The Australian sea lion is the only pinniped species which does not have an annual breeding cycle and is temporally asynchronous across its range. Birth intervals are approximately 17-18 months (SEWPC, 2012m). The pupping period may extend to 8 to 9 months at the larger colonies (The Pages Islands and Dangerous Reef). A consequence of the 17 to 18-month breeding cycle, not synchronised between colonies, is that pupping does not occur at the same time each year (Shaughnessy et al., 2011). Typically, females haul-out a day or two before giving birth and leave approximately 10 days later to forage at sea (SEWPC, 2012m).

Haul-out sites for the Australian sea lion are on Kangaroo Island at Cave Point, Cape Bouguer, Cape du Couedic, North and South Casuarina Islet, Paisley Islet and Cape Bouda (Kangaroo Island Council, 2012).

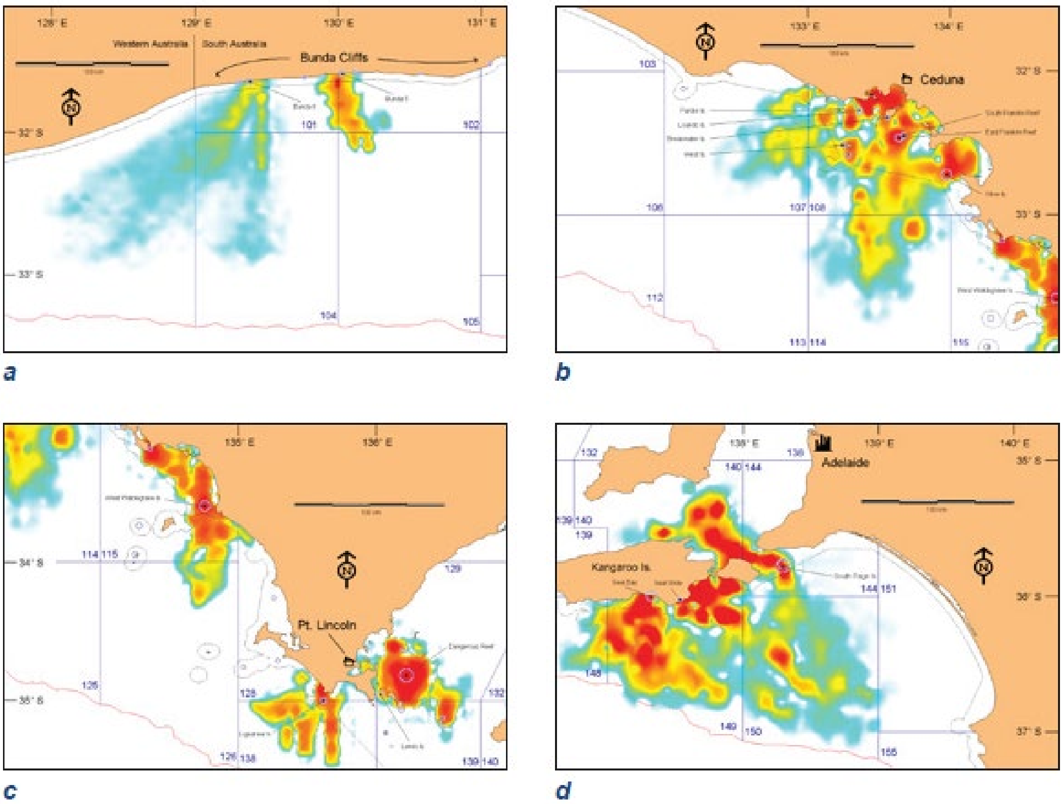
Australian sea lions forage in continental shelf waters, most commonly in depths between 20-100 m (Shaughnessy, 1999). They appear to be benthic foragers eating a variety of prey such as fish, small sharks, rays, invertebrates (e.g. rock lobster), cephalopods and occasionally seabirds such as penguins (DEWHA, 2008; SEWPC, 2013). Foraging areas for males can extend up to 200 km from the coast across the entire

[18] For example, Dangerous Reef is protected by Thistle Island and Lincoln National Park.

continental shelf and forage in deeper waters when compared with females (SEWPC, 2013). The northern boundary of the OA has a small overlap with the NCVA-recognised foraging area for female sea lions (refer Figure 3-47). The NCVA-recognised male foraging area extends to the edge of the continental shelf and is coincident with the Duntroon MSS area for water depths less than 200 m. Habitat is utilised year-round. Both foraging areas are considered as BIAs for the species. It is noted within the NCVA that foraging areas identified along the western Eyre Peninsula (i.e. west from Liguanea Island to Pearson Island) are based upon expert opinion (DoEE, 2017b). Australian sea lions typically travel up to about 60 km from their colony on each foraging trip with a maximum distance of around 190 km when over shelf waters (SEWPC, 2013) and spend approximately 35% of the time at or close to the seafloor (SEWPC, 2013b). The species can remain underwater for 8 minutes at a time (Taronga Zoo, 2018). Lactating females generally forage in depths of less than 150 m (SEWPC, 2012m).

Studies undertaken on the distribution of foraging from breeding colonies for lactating females is provided in Figure 3-48. These studies tracked individual foraging effort within and between the breeding sites with a variety of coastal and offshore habitats being utilised. It should be noted that pups are typically nursed for 15-18 months and weaned approximately one month prior to the birth of the next pup (SEWPC, 2013b). Typically, foraging patterns for females include one day of foraging at sea, followed by a day of rest, whereas adult males typically spend longer periods foraging – up to 2.5 days per trip (SEWPC, 2011b). Foraging capacity develops with age, with 3 to 18 month pups foraging near their natal colonies (~20 km) (SEWPC, 2013b).

Figure 3-48: Distribution of foraging (at sea) effort of 115 tracked lactating Australian Sea Lions (High: red, Medium: orange, Low: blue) (SEWPC, 2013b)



Encounter with adult male sea lions foraging in the marine environment is possible during the survey period.

Recovery Plan for Australian Sea Lion

The Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (SEWPC, 2013) identifies marine debris, vessel strike and pollution and oils spills as being a threat to the species which is relevant to the Duntroon survey activity (refer **Table 3-14**). Marine oil pollution is addressed in Section 6.10, vessel strikes are addressed in Section 6.15 and marine debris is addressed in Section 6.13.

Table 3-14: Recovery Plan for the Australian sea lion (SEWPC, 2013) – Threats relevant to activity

Relevant Threat/Objectives	Action Objective	Relevant Action
Mitigate pollution threats to Australian sea lions.	Implement jurisdictional oil spill response strategies.	Oil Pollution Emergency Plan developed in accordance with NOPSEMA requirements with integration into NATPLAN requirements.
Mitigate vessel strike threats to Australian sea lions.	Collect data on direct killings and confirmed vessels strikes.	Implement requirements of the draft Stragey for mitigating vessel strikes of marine megafauna.
Mitigate impacts of marine debris on Australian sea lion populations	Implement measures to mitigate the impacts of marine debris on Australian sea lion populations noting the linkages with the Treat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life.	Implement legislative requirements for preventing garbage discharge to the environment.

3.7.6.2 New Zealand Fur Seal

The New Zealand fur seal (*Arctocephalus forsteri*) (NZFS) is an EPBC-listed marine species (DoEE, 2017a) known to occur in the region. The species breeds in New Zealand and in southern Australia on the south coasts of WA, SA and at Maatsuyker Island (Tasmania) (Shaughnessy et al. 1999), however most of the population (77%) is found in central SA waters (Kangaroo Island to South Eyre Peninsula). More specifically, large breeding populations which account for more than 80% of the national pup production for the species are found at North Neptune and South Neptune Islands (SA); Kangaroo Island (SA) and Liguanea Island (SA) (SEWPC, 2011b).

The pupping season for the species is between November and January (Shaughnessy et al., 1999). The species prefers the rocky parts of islands with jumbled terrain and boulders and prefers smoother igneous rocks to rough limestone. Colonies are occupied year-round but activity is greatest in summer (Shaughnessy et al. 1999). During the non-breeding season, February to October, the breeding sites are occupied by pups and young juveniles, whilst adult females alternate between periods at the breeding sites and foraging at sea (SMM, 2012)

Figure 3-49 and **Figure 3-51** provides estimated at-sea foraging distribution for male and female NZFSs respectively. Adult males use the entire continental shelf where they overlap with adult females however adult males also forage in deeper waters over the continental shelf slope (Goldsworthy and Page, 2009). In summer and autumn, most adult females use the entire continental shelf, however some also use the pelagic waters associated with the sub-tropical front 600-1000 km south of the continental shelf break. In winter and spring, an increasing proportion of adult females use pelagic waters (Goldsworthy and Page, 2009).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

The species diet is principally fish and cephalopods, but also includes seabirds such as little penguins (Shaughnessy et al. 1999). Female fur-seals dive usually to 80 m during early lactation and later in their lactation they will dive to depths of 20-200 m at distances 80-100 km from shorelines. It is highly likely that the males can dive to over 200 m (SMM, 2012).

Encounter with adult NZFSs foraging in the marine environment is possible during the survey period.

Figure 3-49: Estimated at-sea foraging habitat for male New Zealand fur seals (Goldsworthy & Page, 2009)

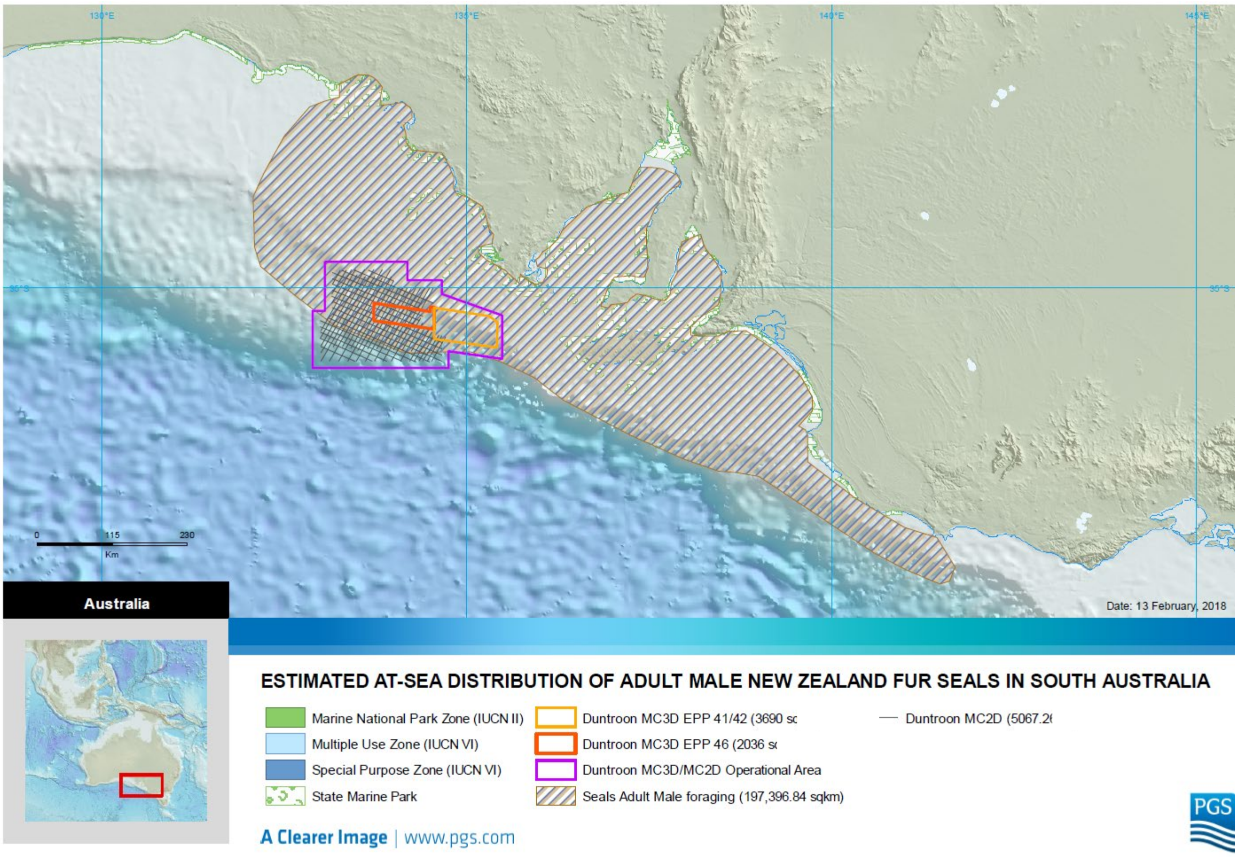
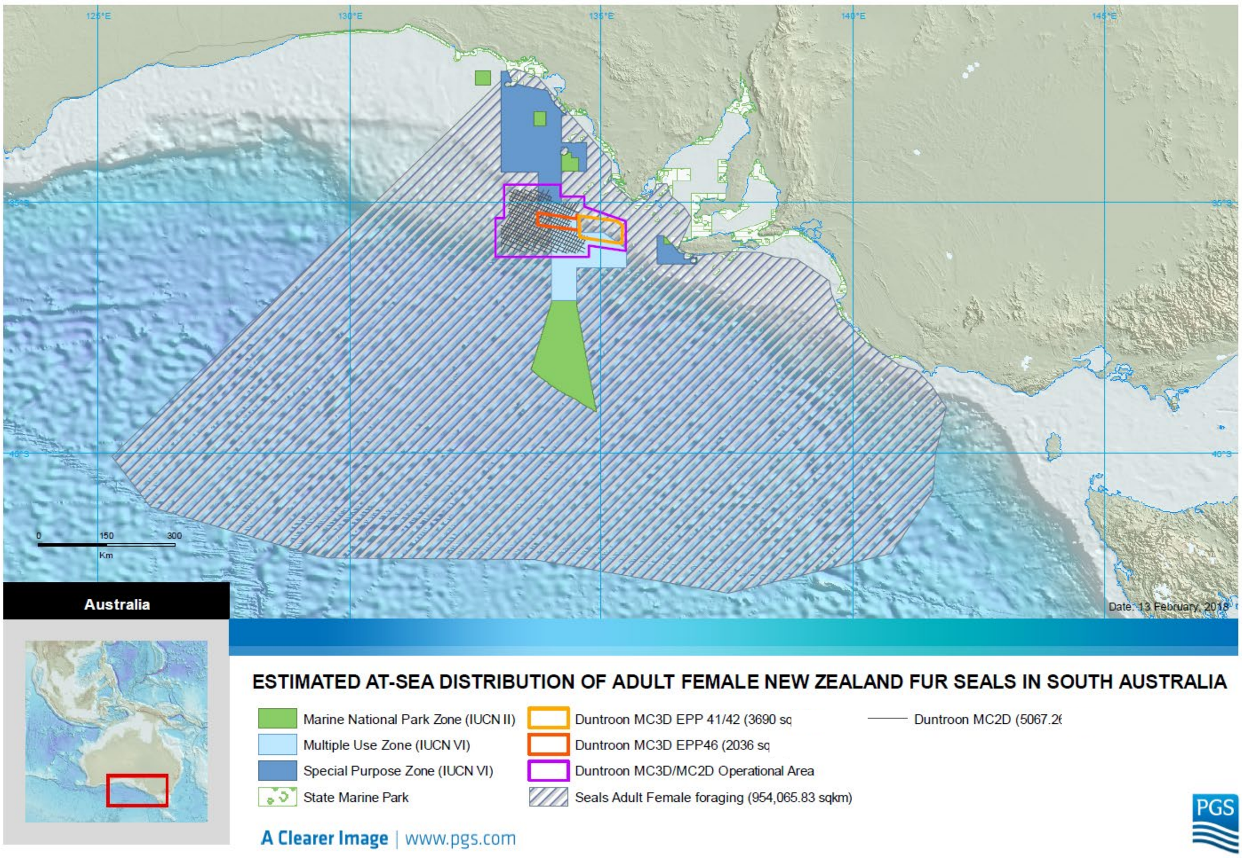


Figure 3-50: Estimated at-sea foraging habitat for female New Zealand fur seals (Goldsworthy & Page, 2009)

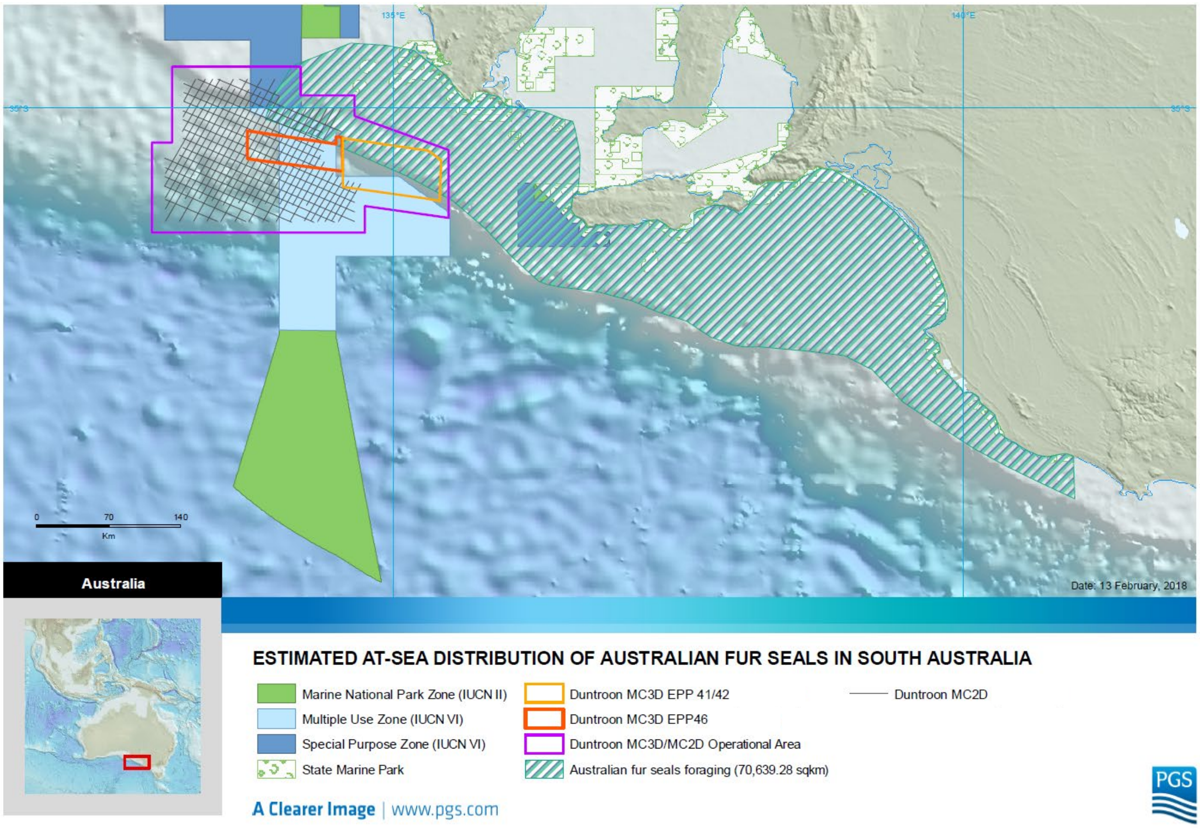


3.7.6.3 Australian Fur Seal

Australian fur seals (*Arctocephalus pusillus*) are found in Australia's southern waters along the coasts of NSW, Victoria, Tasmania and South Australia. There are ten established breeding colonies of the species which are restricted to islands in Bass Strait – six off the coast of Victoria and four off the coast of Tasmania. Three additional developing breeding colonies have been identified including one SA site - Northern Casuarina Island located to the southwest of Kangaroo Island (~ 92 km east). Australian fur seal pups have been recorded at three other SA localities – six at Baudin Rocks (~ 395 km east); two at Williams Island (~52 km NE) and one at Cape Gantheaume (~170 km east) (Shaughnessy et al, 2010). In addition, there have been sightings of the Australian fur seal from Baudin Rocks in the south-east to Point Labatt on the west coast of the Eyre Peninsula. Satellite tracking data has shown that adult males and females travel on the continental shelf of SA waters to the eastern part of the GAB (Shaughnessy et al, 2010) with Australian fur seals not appearing to use regions deeper than 200 m (Goldsworthy & Page, 2009) (refer Figure 3-51).

Most of the SA population is on Kangaroo Island and the nearby Casuarina Islands (Shaughnessy et al, 2010). The Australian fur-seal prefers the rocky parts of islands. On Kangaroo Island, where New Zealand and Australian fur-seals occur, the Australian fur-seals occupy flatter, more open parts of the colony (Shaughnessy 1999). Australian fur-seal colonies are occupied year-round, but the intensity of behavioural interactions between individuals is greatest during the summer breeding season (Warneke 1995a). Australian fur-seals breed during the summer months, with pups born from late October to late December (Shaughnessy, 1999).

Figure 3-51: Estimated at-sea distribution of Australian fur seals in SA (Goldsworthy and Page, 2009)



The Australian fur-seal prefers to forage in oceanic waters of the continental shelf and generally does not dive deeper than 150 m. The species feeds principally on fish and cephalopods (octopus and squid) but will also take seabirds. The primary squid species taken in Tasmanian waters is Gould's Squid (*Nototodarus gouldi*) (Gales et al. 1993; cited in Shaughnessy, 1999). Dietary analysis has shown that of 25—38 species of fish identified, only a few were specific to any location or found only in a season (Gales & Pemberton 1994; Littnan et al. 2007; cited in Shaughnessy, 1999). The most important fish-prey is jack mackerel (*Trachurus symmetricus*), redbait (*Emmelichthys nitidus nitidus*) and leatherjacket (*Monocanthidae* family).

Fish were found to dominate the diet in winter, while cephalopods dominated in summer (Littnan et al. 2007; cited in Shaughnessy, 1999). Prey sizes indicated that adult fish and squid were mostly eaten.

Lactating female Australian fur-seals in the northern Bass Strait have been found to forage exclusively within the shallow waters over the continental shelf of the Bass Strait. The water in this area has a depth of 60–80 m and a sea surface temperature of 16.0–16.8 ºC (Arnould & Kirkwood 2008; cited in DoEE, 2017c). Due to the mobility and foraging requirements of Australian fur-seals, they may occur in areas up to 500 km from a colony and appears to peak in autumn and winter (Lyle & Willcox 2008; cited in DoEE, 2017c), when both males and females are building up their energy reserves for the pupping season (October to December) and females are maintaining milk reserves for their young which they continue to suckle (DoEE, 2017c).

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2017b).

Encounter with adult Australian fur seals foraging in the marine environment is possible during the survey period.

3.7.7 Reptile Species

The EPBC Act Protected Matters database (DOEE, 2017a) identified three species of marine reptile possibly occurring in, or in proximity to, the survey area as threatened and migratory; the green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*) and leatherback turtle (*Dermochelys coriacea*). Details of these species are discussed further in this section.

Table 3-15 provides details of the species which are listed under the EPBC Act.

Table 3-15: EPBC-Listed reptile species for the survey area (DOEE, 2017a; 2018c)

Status:	Likelihood of Occurrence:
E: Endangered	LO: Species or species habitat likely to occur in area
V: Vulnerable	MO: Species or species habitat may occur within area
M: Migratory	FMO: Foraging/Feeding may occur within area
L:Listed	FKO: Foraging/Feeding known to occur in area
	KO: Species or species habitat known to occur within area
	FLO: Foraging/Feeding likely to occur in area
	BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/Advice
Reptiles	Caretta caretta	Loggerhead Turtle	E, M	LO	✓	-	✓	-	[1]
	Chelonia mydas	Green Turtle	V, M	LO	✓	-	✓	-	[1]
	Dermochelys coriacea	Leatherback Turtle	E, M	LO	✓	-	✓	-	[1]

Definitions:

Listed threatened species:	A native species listed (L) under the Commonwealth EPBC Act (Section 178): critically endangered (CE), endangered (E), vulnerable (V)
Listed migratory species:	A migratory (M) species included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.
Listed marine species:	As listed in Section 248 of the EPBC Act.

References:

[1] Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017)

3.7.7.1 Green Turtle

The green turtle nests, forages and migrates across tropical northern Australia usually between the 20°C isotherms although individuals may stray into temperate waters (SEWPC, 2012n). Green turtles are herbivores, feeding on shallow benthic habitats containing seagrass and/or algae including coral and rocky reefs, and inshore seagrass beds (DEWHA, 2007). Major nesting areas are found tropical regions of WA, Northern Territory and Queensland (SEWPC, 2012n).

No biologically significant areas (i.e. feeding or breeding) for the green turtle are in proximity to the survey area. The NCVA does not identify any BIAs for this species within, or adjacent to, the survey area (DoEE, 2017b).

Given the species preferred geographical distribution, encounter with the species during the survey period is considered remote.

3.7.7.2 Loggerhead Turtle

The loggerhead turtle has a global distribution throughout tropical, sub-tropical and temperate waters. In Australia, the loggerhead turtle occurs in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia (DEWHA, 2007). Nesting is mainly concentrated on sub-tropical beaches concentrated in southern Queensland and from Shark Bay to the North West Cape in Western Australia. Foraging areas are more widely distributed (SEWPC, 2012o). Loggerhead turtles are carnivorous, feeding primarily on benthic invertebrates in habitat ranging from near-shore to 55 m (SEWPC, 2012o).

No biologically significant areas (i.e. feeding or breeding) for the loggerhead turtle are in proximity to the survey area. The NCVA does not identify any BIAs for this species within, or adjacent to, the survey area (DoEE, 2017b). Given the species preferred geographical distribution, encounter with the species during the survey period is considered remote.

3.7.7.3 Leatherback turtle

The leatherback turtle is a pelagic feeder, found in tropical, subtropical and temperate waters (Marquez, 1990). Its large body size, high metabolism, thick adipose tissue layer and regulation of blood flow allows the species to utilise cold water foraging areas unlike other sea turtles. For this reason, this species is regularly found in the high latitudes of all oceans including waters offshore from NSW, Victoria, Tasmania and WA (DoEE, 2018e). Adult turtles are found in both pelagic and coastal waters foraging throughout the water column to depths of more than 1200 m (DEWHA, 2007). The species has been recorded feeding in all Australian states and while no major nesting areas have been recorded in Australia (DEWHA, 2007), scattered isolated nesting occurs in southern Queensland and the Northern Territory (DoEE, 2018e). It is thought that most leatherback turtles found in Australian waters have migrated from tropical nesting areas to feed in temperate waters (DEWHA, 2007). The species is recorded as an occasional visitor to north-eastern Kangaroo Island (Kangaroo Island Council, 2012). Adult turtles feed mainly on pelagic soft-bodied creatures such as jellyfish which occur in greatest concentrations at the surface in areas of upwelling or convergence (DoEE, 2018e). The regular occurrence of leatherback turtles is probably due to the seasonal occurrence of large numbers of jellyfish (DoEE, 2018e).

No biologically significant areas (i.e. feeding or breeding) for the leatherback turtle have been identified in proximity to the survey area. The NCVA does not identify any BIAs for this species within, or adjacent to, the survey area (DoEE, 2017b). Encounter with the species in the survey area is possible, thought unlikely due to the survey timeframe which lies outside the key upwelling period.

<u>Recovery Plan (Marine Turtles)</u>

The Recovery Plan for Marine Turtle in Australia (DoEE, 2017) identifies marine debris, chemical/terrestrial discharges/spills, light pollution, vessel disturbance and noise interference as being threats to marine turtles which is relevant to the Duntroon MSS activity (refer Table 3-16). Marine oil pollution is addressed in Section 6.10, lighting is addressed in Section 6.1, marine debris in Section 6.13, vessel disturbance in Section 6.15 and noise interference in Section 6.2.

Table 3-16: Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017) – Threats relevant to activity

Relevant Threat/Objectives	Plan or Action Objective	Relevant Action
Noise Interference	In accordance with the EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines, all seismic survey vessels operating in Australian waters must undertake a soft start during surveys irrespective of location and time of year of the survey. Although these guidelines are specifically designed for interactions with cetaceans, the soft start provision may also afford protection for marine turtles.	Adopt EPBC Policy Statement 2.1 requirements for soft starts.
Vessel Disturbance	Impact from vessels can cause serious injury and/or death to individual marine turtles. This is particularly an issue in shallow coastal foraging habitats and internesting areas where there are high numbers of recreational and commercial craft and in areas of marine development. 'Go slow' zones have been implemented in a number of marine turtle foraging habitats within high marine vessel traffic areas. Although the outcome can be fatal for individual turtles, boat strike (as a standalone threat) has not been shown to cause stock level declines.	The Duntroon OA is not located in shallow coastal foraging areas or internesting areas.
A3: Reduce the impacts from marine debris	Support the implementation of the EPBC Act Threat Abatement Plan for the impacts of marine debris on vertebrate marine life.	Implement legislative requirements for preventing garbage discharge to the environment.
A4: Minimise chemical and terrestrial discharge	Ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs. Quantify the impacts of decreased water quality on stock viability	Oil Pollution Emergency Plan developed in accordance with NOPSEMA requirements with integration into NATPLAN requirements. Duntroon survey area is not located in proximity to 'slow to recover' habitats.
A8: Minimise light pollution	Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that artificial lighting does not impede marine turtle stock recovery. Develop and implement best practice light management guidelines for existing and future developments that are adjacent to marine turtle nesting beaches. Identify the cumulative impact on turtles from multiple sources of onshore and offshore light pollution.	Actions are not considered particularly revelant to Duntroon survey area as there are no sensitive nesting beaches or hatchlings in Victorian waters. Offshore vessel lighting will be minimised as far as possible.

3.7.8 Marine Seabirds

The EPBC Act Protected Matters database search (DoEE, 2017a), based upon a 208 km search radius around the survey boundary identified 32 bird species possibly occurring in, or in proximity to, the survey area as having a threatened classification, 13 species as migratory marine bird species, four as migratory terrestrial and 26 as migratory wetland species. Given this large search radius, many species are terrestrial, do not have a marine or shoreline presence and are not considered further in this section. This includes the following species (DoEE, 2017a):

Common sandpiper (*Actitis hypoleucos*) – a coastal wetlands species; Great egret (*Ardea alba*) – a wetland species; Cattle egret (*Ardea ibis*) – a wetland species; Fork-tailed swift (*Apus pacificus*) – an inland migratory species feeding on insects; Australasian Bittern (*Botaurus poiciloptilus*) – a wetland species inhabiting permanent/seasonal freshwater habitats; Musk duck (*Bisiura lobate*) – a waterfowl species; Sharp-tailed sandpiper (*Calidris acuminata*) – a wetland species; Pectoral sandpiper (*Calidris melanotos*) – a wetlands species; Long-toed stint (*Calidris subminuta*) – a wetlands species; Glossy Black Cockatoo (*Calyptorhynchus lathami halmaturinus*) – a woodland species on Kangaroo Island; Red-necked stint (*Calidris ruficollis*) – a wetland species; Cape Barren Goose (*Cereposis novaehollandiae*) – a grasslands/wetlands species; Double-banded plover (*Charadius bicinctus*) – a wetland species; Oriental plover (*Charadius veredus*) – a grassland species; Latham's snipe (*Gallinago hardwickii*) – a wetland species; Swinhoe's snipe (*Gallinago megala*) – a wetland species; Pin-tailed snipe (*Gallinago stenura*) – a wetland species; Black-winged stilt (*Himantopus himantopus*) – a wetland species; White-throated needle-tail (*Hirundapus caudacutus*) – a woodland species; Mallee fowl (*Leipoa ocellata*) – a scrubland and woodland species; Rainbow bee-eater (*Merops ornatus*) – a woodland species; Grey Wagtail (*Motacilla cinerea*) - Found in mountain streams and rivers and in forested areas; Yellow wagtail (*Motcilla flava*) – a wetland species; Satin Flycatcher (*Myiagra cyanoleuca*) – a woodland species; Little curlew (*Numenius phaeopus*) – a wetland/grassland species; Plains Wanderer (*Pedionormus torquatus*) – a sparse grasslands bird; Australian pelican (*Pelecanus conspicillatus*) – a coastal wetland species; Night Parrot (*Pezoporus occidentalis*) – a species found in arid and semi-arid areas of Australia; Great cormorant (*Phalacrocorax carbo*) – a coastal wetland species; Western Whipbird (*Psophodes nigrogularis leuogaster*) – a species which inhabits mallee and thicket vegetation; Red-necked avocet (*Recurvirostra novaehollandiae*) – a wetland species; Australian painted snipe (*Rostratula australis*) – a species which inhabits freshwater wetlands; Southern Emu Wren (*Stipiturus malachurus parimeda*) – a species on the Eyre Peninsula which prefers shrubland/heath/mallee; Grey-tailed tattler (*Tringa brevipes*) – a wetland species; Common greenshank (*Tringa brevipes*) – a wetland species; Little greenshank (*Tringa stagnatillus*) – a wetland species; and Bassian Thrush (*Zoothera lunulata halmaturina*) – species prefers damp eucalyptus forests

Details of these species are not discussed further in this section.

Table 3-17 provides details of the species which are listed under the EPBC Act which may be present in the Duntroon EMBA.

Table 3-17: EPBC-Listed marine bird species present in the survey area (DoEE, 2017a; 2018c)

Status:

E: Endangered

V: Vulnerable

M: Migratory

L:Listed

Likelihood of Occurrence:

LO: Species or species habitat likely to occur in area

MO: Species or species habitat may occur within area

FMO: Foraging/Feeding may occur within area

FKO: Foraging/Feeding known to occur in area

KO: Species or species habitat known to occur within area

FLO: Foraging/Feeding likely to occur in area

BO: Breeding known to occur in area

RKO: Roosting known to occur

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Birds	Ardenna pacifica	Wedge-tailed shearwater	M	-	X	X	✓(BO)	X	-
	Ardenna tenuirostris	Short-tailed shearwater	M	-	✓	✓ (foraging high numbers)	✓ (BO)	✓ (foraging high numbers)	-
	Arenaria interpres	Ruddy Turnstone	M	-	X	X	✓(RKO)	X	-
	Caldris alba	Sanderling	M	-	X	X	✓(RKO)	X	-
	Calidris canutus	Red Knot	E	MO	✓	X	✓	X	✓(REF 1)
	Calidris ferruginea	Curlew Sandpiper	CE, M	MO	✓	X	✓	X	✓(REF 2)
	Calidris tenuirostris	Great Knot	CE, M	-	X	X	✓ (RKO)	X	✓(REF 3)
	Charadrius leschenaulti	Greater Sand Plover	V, M	-	X	X	✓ (KO)	X	
	Charadrius mongolus	Lesser Sand Plover	E, M	-	X	X	✓ (KO)	X	✓(REF 4)
	Charadrius ruficapillus	Red-capped plover	L	0	X	X	✓ (RKO)	X	-
	Catharacta skua	Great Skua	L	-	X	X	✓ (MO)	X	-
	Diomedea antipodensis	Antipodean Albatross	V, M,	FLO	✓	X	✓	✓(foraging)	✓(REF 5)
	Diomedea epomophora (sensu stricto)	Southern Royal Albatross	V, M,	FLO	✓	X	✓	X	✓(REF 5)
	Diomedea exulans (sensu lato)	Wandering Albatross	V, M,	FLO	✓	X	✓	✓ (foraging)	✓(REF 5)
	Diomedea sanfordi	Northern Royal Albatross	E, M,	FLO	✓	X	✓	X	✓(REF 5)
	Egretta sacra	Eastern reef egret	-	-	X	X	✓	X	-
	Eudyptula minor	Little Pengiun	L	-	X	X	✓ (BO)	✓ (foraging – provision young)	-
	Falco peregrinus	Peregrine falcon	-	-	X	X	✓	X	-
	Haliaeetus leucogaster	White-bellied sea eagle	L	-	X	X	✓ (BO)	X	-
	Halobaena caerulea	Blue Petrel	V,	MO	✓	X	✓	X	✓(REF 6)

Status:

E: Endangered

V: Vulnerable

M: Migratory

L:Listed

Likelihood of Occurrence:

LO: Species or species habitat likely to occur in area

MO: Species or species habitat may occur within area

FMO: Foraging/Feeding may occur within area

FKO: Foraging/Feeding known to occur in area

KO: Species or species habitat known to occur within area

FLO: Foraging/Feeding likely to occur in area

BO: Breeding known to occur in area

RKO: Roosting known to occur

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Birds (Con't)	Larus dominicanus	Kelp Gull	L	-	X	X	✓ (BO)	X	-
	Larus novaehollandiae	Silver Gull	L	-	X	X	✓ (BO)	X	-
	Larus pacificus	Pacific Gull	L	FKO	✓	✓ (foraging)	✓	✓(foraging)	-
	Limosa lapponica baueri	Bar-tailed Godwit	V, M	-	X	X	✓(MO)	X	✓(REF 7)
	Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE, M	-	X	X	✓(MO)	X	✓(REF 8)
	Macronectes giganteus	Southern Giant-Petrel	E, M,	MO	✓	X	✓	X	✓(REF 5)
	Macronectes halli	Northern Giant-Petrel	V, M,	MO	✓	X	✓	X	✓(REF 5)
	Neophema petrophila	Rock parrot	-	-	X	X	✓	X	-
	Numenius madagascariensis	Eastern Curlew	CE, M	-	✓	X	✓(KO)	X	✓(REF 9)
	Numenius phaeopus	Whimbrel	M	-	X	X	✓ (RKO)	X	-
	Pachyptila turtur subantarctica	Fairy Prion (southern)	V	MO	✓	X	✓	X	✓(REF 10)
	Pandion haliaetus	Osprey	M	MO	✓	X	✓	X	-
	Pelagodroma marina	White-faced storm petrel	L	-	X	X	✓ (BO)	X	-
	Pluvialis fulva	Pacific Golden Plover	M	-	X	X	✓ (RKO)	X	-
	Phalacrocorax fuscescens	Black-faced Cormorant	L	-	X	X	✓ (BO)	✓(foraging, breeding)	-
	Phalacrocorax varius	Pied cormorant	-	-	X	X	✓	X	-
	Phoebetria fusca	Sooty Albatross	V, M	LO	✓	X	✓	X	✓(REF 5)
	Pterodroma macroptera	Great-winged Petrel	L	FKO	✓	X	✓	X	-
	Pterodroma mollis	Soft-plumaged Petrel	V	FLO	✓	X	✓	X	✓(REF 11)
	Puffinus carneipes	Flesh-footed Shearwater	M	FLO	✓	X	✓	X	-
	Sterna caspia	Caspian Tern	M	FKO	✓	✓(foraging provision young)	✓	✓(foraging provision young)	-

Status:

E: Endangered

V: Vulnerable

M: Migratory

L:Listed

Likelihood of Occurrence:

LO: Species or species habitat likely to occur in area

MO: Species or species habitat may occur within area

FMO: Foraging/Feeding may occur within area

FKO: Foraging/Feeding known to occur in area

KO: Species or species habitat known to occur within area

FLO: Foraging/Feeding likely to occur in area

BO: Breeding known to occur in area

RKO: Roosting known to occur

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Birds (Con't)	Sterna fuscata	Sooty Tern	L	-	X	X	✓ (BO)	X	-
	Srenula albifrons	Little tern	M	-	X		✓(MO)	X	-
	Sternula nereis nereis	Australian Fairy Tern	V	FLO	✓	✓ (foraging)	✓	✓(foraging)	✓(REF 12)
	Thalasseus bergii	Crested tern	M	-	X	X	✓ (BO)	X	-
	Thalassarche cauta cauta	Tasmanian Shy Albatross	V, M	FLO	✓	X	✓	✓ (foraging)	✓(REF 5)
	Thalassarche cauta steadi	White-capped Albatross	V, M	FLO	✓	X	✓	X	✓(REF 5)
	Thalassarche impravida	Campbell Albatross	V, M	MO	✓	X	✓	✓ (foraging)	✓(REF 5)
	Thalassarche melanophris	Black-browed Albatross	V, M	MO	✓	X	✓	✓	✓(REF 5)
	Thinornis rubicollus rubiciollus	Hooded Plover	V	-	X	X	✓ (KO)	X	✓(REF 13)
	Tringa brevipes	Grey-tailed tattler	M	-	X	X	✓ (KO)	X	-

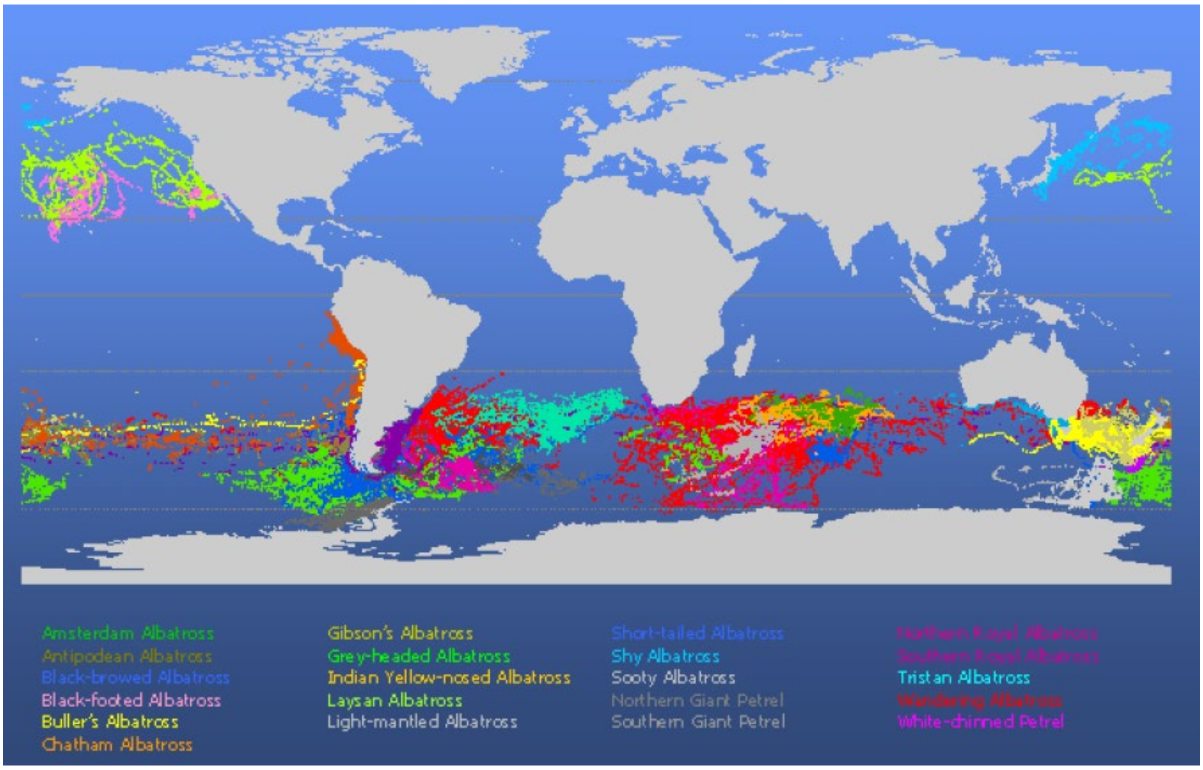
References:

1. Red Knot Conservation Advice (TSSC, 2016a);
2. Curlew Sandpiper Conservation Advice (TSSC, 2015a);
3. Great Knot Conservation Advice (TSSC, 2016b)
4. Lesser sand plover Conservation Advice (TSSC, 2016c)
5. National recovery plan for threatened albatrosses and giant petrels 2011-16 (SEWPC, 2011)
6. Blue Petrel Conservation Advice (TSSC, 2015g)
7. Bar-tailed Godwit (West Alaskan) Conservation Advice (TSSC, 2016d)
8. Bar-tailed Godwit (Northern Siberian) Conservation Advice (TSSC, 2016e)
9. Eastern Curlew Conservation Advice (TSSC, 2015b)
10. Fairy Prion (southern) Conservation Advice (TSSC, 2015f)
11. Soft Plummage Petrel Conservation Advice (TSSC, 2015h)
12. Fairy Tern Conservation Advice (TSSC, 2011)
13. Hooded Plover Conservation Advice (TSSC, 2014)

3.7.8.1 Albatross and petrels

Table 3-17 lists albatross and petrel species which may be present in the survey area. Albatrosses and giant-petrels are among the most oceanic of all seabirds, and seldom come to land unless breeding (SEWPC, 2011c). Many species, such as antipodean albatross, are extremely dispersive, spending most of their time over the pelagic waters of the High Seas while others like adult shy albatrosses, tend to remain sedentary, regularly foraging over coastal waters throughout their adult lives (SEWPC, 2011c). Albatross and giant petrel species exhibit a broad range of diets and foraging behaviours, and hence at-sea distributions are diverse. Combined with their ability to cover vast oceanic distances, all waters within Australian jurisdiction can be considered foraging habitat, however the most critical foraging habitat is those waters south of 25° where most species spend most of their foraging time (SEWPC, 2011c) (refer Figure 3-52).

Figure 3-52: Albatross and Petrel tracking database (SEWPC, 2011c)



The listed albatross species have a widespread distribution throughout the southern hemisphere. They feed mainly on cephalopods, fish and crustaceans, using surface feeding or plunge diving to seize their prey (ACAP, 2012). Albatrosses are colonial, usually nesting on isolated islands and foraging across oceans in the winter months with most observations along the edge of the continental shelf (DEWHA, 2007). Of the species listed, the wandering albatross, black-browed albatross and shy albatross breed in Australian jurisdictions (SEWPC, 2011c). The remaining listed species forage in Australian waters. No breeding colonies or nesting areas for listed albatross species are located within, or adjacent to, the proposed survey area. The closest breeding island to the survey area is Albatross Is (TAS) [shy albatross] (960 km southeast); and Macquarie Island [black-browed albatross & wandering albatross] (2780 km southeast) (ACAP, 2012; SEWPC, 2011c).

The listed petrel species are oceanic and have a widespread distribution throughout the southern hemisphere. They are colonial and breed on sub-Antarctic and Antarctic islands in a circumpolar band generally between 40°S and 60°S. Petrel species feed on small fish, cephalopods (octopus, squid & cuttlefish) and crustaceans along the edge of the continental shelf and open waters (DEWHA, 2007). Of the species listed, the northern giant petrel and southern giant petrel breed in Australian jurisdictions (SEWPC, 2011c). The remaining listed species forage in Australian waters. No breeding colonies or nesting areas for listed petrel species are located within or adjacent to the proposed survey area. The closest breeding island to the survey area is Maatsukyer Is (TAS) [soft plumaged petrel] (~ 1290 km SE); Recherche Archipelago

(WA) [great-winged petrel] (~ 900 km west) (SEWPC, 2012z) and Macquarie Island [blue petrel, northern & southern giant petrels] (~ 2780 km SE) (ACAP, 2012; SEWPC, 2011c).

No biologically significant areas (i.e. nesting and roosting areas) for listed albatross and petrel species lie in proximity to the proposed survey area, however these birds may overfly and forage within the area during the survey period.

Recovery Plan (Threatened Albatross and Giant Petrels)

The Recovery Plan for Threatened Albatross and Giant Petrels (2011-2016) (SEWPC, 2011) identifies marine pollution as a threat to the species which is relevant to the Duntroon survey activity (refer Table 3-18). Marine oil pollution is addressed in Section 6.10 and marine debris is addressed in Section 6.13.

Table 3-18: Threatened Albatross and Giant Petrels (2011-2016) (SEWPC, 2011) – Threats relevant to activity

Relevant Threat/Objectives	Action Objective	Relevant Action
Marine Pollution (oil and marine debris) SO3: Quantify and reduce marine based threats to the survival and breeding parameters of albatrosses and giant petrels foraging in waters under Australian jurisdiction	C11.1: Where feasible, population monitoring programs also monitor, in a standardised manner, the incidence of: i) oiled birds at the nest; ii) marine debris ingestion / entanglement at the nests; and iii) egg shell thinning	**Oil Pollution Monitoring:** No identified nesting locations are located within the predicted oil spill ZPI. Given the location of the nesting locations, and the small number of birds which might be affected by an oil spill, monitoring of populations is not considered feasible. **Marine Debris:** Implement legislative requirements for discharge of garbage to the marine environment to prevent ingestion of marine debris from survey activities.

Blue petrel (*Halobaena caerulea*): This species is listed as vulnerable. The blue petrel previously bred on Macquarie Island, but breeding is now restricted to offshore stacks near Macquarie Island (TSSC, 2015g). The blue petrel forages in Antarctic and subantarctic waters for pelagic crustaceans, fish, cephalopods and insects (TSSC, 2015). Threats to this species include nest destruction and predation. This is not a threat associated with the Duntroon survey activities.

3.7.8.2 *Other listed & regional species*

Flesh-footed shearwater (*Puffinus carneipes*): This species is a listed migratory marine species under Commonwealth legislation and is likely to forage within the survey area. From early September to late May, this species may forage up to 100 km offshore along the continental shelf and slope (SEWPC, 2012z). The species breeds at 41 islands in south-west Western Australia, on Smith Island (~150 pairs) located off the south-east coast of the Eyre Peninsula (approx. 65 km NE from nearest survey boundary) and Lord Howe Island. The species feeds on small fish, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp), other soft-bodied invertebrates (such as *Velella*) and offal. It obtains most of its food by surface plunging or pursuit plunging. It also regularly forages by settling on the surface of the ocean and snatching prey from the surface ('surface seizing'), momentarily submerging onto prey beneath the surface ('surface diving') or diving and pursuing prey beneath the surface by swimming ('pursuit diving') (DoE, 2016n).

The NCVA does not list any BIA for this species as present in the Duntroon EMBA. Encounter with these birds during the survey while they are foraging is possible.

Short-tailed shearwater *(Ardenna Tenuirostris):* This species is listed as a migratory marine species under Commonwealth legislation and spend the southern winter at sea in the northern Pacific off Japan, Siberia and Alaska. The species is found in coastal waters and in summer months is the most common shearwater along the south and south-east coast of Australia, their breeding grounds. The nest is a leaf-lined chamber at the end of a burrow in the ground. The Short-tailed Shearwater feeds on krill, small fish and other small marine creatures and foraging patterns are dependent on upwellings (DoEE, 2018b). Food is caught mostly on the surface of the water but sometimes birds are seen diving for food. The species does not carry any threatened conservation status (Birdlife Australia, 2016).

The Duntroon multi-client survey area overlaps a BIA (foraging in high numbers) for this species which extends from late September to April. The Duntroon OA spatially overlaps the BIA by 30,100 km^2 (5.9% of the BIA) and MC3D surveys by 5,700 km^2 (1.1% of BIA[19]).

Great skua (*Catharacta skua*): This species is a listed marine species under Commonwealth legislation and has a far-ranging distribution, circumpolar from mid to high latitude. In Australia, the species extends from Brisbane along the southern coastline and west to Exmouth (WA). The species breeds in summer on elevated grasslands or sheltered rocky areas adjacent to penguin colonies on sub-Antarctic islands. Most adult birds leave colonies during winter and scavenge on other seabirds, fish, molluscs and crustaceans (DoE, 2016m).

No biologically significant areas (i.e. nesting) are in proximity to the OA. This species may be present along the adjacent coastline or forage over the survey area during the survey.

Pacific gull (*Larus pacificus*): This species is a listed marine species under Commonwealth legislation. This species is the dominant gull across the south-west marine region and breeds in small numbers (usually 1-2 pairs/island) with strongholds at the Recherche Archipelago (~21pairs), Houtman Abrolhos Islands (~51pairs) and The Brothers Islands (near Coffin Bay) (~10pairs) (approx. 100 km northeast of the survey area) (McClatchie et al. 2006). The species forages along the coasts between the high-water mark and the shallow water on sandy beaches feeding mainly on molluscs, fish, birds and other marine animals.

The survey area overlaps a BIA (foraging) for this species (DOEE, 2016c). It is possible this species will be encountered during survey activities. The Duntroon OA spacially overlaps the BIA by 1560 km^2 (1.6% of the BIA in South Australian waters[20]).

Silver gull (*Larus novaehollandiae*): This species is common throughout Australia found at virtually any watered habitat and is rarely seen far from land. As with many other gull species, the silver gull is a successful scavenger for food discards and also eats worms, fish, insects and crustaceans. The species nests in large colonies on offshore islands (Birdlife Australia, 2017b). This species is expected to be present on the adjacent coastline during Duntroon survey activities.

Kelp gull (*Larus dominicanus*): The kelp gull, a listed species, occurs along the entire Australian coastline. The kelp gull prefers the sheltered parts of coasts such as bays, inlets and estuaries, and beaches and reefs on off-shore islands. The kelp gull forages on land or in water, rarely in the air. It feeds mainly on fish and crustaceans but will scavenge when an opportunity arises. The species nests in loose colonies or scattered single pairs on off-shore islands where breeding birds maintain large territories against other gulls. Nests can be a well-made bowl of plants stems, grasses and seaweeds or a loose pile of material on the ground, near rocks or in a tussock (Birdlife Australia, 2017c).

This species is expected to be present on adjacent coastlines during Duntroon survey activities.

Pacific golden plover (*Pluvialis fulva*): This species is a migratory non-breeding visitor to Australia, usually inhabiting beaches, mudflats and sandflats in sheltered areas including harbours, estuaries and lagoons. This species forages on sandy or muddy shores or margins of sheltered areas such as estuaries and lagoons, though it also feeds on rocky shores, islands or reefs and roosts near foraging areas, on sandy beaches and spits or rocky points occasionally among or beneath vegetation including mangroves or low saltmarsh, or among beachcast seaweed. Pacific golden plovers mainly eat molluscs, polychaete worms, insects and insect larvae, spiders and crustaceans and very occasionally eat seeds, leaves, lizards, birds' eggs and small fish (DoEE, 2017k). This species may be present in sheltered areas on the adjacent SA coastline during Duntroon survey activities however no adjacent coastlines are considered important habitat for the species (Bamford et al, 2008).

Lesser sand plover (*Charadrius mongolus*): This species is a listed endangered species under the EPBC Act. The species usually occurs in coastal littoral and estuarine environments roosting in large inter-tidal sand flats or mudflats in sheltered bays, estuaries and occasionally sandy ocean beaches. It is a non-breeding visitor to Australia with nationally important areas located in NSW (Richmond and Shoalhaven Rivers, Botany Bay and Alva Beach (Ayr, Queensland). The species roosts near foraging areas – on beaches, banks

[19] Short-tailed shearwater BIA measures 511,256 km^2.
[20] Pacific Gull BIA measures 99,750 km^2.

and spits and eats invertebrates, such as molluscs (especially bivalves), worms, crustaceans (especially crabs) and insects (DoEE, 2017l). The species departs for northern hemisphere breeding grounds in April and returns in September. There are no important areas adjacent to the Duntroon OA (Bamford et al, 2008).

Conservation Advice (Lesser sand plover): Information from the conservation advice for the lesser sand plover (TSSC, 2016c) identifies threats, especially eastern and southern Australia, to include ongoing human disturbance, habitat loss and degradation from pollution, changes to the water regime and invasive plants.

Ruddy turnstone (*Arenaria interpres*): This migratory species is widespread within Australia during its non-breeding period (September to March). The ruddy turnstone breeds on the coasts of Europe, Asia and North America, generally north of 60° latitude. It is found in most coastal regions and strongly prefers rocky shores or beaches where there are large deposits of rotting seaweed mainly foraging between lower supra-littoral and lower littoral zones of foreshores (from strand-line to wave-zone). The species eats insects, worms, crustaceans, molluscs, and spiders. It has occasionally been known to eat fish, bird's eggs and carrion and human food scraps (DoEE, 2017j). Kangaroo Island and Ceduna Bays is identified as important areas for the species (Bamford et al, 2008). This species may be present on adjacent SA shorelines during Duntroon survey activities.

Grey tattler (*Tringa brevipes*): This migratory species is a non-breeding visitor to Australia and is often found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. It can also be found at intertidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide. The species usually forages in shallow water, on hard intertidal substrates, such as reefs and rock platforms, in rock pools and among rocks and coral rubble, over which water may surge with a diet of polychaetes, molluscs, crustaceans, insects and, occasionally fish. The grey-tailed tattler usually roosts in the branches of mangroves or, rarely, in dense stands of other shrubs, or on snags or driftwood rarely on beaches (DoEE, 2017m). There are no important sites which lie within the EMBA for this species.

This species may be present in sheltered areas on the adjacent SA coastline during Duntroon survey activities.

Bar-tailed godwit (*Limosa lapponica bauera*): This species is threatened and migratory and has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria. In South Australia it has mostly been recorded around coasts from Lake Alexandrina to Denial Bay. The migratory bar-tailed godwit (western Alaskan) does not breed in Australia but nests in the northern hemisphere during the boreal summer with egg laid from late May through June. During the non-breeding period, the distribution of bar-tailed godwit (western Alaskan) is predominately New Zealand, northern and eastern Australia (Bamford et al. 2008). In Australia, *L. l. baueri* mainly occur along the north and east coasts (TSSC, 2016d; TSSC 2016e) in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays with feeds on worms, molluscs, crustaceans, insects and some plant material (TSSC, 2016c).

Conservation Advice (Bar-tailed godwit): The conservation advice for the bar-tailed godwit (TSSC, 2016d; TSSC, 2016e) identifies threats to the species as ongoing human disturbance as well as habitat loss and degradation from pollution, changes to the water regime and invasive plants.

This species may be present in protected areas along the SA coastline during survey activities.

Little tern (*Stenula albifrons*): This migratory species widespread and occur around from Broome, around the northern coastline to south-eastern South Australia. Little Terns nest on sand-spits, banks, ridges or islets in sheltered coastal environments, such as coastal lakes, estuaries and inlets, on wide and flat or gently sloping sandy ocean beaches, and also, occasionally, in sand-dunes. Breeding occurs between September and February in a shallow scrape in the sand sometimes laced next to debris (driftwood, etc.) above the high-tide mark (DoE, 2016t). The species forages in shallow waters of estuaries, coastal lagoons and lakes and frequently over channels next to spits and banks or entrances on small fish crustaceans, insects and molluscs taken by plunge diving. They forage along open coasts, less often at sea and usually within 50 m of the shore. Little Terns feed mainly on small fish (< 10 cm in length), but also eat crustaceans, insects, annelids and molluscs (DoE, 2016t).

This species may be present along sandy embayments on the adjacent SA coastline during the Duntroon survey.

Crested tern (*Thalasseus bergii*): This species is a migratory species which occur singularly or in flocks in coastal areas, estuaries, inlets, islands and occasionally on large inland lakes or rivers. They are often seen perching with gulls on beaches, sand spits or jetties. The crested tern feeds mainly on small surface fish. Birds typically plunge downwards into the water to grab prey behind the head. They will also take squid, crabs, insects and other aquatic prey (PWS, 2012). It is possible this species may be present on the adjacent SA coastline during Duntroon survey activities.

Sooty tern (*Sterna fuscata*): This species breeds on tropical islands and ranges through most of tropical oceans. The species is dispersive and migratory. At most colonys adults leave for the open sea after breeding and become strongly pelagic for 2-3 months before returning to the breeding grounds. Its diet consists predominantly of fish up to 18 cm long (usually 6-8 cm) and squid, but it also occasionally takes crustaceans, insects and offal. The species breeds on flat, open, sparsely or heavily vegetated, oceanic or barrier islands of sand, coral or rock in productive tropical and subtropical offshore waters rich in plankton, fish and squid. The species nest is a slight depression or scrape on the ground. It shows a preference for nesting on flat, bare sand, coral grit or shell amongst low vegetation on beaches above the high-water mark (Birdlife International, 2017). This species is not expected to be present along the adjacent SA coastline given its preferred habitats.

Australian fairy tern (*Sternula nereis nereis*): This species is listed as vulnerable under Commonwealth which is likely to forage in the survey area. It occurs along the coasts of Victoria, Tasmania, South Australia and Western Australia. It is a fish-eating bird and nests on sheltered sandy beaches, spits and banks above the high tide mark and below shoreline vegetation where the substrate is sandy and the vegetation sparse. The fairy tern is an aerial diver for bait-sized fish in shallow, inshore waters often observed near the shoreline and is rarely found out of the sight of land. The species forages by working against the tidal flow in estuaries, periodically hovering 5-15 m above the water surface (Pulham & Wilson, 2013). The species can also feed on plant material, molluscs and crustaceans in inshore waters and undergoes long distance movements within Australia. It is reported that there are only a few pairs in Victoria (Birdlife International, 2016). The species breeds between October and February and is very vulnerable to extreme weather events such as storms, floods, high-tide or wind-blown events (DoE, 2016o). While no specific locations have been identified in coastal areas, this species may be present along and within sandy embayments on the adjacent Eyre Peninsula.

The survey area lies adjacent to a BIA (breeding and foraging) along the adjacent SA coastline and adjacent waters. No encounter with the species (i.e. over-fly only in survey area) during survey activities is expected.

Conservation Advice (Australian Fairy Tern): The conservation advice for the Australian fairy tern (TSSC, 2011) identifies the following as threats:

- Human disturbance causing direct destruction or desertion of nests allowing predation of eggs; and
- Oil spills (particularly in Victoria from offshore production assets) which may threaten the species breeding habitat.

These threats may have relevance to the Duntroon survey activity with respect to oil spills and any oil spill response activities initiated (refer Section 6.11). Marine oil pollution is addressed in Section 6.10.

Table 3-19: Conservation advice for the Australian Fairy Tern (TSSC, 2011) – Threats relevant to activity

Relevant Threat/Objectives	Relevant Action
Oil Spill Human disturbance causing direct destruction of nests or desertion of nests.	**Oil Spill Response:** Ensure relevant management measures are adopted during any spill response activities which require shoreline access.

Fairy prion (*Pachyptila turtur subantarctica*): This species is a listed as vulnerable marine species under Commonwealth legislation and are often beach-cast on the south-eastern coast of Australia and seen foraging offshore over the continental shelf and pelagic waters. Data from the south-eastern Australian Seabird Atlas confirm this pattern, with 83% (of 24,505 individuals) seen over the continental slope, 9% over continental shelf and only 8% over open ocean. The southern Fairy Prion is found flying over the ocean where sea surface temperatures are 8.6° to 20.2° C (Reid et al. 2002; cited in DoE, 2016p).

The species is common in South Australia and is recorded breeding on subantarctic and cool temperate islands (Bass Strait islands, Tasmania, Macquarie Island) between September and early March. Fairy prions eat mostly euphausiids and other small crustaceans, but also eat small quantities of fish and pteropods (free-swimming sea snails and slugs). The species flies just above the surface of the ocean hunting by surface-seizing, dipping, pattering or surface-plunging (DoE, 2016p). There are no recorded nesting sites for the fairy prion on the adjacent Eyre Peninsula coastline.

No biologically significant areas are in proximity to the survey area. This species may be present along the adjacent coastline or forage over the survey area during the survey.

Recovery Plan (Fairy prion): The recovery plan for this species ceased to be in effect from 1 October 2015.

Threats listed in the Conservation advice for the species (TSCC, 2015f) include interference from pest species (at Macquarie Island), soil erosion affecting suitable nesting sites and fires affecting breeding success. These threats (impacts) are not present from the Duntroon survey.

Osprey (*Pandion haliaetus*): This species is a listed marine migratory wetland bird species under Commonwealth legislation and is found in temperate and tropical regions of all continents except Antarctica. In Australia the species is mainly sedentary and is found patchily around the coastline. The species is found in small numbers in South Australia. Breeding occurs near cliffs, rocks, rock stacks or islets; on the ground on rocky headlands, coral cays, deserted beaches, sand-hills or saltmarshes around the northern coast of Australia from Albany (WA) to Lake Macquarie (NSW). The species is a diurnal fish-eating bird of prey with diet consisting almost exclusively of fish (DoE, 2016r). Home ranges of the species has not been quantified, although one male was seen observed carrying prey 3 km from its nest site to forage.

Given the observed home range of the species, encounter with the species during survey activities is not expected.

Curlew sandpiper (*Calidris ferruginea*): This species is listed as a critically endangered, migratory wetland species with habitat which may occur in the survey area. This species occurs around the coast and has been recorded in the coastal and sub-coastal areas of Streaky Bay and the Coorong. Breeding is restricted to the Arctic with nesting occurring in June and July. The southern migration commences in July with arrival on Australian northern waters in late August/early September. The return northern migration commences in March. Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and around non-tidal swamps, lakes and lagoons near the coast. Curlew sandpipers forage on mudflats and nearby shallow water. They forage at the edges of shallow pools and drains of intertidal mudflats and sandy shores. At high tide, they forage among low sparse emergent vegetation, such as saltmarsh, and sometimes forage in flooded paddocks or inundated salt-flats. Occasionally they forage on wet mats of algae or waterweed, or on banks of beach-cast seagrass or seaweed. This species forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds (DoE, 2016s).

Given the preferred habitat of the species, encounter during survey activities is not expected.

Conservation Plan for Curlew Sandpiper: While a conservation plan is not available for the species, the conservation advice for the species (TSCC, 2015a) lists human disturbance, habitat loss and degradation from pollution, changes to water regime and invasive plants as threats to the species. Marine oil pollution from survey activities is addressed in **Section 6-10**, however based upon the location of the survey to coastal wetland areas oil spill effects would not be expected.

Eastern curlew (*Numenius madagascariensis*): This species is a listed marine migratory and critically endangered wetland species under Commonwealth legislation which may have habitats in the survey area. Within Australia, the eastern curlew has a primarily coastal distribution. In South Australia, the species is scarce between the Victorian border and Cape Jaffa and patchily distributed from the Coorong north-west to the Streaky Bay area and has previously been recorded in Lake Alexandrina and Lake Albert. The species breeds in Russia, Mongolia and north-eastern China from early May to late June and arrives in Australia as early as late July. They leave Australia between late February and March-April. In the non-breeding season, the eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The eastern curlew is carnivorous mainly eating crustaceans (including crabs, shrimps and prawns), small molluscs, and some insects (TSSC, 2015b).

Conservation Plan for Eastern Curlew: While a conservation plan is not available for the species, the species conservation advice (TSSC, 2015b) lists human disturbance, habitat loss due to coastal development and pollution around settled areas reducing availability of food as threats to the species. These threats are not associated with any of the impacts from the Duntroon survey.

Caspian tern (*Sterna caspia*): This species is listed as a migratory marine bird under Commonwealth legislation which may feed and forage in the survey area. In South Australia, the species occurs from Carpenters Rocks to Nuyts Archipelago and Ceduna. Breeding has been recorded along the coast from the Coorong, north-west to Ceduna. The Caspian tern is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and in near-coastal or inland terrestrial wetlands that are either fresh or saline. In offshore areas the species prefers sheltered situations, particularly near islands, and is rarely seen beyond reefs. The species diet consists predominantly of fish as well as the eggs and young of other birds, carrion, aquatic invertebrates (e.g. crayfish), flying insects and earthworms (DoEE, 2016b).

The survey area lies adjacent to a BIA (foraging) along the adjacent south Australian coastlines and adjacent waters from the HOB to the east of Kangaroo Island (not including the Gulfs).

Given the preferred habitat of the species, encounter during survey activities is not expected.

Red knot (*Calidris canutus*): This species is listed as threatened (endangered) under the EPBC Act. The species breeds in the northern hemisphere, with egg-laying occurring in June and subsequent incubation for 21-22 days and is a non-breeding visitor to Australia. In Australasia, the species mainly roosts on inter-tidal mud flats, sandflats and sandy beaches of sheltered coasts in estuaries, bays and inlets (DoEE, 2017n). The species forages in soft substrate near the edge of the water eating mostly worms, bivalves, gastropods, crustaceans and echinoderms (DoEE, 2017n). The species is a regular visitor to the Coorong, north and west to the Yorke Peninsula and Port Pirie (TSSC, 2016). The species may be present along sheltered embayments adjacent to the Duntroon OA however this does not represent important habitat for the species. Important habitats are located along the Port Pirie coastline and Ceduna Bay (Bamford et al, 2008).

Threats to the global population of the red knot relevant to the Duntroon survey to the global population of the red knot include pollution/contamination impacts and disturbance (TSSC, 2016a).

Great knot (*Calidris tenuirostris*): This species is a critically endangered, migratory species. The great knot breeds in the northern hemisphere and undertakes biannual migrations along the East Asian-Australasian Flyway, EAAF. The great knot arrives on southern non-breeding grounds between August and October and returns in late March to early April (TSSC, 2016b). Most of the population winters in Australia (probably >90%; Bamford et al. 2008), mainly at sites on the northern coast (TSSC, 2016b). The species is much less common in south-west Australia, South Australia, Victoria and Tasmania (TSSC, 2016b). In Australia, great knots prefer sheltered coastal habitats with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons. They are occasionally found on exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, salt lakes and non-tidal lagoons (TSSC, 2016b). The great knot feeds on invertebrates by pecking at or just below the surface of moist mud or sand. They feed on bivalves, gastropods, crustaceans and other invertebrates (TSSC, 2016b). Given the preferred habitat of the species, it is unlikely the species will be present on the adjacent SA coastline during survey activities.

Conservation Advice (Great Knot): The conservation advice for the great knot (TSSC, 2016b) identifies threats to the species to include ongoing human disturbance and pollution/contaminants.

Greater sand plover (*Charadrius leschenaulti*): This species is listed as vulnerable and migratory under the EPBC Act. The greater sand plover breeds in the northern hemisphere and undertakes annual migrations to and from southern feeding grounds for the austral summer. The greater sand plover distribution in Australia during the non-breeding season is widespread, although the most are found in northern Australia. The species is present at the following locations in SA - the Coorong, Gulf St Vincent and Spencer Gulf, as well as on the Eyre Peninsula, west to about Streaky Bay (TSSC, 2016c). In Australia, the species is almost entirely coastal, inhabiting littoral and estuarine habitats. They mainly occur on sheltered sandy, shelly or muddy beaches, large intertidal mudflats, sandbanks, salt-marshes, estuaries, rocky islands rock platforms, tidal lagoons and dunes near the coast. No important sites are listed for the species along the adjacent SA coastline (Banford et al, 2008). During the non-breeding season, the diet mostly consists of molluscs, worms, crustaceans (especially small crabs and sometimes shrimps) and insects (TSSC, 2016c).

Conservation Advice (greater gand glover): Information from the conservation advice for the greater sand plover (TSSC, 2016c) identifies threats, especially eastern and southern Australia, to include ongoing human disturbance, habitat loss and degradation from pollution, changes to the water regime and invasive plants.

Red-capped plover (*Charadrius ruficapillus*): This EPBC-listed species is the most common and widespread of Australia's beach-nesting shorebirds. They usually inhabit wide, bare sandflats or mudflats at the margins of saline, brackish or freshwater wetlands where they forage. Their speckled eggs are laid in a shallow depression in the ground, often beneath a low shrub, or out in the open if near water. The nest site is a shallow scrape on a beach or stony area, nearly always close to water. The red-capped plover forages for molluscs, small crustaceans and some vegetation, on mudflats, sandy beaches and salt-marsh.
It is possible this species will be present on adjacent shorelines during survey activities (Birdlife Australia, 2017d).

Whimbrel (*Numemius phaeopus*): This species is a non-breeding regular migrant to Australia and New Zealand, with primarily a coastal distribution. In SA it is found between the mouth of the Murray River, Kangaroo Island, Gulf St Vincent, and at the Price and St Kilda Saltfields. The whimbrel is often found on the intertidal mudflats of sheltered coasts and harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. It is occasionally found on sandy or rocky beaches, on coral or rocky islets, or on intertidal reefs and platforms. The whimbrel is mainly carnivorous, taking annelids, crustaceans (including crabs and shrimps), and, rarely, vertebrates. The whimbrel leaves for breeding grounds in July and returns from February onwards (DoEE, 2017o). There are no important sites in proximity to the Duntroon OA (Bamford et al., 2008).

It is possible this species may be present on the adjacent SA coastline in sheltered environments during survey activities.

Sanderling (*Caldris alba*): This is a migratory species almost always found on the coast, mostly on open sandy beaches exposed to open sea-swell, on exposed sandbars and spits, and shingle banks, where they forage in the wave-wash zone and amongst rotting seaweed. Sanderlings also occur on beaches that may contain wave-washed rocky outcrops. They roost on bare sand high on the beach, clumps of washed-up kelp, coastal dunes and rocky reefs and ledges (DoEE, 2017p). The species is non-breeding in Australia and forage on plants, seeds, worms, crustaceans, spiders, insects, and occasionally on medusae, fish and larger molluscs and crustaceans taken as carrion (DoEE, 2017p). The Coorong, Coffin Bay and Discovery Bay NPs are all considered important areas for this species (Bamford et al, 2008). This species may be present on the adjacent coastline to the Duntroon OA during survey activities.

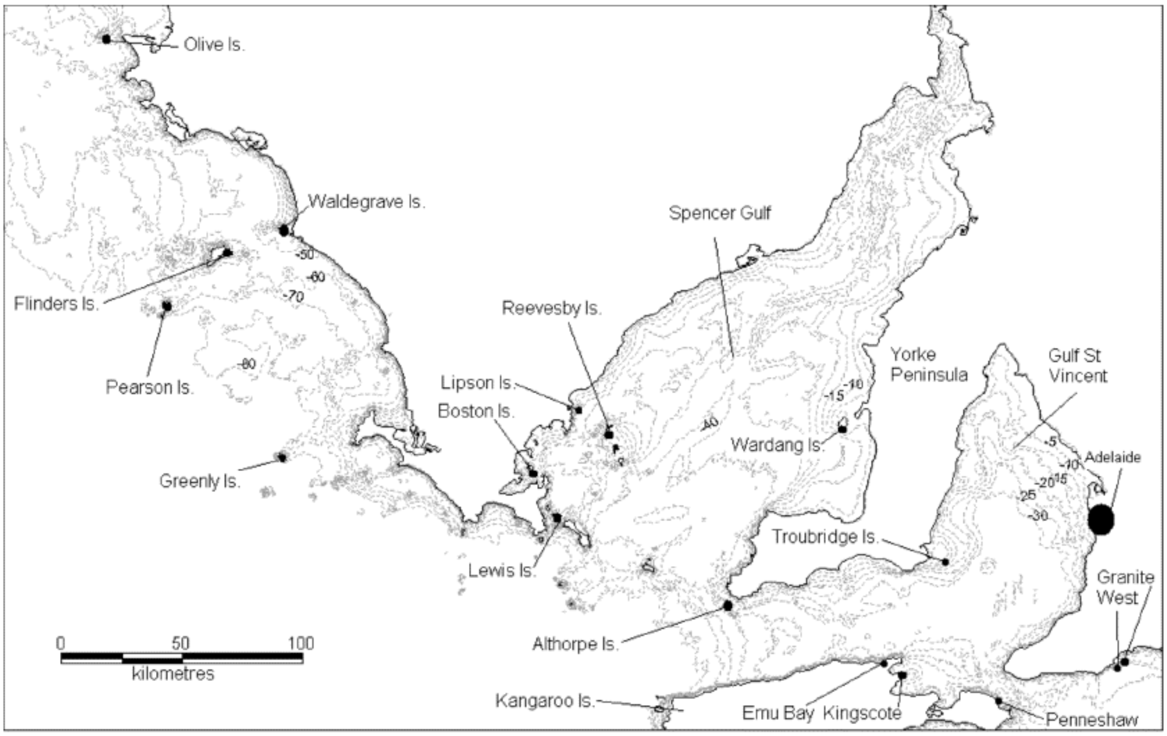
Wedge-tailed shearwater (*Ardenna pacifica*): This migratory species breeds on the east and west coasts of Australia and on off-shore islands and is widespread across the Indian and Pacific Oceans. No breeding areas are identified within the Duntroon EMBA (DoEE, 2017q). The wedge-tailed shearwater is a pelagic, marine bird known from tropical and subtropical waters (DoEE – 2017q). The species tolerates a range of surface-temperatures and salinities, but is most abundant where temperatures are greater than 21 °C. When feeding, wedge-tailed shearwaters fly less than ten metres above the surface of the ocean and dive to a depth of two to three metres. Food is taken by contact-dipping, dipping, surface-seizing and, rarely, deep-plunging wedge-tailed shearwater birds are known to mostly consume fish, some cephalopods, insects, jellyfish and prawns (DoEE, 2017q). This species may be present on the adjacent SA coastline during survey activities.

Black-faced cormorant (*Phalacrocorax fuscescens*): This listed species is Australia's only cormorant that does not occur at terrestrial wetlands and is confined to inshore marine habitats. The species occurs along two sections of Australia's southern coastline, Eden (NSW) to the Head of Bight (SA) including Tasmania and south-western Western Australia near Albany, where it breeds throughout the year in large colonies on dozens of rocky offshore islands. Nests are built from seaweed and driftwood on bare rock. The cormorants forage by diving to depths of up to 12 m in pursuit of small fish. They often roost in the company of other birds, especially gulls and other species of cormorants. The black-faced cormorant frequent coastal waters and are found in flocks in large bays, deep inlets, rocky headlands and islands. They seldom visit beaches

(Birdlife Australia, 2017e). As identified on the NCVA, a foraging and breeding BIA lies adjacent to the Duntroon OA (DoEE, 2017b).

Little penguin (*Eudyptula monor*): While this species is not listed under Commonwealth legislation, the fairy penguin is an iconic species which attracts tourism. The species inhabits temperate waters and, in South Australia, is present at colonies located at Pearson Island, Troubridge Island (Yorke Peninsula) (SEWPC, 2012z) and other colonies at Kangaroo Island (Kingscote, Penneshaw), Granite island (Victor Harbour) (Foundation for National Parks & Wildlife, 2014), the Althorpe Islands (Investigator Strait), Goose Island, Greenly Island, Investigator Group Islands, Lipson Island (near Tumby Bay, Eyre Peninsula) and Sir Joseph Banks Group (Spencer Gulf). The closest colony to the Duntroon OA is Greenly Island located approximately 30 km north (refer Figure 3-53).

Figure 3-53: Location of main penguin colonies in South Australia (Wiebkin, 2011)



In South Australia, the population has been estimated at 20,000-50,000 breeding pairs (Robertson et al, 1996; cited in SEWPC, 2012a), with large colonies at Pearson Island (around 12, 000 pairs; Weikben, 2011) and Troubridge Island (around 3,000 pairs) (SEWPC, 2012a). Other population statistics relevant to the Duntroon OA include Waldegrave Island (>500 estimated from observer walking the colony in 2006), Dorothee Island (~200 from survey data in 2004), Flinders Island (< 20 estimated from observer walking the colony in 2006), Greenly Island (1500 estimated from observer walking the colony in 2004), Lewis Island (<100 from survey data in 2006) and Althorpe Island (132 from survey data in 2004) (Weikben, 2011).

The species feeds mainly on pelagic shoaling fish, cephalopods and occasionally crustaceans. Prey is captured by pursuit diving typically to a depth of 10-20 m for an average of 24 seconds but dives as deep as 72 m has been recorded (PFPI, 2018). The species forages within a radius of 8-15 km (5-10 miles) from their burrow during breeding season; and generally, within 20 km (12.5 miles) of shore in non-breeding season, however longer trips of up to 700 km may occur in non-breeding season (Australian Wildlife, 2014).

Nesting colonies occur in burrows on sandy or rock islands often at the base of cliffs or in sand dunes adjacent to marine areas (Birdlife International, 2014) during the period June to December. Mating occurs between August and October with eggs laid in September and October. From this point until the chick hatches, parents alternate between incubation duties and feeding at sea. Chick feeding occurs from December into January. Moulting occurs in February-April, during which time individual penguins are unable to go to sea for at least 17 days and therefore lose a considerable amount of weight. The winter period is important for little penguins as individuals gain the weight lost during the moult and prepare for the upcoming breeding season (Gormley & Dann, 2009).

A BIA for the species (foraging – provisioning young) is located on the South Australian coastline adjacent to the Duntroon survey area from Cape Catastrophe to Coffin Bay. As the closest colony is located 30 km from the nearest survey boundary, fairy penguin presence within the survey area is expected to be rare however may forage within the EMBA.

Hooded plover (*Thinornis rubicollis*): Species is sedentary and inhabit sandy ocean beaches feeding on tiny invertebrates (insects, sand-hoppers, small bivalves and soldier crabs) from the sand near the water's edge. The species lays their eggs in shallow scrapes in the sand either on the upper beach (above high tide mark) or adjacent backing sand dune typically next to vegetation. The highest densities of hooded plover occur on broad, flat and wide wave-washed zone with large amounts of beach-washed seaweed. Densities are lowest on narrow steep beaches where there are few or no dunes (Birdlife Australia, 2017a). The species captures its prey by running across the surface for marine worms, molluscs, crustaceans, insects, water plants and seeds. They nest in solitary pairs and defend their breeding territories (ranging from 400-1,800 m near the shoreline) from August to March (Barton *et al*., 2012).

The conservation advice for the hooded plover has been assessed for the activity and the following threats are identified include human disturbance (managing access to key beaches when breeding), oils spills threatening species habitats (oil spill plans to ensure effective rehabilitation of oiled birds) and entanglement and ingestion of marine debris (TSSC, 2014) as being applicable to the Duntroon survey activity.

Rock parrot (*Neophema petrophila*): The rock parrot is confined to coastal habitats along Australia's southern coastline in South Australia and Western Australia, where it usually occurs within a few hundred metres of the shore. It is often recorded along rocky shores and islands, among low coastal scrub, or in sand dunes and on sandy beaches, where it is often seen along the strand line among beachcast seaweed (Birdlife Australia, 2017f). The rock parrot lives on the rocky coastline of south and west Australia. There are two major populations, in the east along the coast from Kingston to Ceduna in South Australia and in Western Australia from Cape Arid National Park to Geraldton (Birdlife Australia, 2017). The rock parrot feeds on seeds and fruits of a wide variety of grasses, rushes, shrubs and salt-tolerant plants. The rock parrot breeds mostly on off-shore islands, nesting in a rock crevice, tunnel or abandoned seabird nesting burrow, or on a rocky ledge often behind a 'curtain' of succulent shrubs (Birdlife Australia, 2017f).

This species is expected to be present along adjacent SA coastlines during Duntroon survey activities.

Pied cormorant (*Phalacrocorax varius*): The pied cormorant is found throughout mainland Australia more commonly in the south and along the coast of south-western Australia. The pied cormorant is found in marine habitats, including estuaries, harbours and bays (Birdlife Australia, 2017). The species diet consists mostly of fish but will also take crustaceans and molluscs. When foraging, the cormorant swims low on the water, and when it spies a fish, it quickly plunges below the water's surface. When it pursues the fish, it swims by propelling itself with its large, webbed feet and steering with half-opened wings (Birdlife Australia, 2017g). Fish may be eaten below the water or when the cormorant returns to the surface. The pied cormorant breeds in colonies on coastal islands, flooded tree plains, mangroves and sometimes on artificial structures such as beacons. Nests are constructed from seaweed twigs or sticks cemented together with droppings and are placed in a tree or on the ground (Birdlife Australia, 2017g).

This species is expected to be present along adjacent SA coastlines during Duntroon survey activities.

The Neptune Islands also carry the following terrestrial species (refer Section 3.2.2):

- **Cape Barron goose** (*Cereopsis novaehollandiae)* which lives on small, windswept and generally uninhabited offshore islands and can survive on brackish water. The species are grazing birds eating the common island tussock *Poa poiformis* as well as spear grass. Nesting commences in autumn, hatched goslings develop through the winter and fledge during spring (Tasmanian Parks & Wildlife, 2014).

  This species is not expected to be affected by the survey activities.
- **White bellied sea-eagle** (*Haliaeetus leucogaster*) which is found throughout south-east Australia and breeds and forages near water. It catches fish by flying low over the water and grasping it with its talons or may dive at a 45° angle and briefly submerge to catch fish near the surface. Fish forms

half its diet with the remainder being obtained from carrion and a wide variety of animals (turtles, sea snakes, birds) opportunistically. The species forages over large expanses of open water with coastal birds foraging over in-shore waters. Home range for the species can be up to 100 km^2.

The species is considered vulnerable in South Australia and as a marine migratory bird under Commonwealth legislation. The breeding season in Australia is June to August and breeding sites are distributed along the coastline especially the eastern coast extending from Queensland to Victoria and into Tasmania (DoE, 2016q).

Given the observed home range of the species, encounter with the species during survey activities is not expected.

- **Peregrine falcon** (*Falco peregrinus*): This species is found cross a variety of habitats (arctic tundra to the tropics) and found widely across Australia. It requires abundant prey, secure nest sites and prefers coastal and inland cliffs or open woodlands near water (Birdlife Australia, 2016). This species feeds on medium-sized birds but will sometimes hunt small mammals, small reptiles or insects. The species mates for life and pairs maintain a home range of 20-30 km throughout the year. It nests in a scrape normally on cliff edges and eggs are laid from July to August in Australia. Young peregrine falcons disperse widely, but often return to their original home area to breed when mature (Birdlife Australia, 2016).

  This species is not expected to be encountered during survey activities.

3.8 Social Environment

Coastal environments adjacent to the Duntroon OA predominantly support commercial fishing and ecotourism (Eyre Peninsula, Kangaroo Island). Defence activities (military flying) are undertaken in SA waters in Investigator Strait and the adjacent gulfs (north and east of the survey area) (DEWHA, 2007). Besides Adelaide, key regional centres in the area include Port Lincoln, Ceduna and Whyalla (Gardner et al. 2006). The Duntroon OA is situated in a region of commercial merchant shipping.

3.8.1 Commercial Shipping

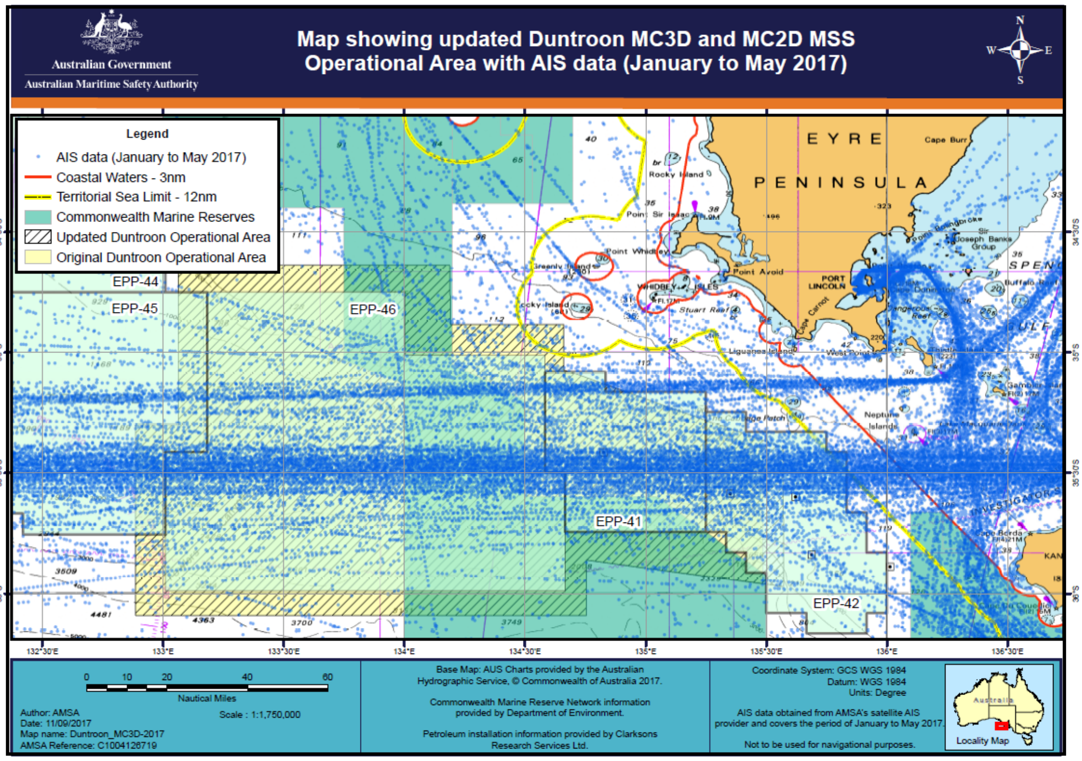
Key ports within the area include:

- Port Lincoln (handles grain, seed, fertiliser and petroleum);
- Withernell Bay, Port Bonython (handles petroleum);
- Port Pirie (handles zinc, lead, minerals, coal and ore);
- Wallaroo (handles seeds, grains and fertilisers);
- Port Giles (handles grains, seeds, petroleum);
- Whyalla (handles iron ore and steel products);
- Ardrossan (grain); and
- Port Adelaide (handles wine, meat, flour, fruit, fertiliser, timber).

Vessels involved in these activities include container ships, bulk carriers, cruise liners and oil tankers.

Ship visits to these ports (2002-2003) were in the range 1-250 (per port) however vessels visiting Port Adelaide in the same period were more than 1000 vessels (i.e. 3 vessels per day) (Gardner et al. 2006). Shipping data obtained from AMSA (Gardner et al. 2006) indicates that there is a major shipping channel running east-west through the Southern Ocean between Cape Leeuwin and eastern Australian ports (refer Figure 3-54). AMSA (2017) has identified that this shipping channel (Investigator Strait to Cape Leeuwin) passing through the Duntroon OA will create conditions for the encounter of heavy vessel traffic (on average 4+ heavy commercial vessels per day) during the survey. In accordance with advice provided by AMSA, the AMSA Rescue Coordination Centre (RCC) and the Australian Hydrographic Service (AHS) will be advised of the survey details prior to commencement such that RCC radio warnings and a Notice to Mariners can be issued to shipping (refer to **Stakeholder No: 12** records).

Figure 3-54: Shipping Routes in the Survey area (AMSA, 2018)



3.8.2 *Marine Tourism*

Regional marine tourism ranges from whale-watching, diving, recreational fishing, recreational beach use and cruise ship visits and focuses on the Eyre Peninsula, Yorke Peninsula and Kangaroo Island (Gardner et al, 2006).

Marine tourism has expanded rapidly in the past two decades resulting from the natural values of the region. Major tourism areas in South Australia are identified in Table 3-20.

Table 3-20: Domestic and International Visitors to Key SA Tourism Areas 2003/4 (Gardner et al, 2006).

Tourism Area	Total Number of Visitors	Domestic Visitors (%)	International Visitors (%)
Adelaide	2 467 000	89	11
Eyre Peninsula	430 000	97	3
Flinders Ranges	680 000	92	8
Yorke Peninsula	526 000	99.5	0.5
Fleurieu Peninsula	565 000	98	2
Kangaroo Island	127 000	77	22

Eyre Peninsula

The Eyre Peninsula offers as variety of natural landscapes, ranging from inland regional areas to coastal landscapes. A high proportion of the visitors to the peninsula are residents of regional SA (41%) or visitors from WA (6%). According to the SA Tourism Commission (2004), one of the most popular activities in the area is recreational fishing followed by visiting the beach (Gardner et al, 2006).

The Eyre Peninsula is bounded by the Spencer Gulf and GAB in the west. Coastal waters around the Eyre Peninsula contain marine life including sea lions, bottlenose dolphins, southern right whales and terrestrial fauna. The peninsula is acknowledged as one of the finest fishing areas in Australia. Fishing options include rock or surfcasting or fishing charters out of major towns. Species such as bluefin tuna (Port Lincoln), kingfish (Port Lincoln, Arno Bay), oysters (Franklin Bay, Coffin Bay) and Murray cod are also farmed or processed in the area. These areas are located in-shore in protected areas.

Cruise operators operate from Eyre Peninsula ports to view or swim with sea lions, fur seals (Hopkins Island ~ 63 km NE); swim with tuna (Port Lincoln) or cage dive with white sharks (Neptune Island North ~ 49 km NE) (South Australia Government, 2014). On the west coast, tourists can snorkel with sea lions and bottle-nosed dolphins from the sheltered waters of Baird Bay (~165 km north). On the east coast water-based sports are popular with diving activity recorded in the Sir Joseph Banks Group Marine Park, Gambier island Marine Park Group and South Spencer Gulf Marine Park (adjacent to Yorke Peninsula).

Consultation with the District Council of Lower Eyre Peninsula (**Stakeholder No: 30 records**), City of Port Lincoln (**Stakeholder No: 39 records**) and Regional Development Australia Whyalla and Eyre Peninsula (**Stakeholder No: 40 records**) are provided in Appendix I.

Kangaroo Island

Kangaroo Island is listed by the Australian Tourism Commission (2005) as one of the nine unique wonders of Australia. The Island is promoted as 'unspoilt', 'natural', and 'clean and green' with the Council conscious of the need to manage human impacts to ensure the protection of the Island and maintain its reputation as a special tourist destination.

Limited development on the island has ensured that an abundance of wildlife remains including sea lions, penguins, dolphins, koalas and kangaroos. The activities undertaken by tourists on the island include going to the beach, wildlife viewing, bushwalking or sightseeing (Gardner et al, 2006). The environment of Kangaroo Island is characterised by extensive areas of National Parks and Conservation Parks accounting for nearly 30% of the island (Kangaroo Island, 2013; cited in Bight Petroleum, 2014). Important key natural values important to Kangaroo Island are its spectacular coastal features; clean beaches; unspoilt natural settings; a diversity of native flora and fauna; a rare seal colony; and pollution and contamination free conditions (Kangaroo Island Council, 2013; cited in Bight Petroleum 2014).

Tourism is estimated to generate 15% of direct employment on the Island and this is projected to increase by 17.7% in 2021. The tourism market has been estimated at $63M per annum to the island community (Kangaroo Island Council, 2013; cited in Bight Petroleum, 2014).

Consultation records with Kangaroo Island Council are provided in Appendix I (**Stakeholder No: 21 Records**).

The marine tourism activities of the area include:

- **Recreational Beach Use**: Sightseeing, swimming, surfing, snorkelling[21];
- **Diving:** Nine underwater heritage trails which explore historic shipwrecks are listed for South Australia and consist of the *Underwater Trail*, extending form Port Willunga to southeast of Ardrossan (*Grecian*, *Zanoni*, *Star of Greece* and *Norma*); the *Garden Island Trail*, located inside the Port River (northern arm); the *Investigator Strait Trail* located between southern Yorke Peninsula and Kangaroo Island; *Jervois Basin Trail* located in the upper reaches of the Port River; *Kangaroo Island Shipwreck Trail* (shipwrecks located at coastal points around the island); the *Port Elliott Trail* (Port Elliott); the *River Boat Trail* (Murray River from Border Cliffs to Goolwa); the *Southern Ocean Shipwreck Trail* (Victorian Border to Murray Mount); and *Wardang Island Maritime Heritage Trail* (near Port Victoria in Spencer Gulf) (DEWNR, 2014)[22].
- **Marine Mammal Watching:** Whale watching is becoming increasingly popular (~15% per year growth between 2001 and 2003) (Gardner et al. 2006). In SA, 159,900 people participated in whale watching in

[21] These activities remain unaffected by seismic activities located more than 95 km to the west.
[22] Seismic survey activities are not expected to affect these heritage trail activities.

2003 with an estimated expenditure of $10M. In 2003 there were 9 licenced operators with boat-based observation accounting for approximately 20% of viewing and the remainder land-based (Gardner et al. 2006). In South Australia whale watching is found in two main areas – along the coast of the southern Fleurieu Peninsula (80 km south of Adelaide) and the Head of Bight Marine Park (land-based on the Yalata Indigenous Protected Area). These areas are significant for southern right whales with tours operating from Fowlers Bay (110 km west of Ceduna) and Victor Harbour between June and October (SA Whale Centre, 2014); and from Kangaroo Island between May and October (Planet Whale, 2014). These tours typically are 1-3 hours long (total) and focus on near-shore southern right whale activity. Timeframes for tours preclude whale-watching activities in the Duntroon OA.

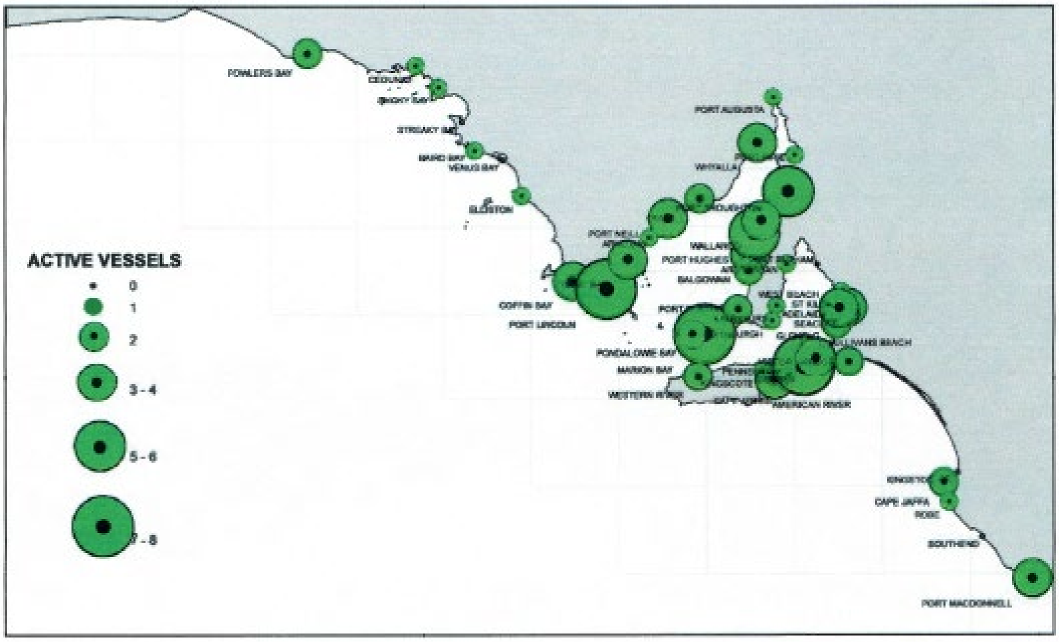
- **Charter Boating:** Coastal tourism includes an increasing number of commercial passenger vessels that take tourists sightseeing, fishing, diving, marine mammal watching and ferry them to island resorts (Gardner et al. 2006). In SA, charter boats are concentrated around Port Adelaide (refer Figure 3-55) however some are based on Kangaroo Island, the Eyre Peninsula and Streaky Bay. The most common activity for these boats is recreational fishing, closely followed by nature-based tourism. Fishing operators which use deeper waters in South Australia target offshore species such as the striped marlin (SEWPC, 2012b). The lack of charter boats along much of the SA coast reflects the often stormy and rough conditions common in the area and the lack of major population centres (Gardner et al. 2006). Charter boats in the Duntroon OA are expected to be infrequent due to the prevailing oceanic weather conditions (refer to Section 3.8.3.2 for Charter Boat Fishery details).
- **Recreational Boating:** Recreational boating in Australia has increased dramatically in recent years due to increases in disposable incomes and the decrease in boating costs. In 2002, 75000 boats were owned by South Australians reliant on available slipways, boat-lifters and over-beach launching facilities (Gardner et al. 2006). Recreational vessels are typically small non-ocean-going vessels not suitable for the conditions within the Duntroon OA. No recreational vessels are expected to be present in the OA.
- **Yacht Racing:** Annual yacht races held in the region include the Melbourne to Adelaide yacht race (December) and the Blue Water Classic between Adelaide and Port Lincoln (February) which attracts more than 50 entrants. The socio-economic impact of yacht racing in the region is minor compared to the eastern states where there are 12 yacht races held each year (Gardner et al. 2006). These races are located inshore of the OA, outside the survey period and not expected to be affected by the Duntroon survey activities.
- **Cruise Ship Visits:** Penneshaw (north-eastern Kangaroo Island) has hosted cruise liners since 2012 when the new landing platform was completed. During 2016/17 there were 19 cruise ships scheduled to visit the island (SA Tourism Commission, 2016). Routes taken by cruise liners to and from Penneshaw track the commercial shipping lanes defined in Section 3.7.1. No impact to this tourist activity from survey activities is expected to liners located in Penneshaw.
- **Fishing (recreational including charter):** Based upon 2013-14 recreational fishing figures, approximately 18.3% of South Australians participate in recreational fishing and is one of the most popular leisure activities in SA. Most recreational fishing effort occurs in marine waters (gulf areas). The most common platform for recreational fishing was non-charter boat fishing followed by land-based fishing with a much smaller proportion utilising charter fishing (PIRSA, 2016). The bulk of recreational fishing in SA involves line fishing (84.3%) followed by lobster pots/crab nets (9.4%). Most fishing effort occurs in marine waters including estuaries, inshore (within 5 km of shoreline) and offshore (greater than 5 km from shoreline) waters (87% total) whereas freshwater fishing only accounted for 13% of effort. Regionally, Spencer Gulf has the highest fishing effort (37%), followed by the Gulf of St Vincent and Kangaroo Island (28%), the West Coast (16%) and South-East Coast (6%) (refer to for definitions). Overall boat-based fishing effort (60.5%) was higher than shore-based (39.5%) fishing effort and recreational fish species caught in marine waters include King George whiting, snapper, southern garfish, southern calamari, blue swimmer crab, southern rock lobster, Australian salmon and pipis (Giri and Hall, 2015). During 2014/15 a total of 94,917 fish were captured by the recreational fishing sector. Within this total only a small number of fish (~500 in total) have been captured within 'other' SA regions (Tsolos and Boyle, 2015).

Areas of recreational fishing activity in coastal areas adjacent to the Duntroon OA are waters off the southern and western Eyre Peninsula[23] and Kangaroo Island targeting tuna, snapper, Australian salmon and trevally (SEWPC, 2012b). Most charter fishing boat activity (recreational fishing) occurs around reef, seagrass meadows, non-vegetated soft bottom, sheltered beach and tidal flat habitats (PIRSA, 2011) and includes inshore/offshore scale fishing and game fishing (Rogers et al, 2017). As identified in Figure 3-55 charter fishing vessels operate predominantly from Port Lincoln, Marion Bay, Cape Jervis and Port Hughes (> 5 active vessels per year over the past 3 years). Port Broughton, Adelaide, Port MacDonnell, Whyalla, Coffin Bay and Wallaroo had moderate activity (average of 4 operators per year) (Steer and Tsolos, 2016). Refer to Section 3.8.3.2 for Charter Boat Fishery statistics.

During 7th – 13th April 2018, a "blue water classic" fishing competition was conducted by the Game Fishing Club of South Australia with the tournament base located at Memory Cove (Port Lincoln National Park (GFCSA, 2018). GFCSA (**Stakeholder Record 71**) has advised that the tournament in 2019 may be held in either March or April 2019 with competitor fishing no more than 20 nm from the coast. The southern extremity of the competition is the southern Neptune Islands.

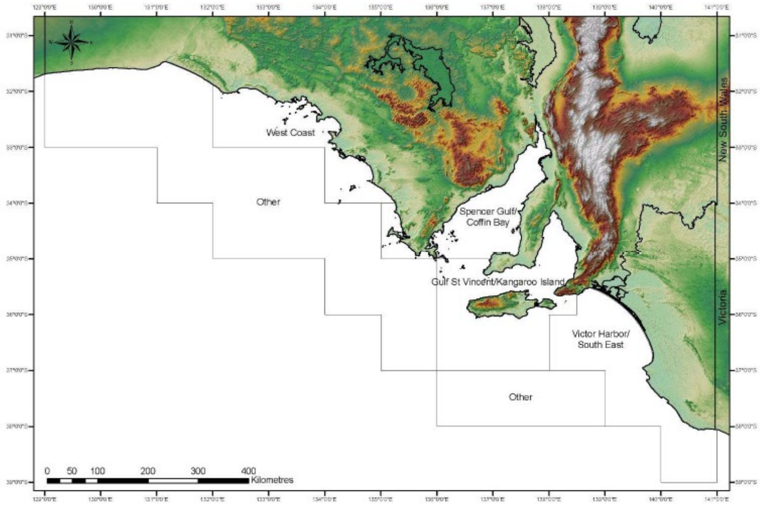
No feedback has been provided from the South Australian Recreational Fishing Advisory Council (**Stakeholder No: 10 records**), Kangaroo Island Fishing Adventures (**Stakeholder No: 51 records**), Kangaroo Island Marine Adventures (**Stakeholder No: 52 Records**), RecFish SA (S**takeholder No: 57 Records**) or the Recreational Charter Boat Fishery (**Stakeholder No: 55 records**).

Figure 3-55: Average active Charter Boat Operators per year and port of operation in SA (Steer & Tsolos, 2016)



[23] Tours target Wedge Island and Thorny Passage Islands (1-day tour). Longer tours (3 days) depart either from Port Lincoln to Wedge Island, Thistle Island, Neptune Islands and Kangaroo Island; or from Coffin Bay to Greenly and Rocky Islands or Pearson and Flinders Island (SA) between January to June (Why Not Fishing Charters, 2014; Absolute Fishing Charters, 2014)

Figure 3-56: Australian Charter Boat Fishery amalgamated fishing region (Tsolos and Boyle, 2015)



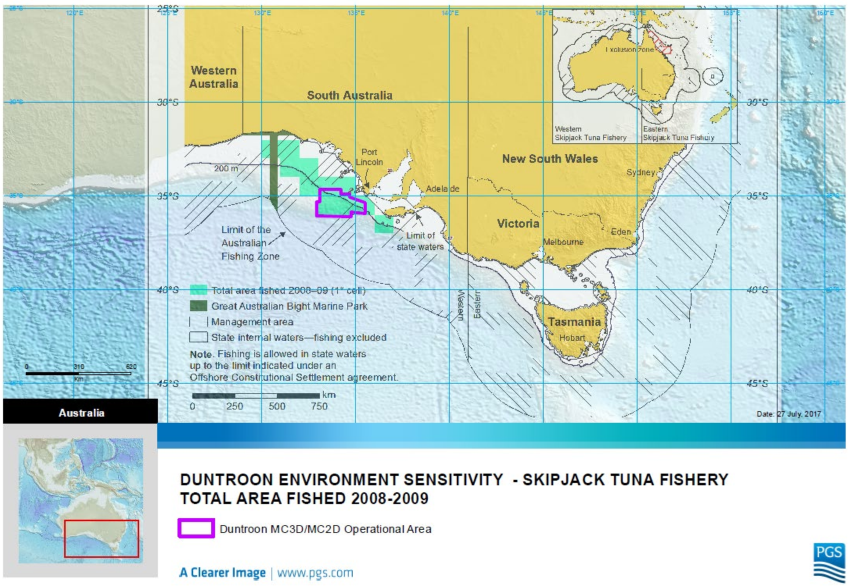
3.8.3 Commercial Fisheries

3.8.3.1 Commonwealth fisheries

The following Commonwealth fisheries have management areas which overlap with the proposed Duntroon OA:

- **Skipjack Tuna (Western) Fishery (STF)**: This fishery lies in the Australian Fishing Zone (AFZ) waters and targets Skipjack Tuna (*Katsuwonus pelamis*). When the fishery is open, the primary fishing technique is purse seine. The fishing season extends all year round from 1 July to 30 June (AFMA, 2010a). Figure 3-57 provides details of the areal extent of the fishing management area and the areas fished during 2008-9 season (Patterson et al, 2018). *There has been no fishing effort in the STF management area since that season*. Australia is at the edge of the species range and tuna stocks are highly variable reliant on recruitment from areas in equatorial regions (Kailola et al., 1993). *Encounter with skipjack tuna fishermen is not expected in the Duntroon OA during the proposed survey. This fishery is not considered further in this EP*.

Figure 3-57: STF area fished (2008-9) (Patterson et al, 2018)



- **Small Pelagic Fishery (Western sub-area):** The Small Pelagic Fishery (SPF) lies in the AFZ in southern Australian waters from 28°10'00" S (southern Queensland) to 30°00'00" S (southern Western Australia). The western and eastern sub-areas are divided by an east-west divide at longitude 146° 30'É (Ward et al. 2013).

  The main features, target species, sustainability and catch statistics of the SPF are provided in Table 3-21. The total TAC and catch figures for the SPF fishery (2011-12 to 2017-18) and its fishing history within the Duntroon OA are provided in Table 3-22.

  Spawning details for the target species are provided in **Table 3-23**. Target species typically inhabit waters to a maximum depth range of 500 m and, while the fishery has traditionally used a purse seine fishing method, it has now also included a mid-water trawl technique. In 2015-16, the fishery had two purse seine vessels and one midwater trawl vessel actively operating in the fishery. The effort in this area increased in 2014-15 and 2015-16 with the introduction of a factory trawler, however this midwater trawler has now left Australian waters and is not expected to return (pers. Com. S. Boag, SPFIA).

  The spatial distribution of this fishery in 2017-2018 is provided in Figure 3-58. Areas fished in 2016-17 include southern and northern NSW and areas south of Kangaroo Island. Vessels in the fishery also fish under other licences and do not always participate in the fishery. *This fishery is not considered further in this EP*.

Table 3-21: Main Features and Statistics of the Small Pelagic Fishery

Feature	Description				
Primary Landing Port	Fishery has traditionally operated off the west and east coast of Tasmania with the primary landing ports of Triabunna, Eden, Iluka, Geelong and Port Lincoln				
Management Methods	Harvest strategy used to set recommended biological catch and total allowable catch (TAC) for each stock.				
Industry Representation	Small Pelagic Fishing Industry Association (Simon Boag) who advises that there is only one active vessel in this fishery present in southern NSW waters [**Consultation Record 60**].				
Fishing Season	1 May to 30 April Harvest season: Not specified (not relevant to the Duntroon OA)				
Encounter Rate	Based on the 2016-17 fishing status reports encounter with SPF fishermen is unlikely. SPFIA advise no activity in the fishery in SA.				
Licences:	32 Statutory Fishing Rights (2015-16) based on quota (TAC)				
Active Vessels:	Purse Seine: 2; Mid-water Trawl: 1 (now left fishery)				
Area Fished in Fishery 2016-17 (km^2) Area Fished in Fishery 2017-18 (km^2)	Not Relevant Not Relevant				
OA overlap with Fished Area (km^2)	Nil				
Catch Effort in Duntroon OA	No Catch recorded. Confidential < 5 Licencees in the area during year.				
Fishery Statistics	2016-17			2017-18	
Stock (Target species) (West)	TAC (Tonnes)[24]	Catch (tonnes)	Real Value ($M)	TAC (Tonnes)	Catch (tonnes)

[24] The Total Allowable Catch (TAC) is based upon a harvest strategy which is a science-based to ensure that commercial fish species are managed for long-term sustainability and economic profitability. In setting TACs from recommended biological catch data – catch from all types of fishing (commercial/recreational) is taken into account (e.g. discards, state and recreational catches) (DAFF, 2007).

Feature	Description				
Australian Sardine (*Sardinops sagax*)	1,880	131	Confidential	9,550	97
Blue Mackerel (*Scomber australasicus*)	8,830	2014	Confidential	15,320	2858
Jack Mackerel (*Trachurus declivis*)	22,270	4652	Confidential	19,800	2748
Redbait (*Emmelichthys nitidus*)	6,190	1241	Confidential	4,230	10
TOTAL (East & West)	39,170	8038	Confidential	48,900	5,713
References: Patterson et al (2017); AFMA (2016); Patterson et al (2018)					

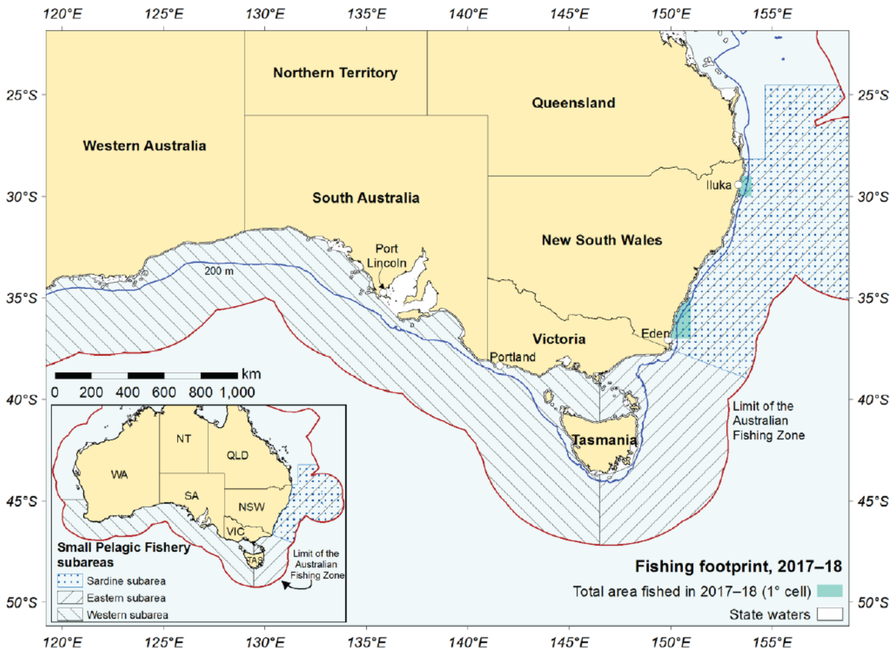
Table 3-22: TAC and Catch 2011-12 to 2016-17 and presence in Duntroon OA

Year	Total Allowable Catch (tonnes)	Total SPF Catch (t)	Fishing in Duntroon OA
2011-2012	30 300	153	Yes (<5 vessels)
2012-2013	36 300	16	Yes (< 5 vessels)
2013-2014	34 270	78	No
2014-2015	34 920	665	Not Available
2015-2016	39,170	12,004	No
2016-2017	39,170	8,038	No

Table 3-23: SPF Target Species –Spawning Details

Species (TAC & Catch %)	Spawning Details
Jack mackerel (*Trachurus declivis*)	Spawning widespread throughout the species range and occurs in the GAB in late spring to early summer (Kailola et al. 1993). Serial spawners at the shelf break (Kailola et al.1993)
Blue mackerel (*Scomber australasicus*)	Present in depths of 40-200 m of water. Species is widespread (Kailola et al. 1993) and is a serial spawner throughout late spring to early autumn. Egg surveys show highest abundances in depths of 40-120 m and sea surface temperatures of 18-22^{o}C. Results of an exploratory survey suggest the western GAB is an important spawning area (Ward et al. 2011; Ward et al. 2009).
Redbait (*Emmelichthys nitidus*)	Commonly found in water depths between 20-100 m (Bruce et al. 2002). Serial spawning takes place between October and January in Tasmanian waters (Kailola et al. 1993)
Australian sardine (*Sardinops sagax*)	Present at all depths in the water column to approximately 200 m. Multiple–batch spawning occurs in inshore continental shelf areas of the GAB during summer and autumn (January to March). In South Australia there is evidence that juveniles remain in bays, inlets and estuaries until 12 months of age before moving offshore (Bruce et al. 2002). Refer to more information under the South Australian Sardine Fishery (**Section 3.7.3.2**).

Figure 3-58: Small Pelagic Fishery – Area fished (2017-2018) (Patterson et al, 2018)



- **Southern and Eastern Scalefish and Shark Fishery:**
    - **Great Australian Bight Trawl Sector (GABTS):** The GABTS lies in AFZ waters (excluding state fishery shelf waters) and extends from Cape Leeuwin (WA) to Cape Jervis (SA) targeting the shelf-break species across the GAB. The fishing method used is otter trawl and Danish-seine (Patterson et al. 2017).

      The main features, target species, sustainability and catch statistics of the GABTS are provided in **Table 3-24**. The TAC and catch figures for the GABTS fishery (2011-12 to 2017-2018) and its fishing history in the Duntroon OA are provided in **Table 3-25**.

      The GABTS can be divided into a continental-shelf fishery (at depths of less than 200 m) which operates year-round, an upper continental-slope fishery (at depths of about 200–700 m) and a deep-water fishery (on the mid- to lower slope, depth 700–1000 m). The deep-water fishery historically targeted orange roughy (*Hoplostethus atlanticus*). However, since 2007, when most of the historical orange roughy fishing grounds were closed under a Conservation Programme (AFMA 2006), little effort has occurred at these depths (Patterson et al. 2015).

      For upper continental-slope trawling, target species include blue grenadier (*Macruronus novaezelandiae*), western gemfish (*Rexea solandri*) and pink ling (*Genypterus blacodes*) (Patterson et al. 2018). The continental shelf continues to be the focus of fishing effort, with 11,386 trawl hours in 2017-18 compared with 1140 trawl hours on the continental slope (Patterson et al, 2018).

      Figure 3-59 (a) provides catch and effort on the GABTS shelf fishery (1988/89 to 2017/18) and (b) the GABTS slope fishery (1988/89 to 2017/18).

      Table 3-26 provides the spawning details for these target fish species.

Table 3-24: Main Features and Statistics of the GABTS

Feature	Description
Primary Landing Port	Port Lincoln, Thevenard, Adelaide (SA)
Management Methods	Total Allowable Catch (TAC) has been set based upon references to unfished biomass.

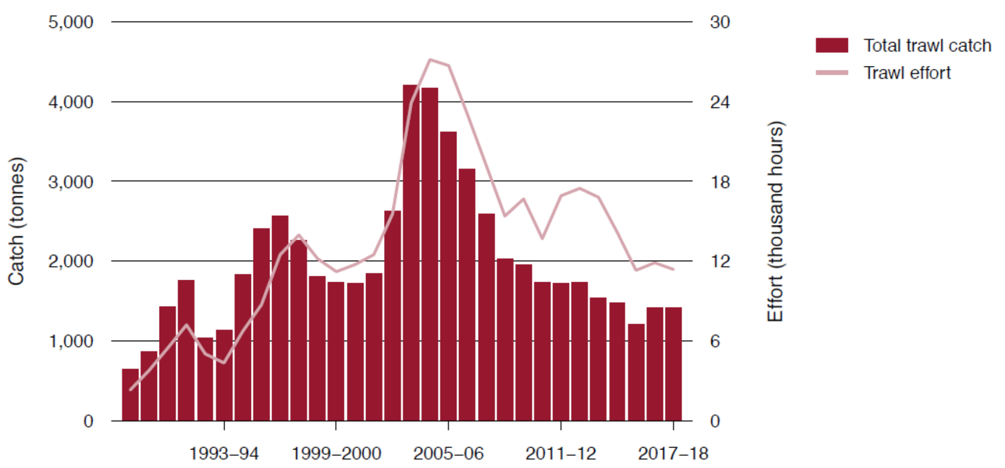
Industry Representation	Great Australian Bight Industry Association (GABIA) represent fishery. Some concerns have been raised over stock assessment survey to be undertaken between February and April and possible impacts of seismic on fish distribution if survey was undertaken during period March to May [**Consultation Record 3**].				
Fishing Season	1 May to 30 April. Shelf fishery: Operates year-round. Deepwater Flathead (Oct to Dec); Bight Redfish (Feb-Apr).				
Encounter Rate	Based on available information, encounter with GABTS fishermen during the Duntroon MSS is possible with any encounter likely in shelf environments in very low numbers.				
Licences:	10 Statutory Fishing Rights (2016-17) based on quota (TAC)				
Active Vessels:	Seine: 1; Trawl: 4 (Seine operates only in summer on the continental shelf)				
Total Area Fished in 2016-17 (km^2) Total Area Fished in 2017-18 (km^2)	80,781 km^2 127,872 km^2				
OA overlap with Fishery (16/17) (km^2) OA overlap with Fishery (17/18) (km^2)	1,433 km^2 (or 1.8% of GABTS area actively fished) (MC2D Area) 12,183 km^2 (or 9.5% of GABTS area actively fished) (MC2D Area)				
Catch Effort in Duntroon OA (16/17) Catch effort in Duntroon OA (17/18)	No Catch Available. Confidential < 5 Licencees in the area during year. No Catch Available. Confidential < 5 Licencees in the area during year.				
Fishery Statistic	2016-17			2017-18	
Stock (Target species)	TAC (Tonnes)	Total Catch (tonnes)	Total Real Value ($M)	TAC (tonnes)	Catch (tonnes)
Bight Redfish (*Centroberyx gerrardi*)	800	274	1.43	800	308
Deepwater Flathead (*Platycephalus conatus*)	1,150	636	5.86	1128	548
Ocean Jacket	-	228	0.63	-	193
Orange Roughy	0	0	0	0	0
TOTAL	1950	1138	10.04	1928	1049
Source: [1] ABARES (2016); [2] AFMA, 2016; Patterson et al (2018)					

Table 3-25: TAC and Catch 2011-12 to 2016-17 & Fishing within Duntroon OA

Year	Total Allowable Catch (tonnes)	Catch (t)	Fishing in Duntroon OA
2011-2012	3,366	2,280	No
2012-2013	3,894	2,150	No
2013-2014	3,738	2,170	Yes (< 5 vessels)
2014-2015	3,508	1,003	Yes (< 5 vessels)
2015-2016	3,508	1,038	Yes (< 5 vessels)
2016-2017	2,329	1,139	Yes (< 5 vessels)

Figure 3-59: Catch and Effort of (a) GABTS shelf and (b) GABTS slope 1988-89 to 2017-18

(a)



(b)

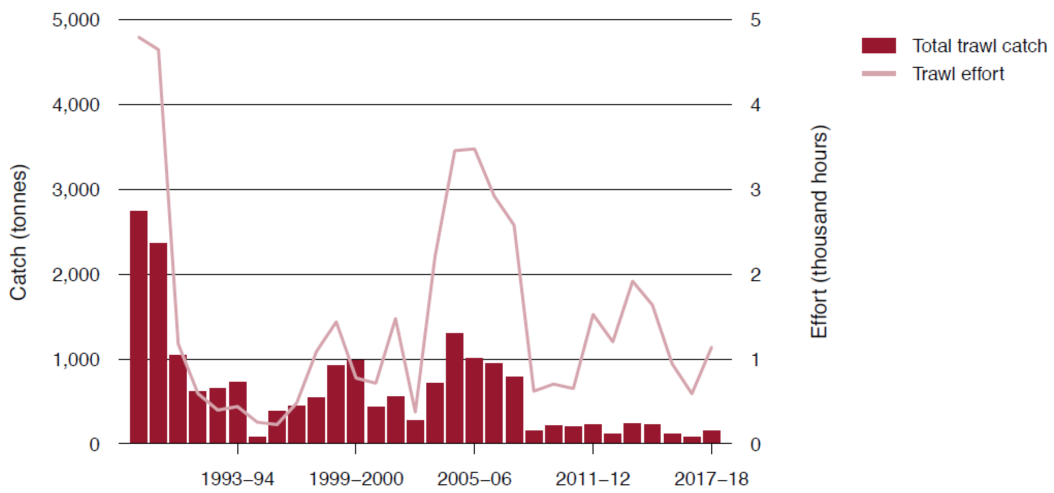


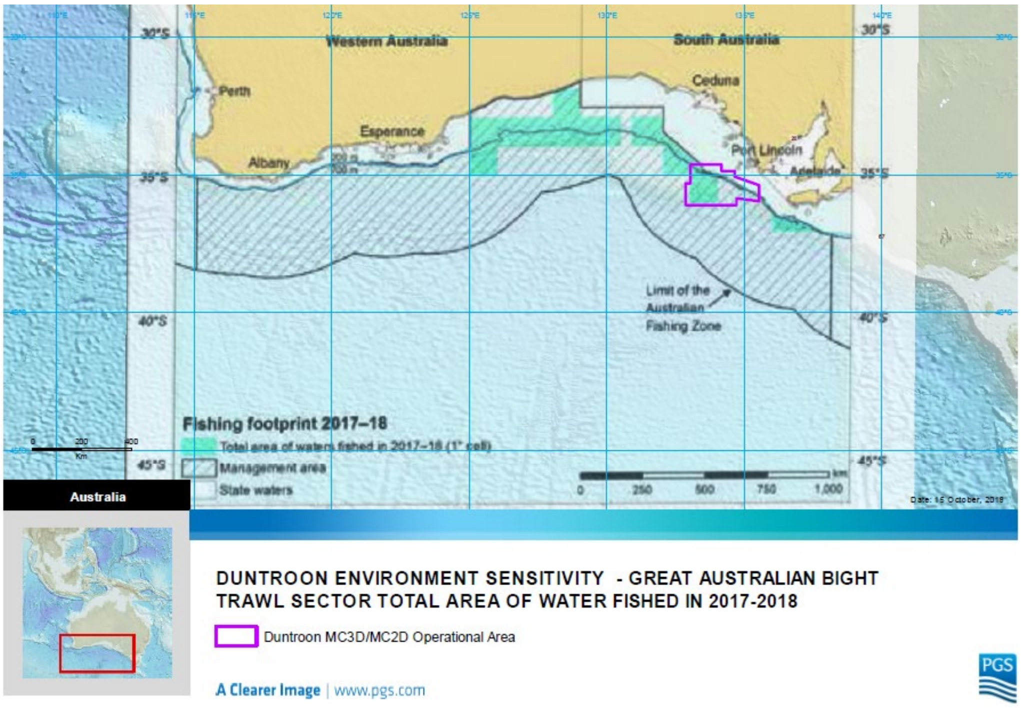
Table 3-26: GABTS Target Species –Spawning Details

Species	Spawning Details
Deep-water flathead (*Platycephalus conatus*)	The species is demersal with habitat on continental shelf/slope to 490m. Spawning period in GAB lasts from October to February (Kailola et al, 1993).
Bight redfish (*Centroberyx gerrardi*)	Endemic to temperate waters of southern Australia and is a benthopelagic species on rocky reefs at depths 11-260m (Gomon & Bray, 2011). Serial spawner during summer and early autumn. They form spawning aggregations over lumps on the seabed (AFMA, 2018).
Ocean Jacket	Peak spawning peaks during autumn (April) for populations off South Australia. Spawning fish form aggregations in water 85-200m deep. Females produce about 0.7-2 Million eggs per spawning season. Species is a broad cast spawner (AMFA, 2018). Spawning grounds are located to the west of Pearson Island (~70 km from the nearest OA boundary) (Grove-Jones & Burnell, 1991)

Species	Spawning Details
Blue grenadier (*Macruronus novaezelandiae*)	Species occupies water column with most common depths between 200-700m. Spawning area is located on the west coast of Tasmania with spawning occurring in winter (Bruce et al. 2002).
Western gemfish (*Rexea solandri*)	Species inhabits deeper continental shelf and upper slope waters from 100-700 m (Kailola et al. 1993). Spawning of the western gemfish appears to occur in the west of the GAB in summer (Bruce et al. 2002)
Pink ling (*Genypterus blacodes*)	Species present in continental shelf and slope waters between 40-700 m. Spawning occurs off Strahan (Tas.), Lakes Entrance (Vic) and Gabo Island (NSW) during spring (Bruce et al. 2002).

Figure 3-60 provides details of the relative fishing intensity within the GABTS for 2017-18 fishing year. In feedback associated with the Bight Petroleum Lightning survey, GABIA identified that the fishery was concentrated within the GAB between longitudes 125°E and 133°E along the shelf-break, but principally from 126-132°E at water depths 100-250 m. GABIA advised of a Gulper Shark closure for re-stocking between 133°45’ and 134°45’ (no trawling is allowed in this area). While small levels of GABIA activity have been present in the Duntroon OA (MC2D area), most activity was recorded near the shelf break around the Head of Bight. Based on available information, encounter with GABTS fishermen during the Duntroon survey is possible with any encounter likely in shelf environments in very low intensity during MC2D survey activities.

Figure 3-60: Relative fishing intensity in the GABTS 2017-18 fishing season (Patterson et al, 2018)

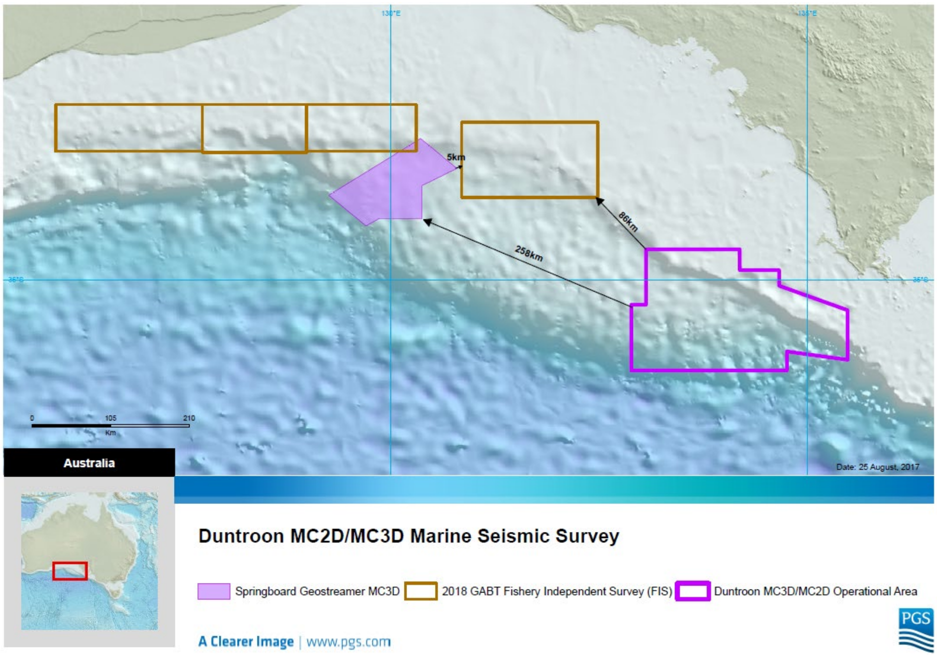


Stock Assessment Surveys:

The GABTF undertakes stock assessments on a biennial basis. GABIA advised during 2018 (late February to early April) a Fisheries Independent Survey (FIS) wouldl be conducted. This stock assessment is planned in 2020 for the same timeframe.

Figure 3-61 provides the location of the stock assessment areas which are located at least 86 km northwest of the nearest Duntroon OA boundary. Given the biennial nature of this survey, and the Duntroon survey timeframe (2019/20) there is no temporal overlap with the FIS (no conflict).

Figure 3-61: GABTS Stock Assessment Areas 2018 (GABIA, 2017)



- **Gillnet Hook & Trap Sector (GHTS):** The GHTS lies in AFZ waters extending from the Victorian border across shelf waters to the SA/WA border (refer **Figure 3-62**). Prior to 2003 waters in this fishery included SA and eastern Victoria, however spatial closures in SA to prevent impacts to the Australian sea lion have resulted in gillnet effort being concentrated off eastern Victoria (ABARES, 2016). Most gillnet shark fishing occurs in waters adjacent to the Victorian coastline and throughout Bass Strait (ABARES, 2016). The fishery predominantly uses demersal gillnets and a variety of line methods to catch target species (Patterson et al. 2015). A gillnet closure currently exists over a significant portion of the Duntoon OA on the continental shelf (Area D(1)) until March 9, 2019 to protect sea lions (AFMA, 2018). In addition, shark gillnet operators are excluded from fishing in water depths >183m to primarily to protect recovering adult school shark and gulper shark populations (ABARES, 2016). A demersal auto and manual longline closure is in place across a segment of continental slope to protect a 'gulper shark' breeding area..

  The main features target species, sustainability and catch statistics of the GH&T Fishery are provided in **Table 3-27**. The TAC and catch figures for the GH&T fishery (2011-12 to 2016-17) and its fishing history in the Duntroon OA are provided in **Table 3-28**. As the fishing intensity in the Duntroon OA is less than 5 vessels, catch data for the Duntroon OA is confidential and no area specific catch data is available (Patterson et al, 2017).

  Table 3-29 provides the spawning details for these target fish species.

Table 3-27: Main Features and Statistics of the GH&T Fishery

Feature	Description
Primary Landing Port	Adelaide, Port Lincoln, Robe (SA); Lakes Entrance, San Remo, Port Welshpool (Vic); Devonport, Hobart (Tas).
Management Methods	Managed by a combination of input controls (gear restrictions and closed areas) and output controls (individual transferrable quotas and limits on the proportion of school shark to gummy shark).
Industry Representation	Represented by the Southern Shark Industry Alliance (SSIA) and Sustainable Shark Fishing Association (SSF). SSIA advises that the gillnet shark fishery is low in the area due to closures. Hook fishing is the active fishery in the area (pers.com S. Boag, 2018) [**Consultation Record 61**]. No response has been provided by the SSF to survey activities.

Feature	Description				
Fishing Season	1 May – 30 April. Peak Harvest: Harvest periods are defined by the lunar cycle (full moon) (pers.com S. Boag)				
Encounter Rate	Based on fishing status reports while encounter with GHTS fishermen is possible but unlikely. Fish capture in the OA is low with catch data confidential.				
Licences:	61 (Shark Gillnet), 13 (Shark Hook), 37 (Scalefish Hook) Statutory Fishing Rights (2016-17) based on quota (TAC)				
Active Vessels (2016-17): Active Vessels (2017-17):	36 (Shark Gillnet), 26 (Shark Hook), 17 (Scalefish Hook) 36 (Shark Gillnet), 27 (Shark Hook), 17 (Scalefish Hook)				
Total Area Fished in 2016-17 (km^2) Total Area Fished in 2017-18 (km^2)	276,215 km^2 (Shark Gillnet Fishery) 271,144 km^2 (Shark Hook Fishery) 403,927 km^2 (Scalefish Hook Fishery) 307,750 km^2 (Shark Gillnet Fishery) 385,974 km^2 (Shark Hook Fishery) 344,834 km^2 (Scalefish Hook Fishery)				
OA overlap with Fishery 16/17(km^2) OA overlap with Fishery 17/18(km^2)	1,299 km^2 (Duntroon OA in waters <200m) or 0.5% of Shark Gillnet Fishery Area) 4,140 km^2 (Duntroon OA) or 1.5% of Shark Hook Fishery Area 18,976 km^2 (Duntroon OA) or 4.7% of Scalefish Hook Fishery Area 648 km^2 (Duntroon OA in waters <200m) or 0.2% of Shark Gillnet Fishery Area) 14,847 km^2 (Duntroon OA) or 3.8% of Shark Hook Fishery Area 14,847 km^2 (Duntroon OA) or 4.3% of Scalefish Hook Fishery Area				
Catch Effort in Duntroon OA (16/17) Catch Effort in Duntroon OA (17/18)	No Catch available. Confidential < 5 Licencees in the area during year. No Catch available. Confidential < 5 Licencees in the area during year.				
Fishery Parameter	2016-17 Fishing Season			2017-18 Fishing Season	
Stock (Target species)	TAC (Tonnes) (Total)	Catch (tonnes) (Total/GHTS tonnage*)	Total Real Value ($M) (Tota/GHTS value)	TAC (Tonnes) (Total)	Catch (tonnes) (Total/GHTS tonnage)
Shark Hook and Gillnet Sector					
Gummy Shark (*Mustelus antarcticus*)	1836	1669 (1526)	17.93 (16.89)	1916	1774 (1604)
Elephantfish (*Callorhinchus milii*)	163	76 (45)	<0.1 (<0.1)	122	62 (27)
Sawshark (*Pristiophorus cirratus, P. nudipinnus*)	482	200 (112)	0.52 (0.27)	481	205 (98)
School shark (*Galeorhinus galeus*)	215	173 (149)	1.7 (1.51)	215	206 (181)
TOTAL	2696	2118 (1832)	20.23 (18.7)	2734	2216 (1910)
Scalefish Hook Sector (includes target species where GHaT catch > 1 tonne)					
Blue-eye trevalla	410	432 (388)	4.05	458	327 (276)
Blue Grenadier	8810	1311 (5)	2.54	8765	1624 (5)
Deepwater sharks (western zone)	215	75(0.5)	NA	215	80 (0.6)
Flathead (several species)	2882	2874 (1)	18.6	2712	2436 (1)
Gemfish (western zone)	247	73(4)	0.19	199	77 (<1)

Feature	Description				
Jackass morwong	475	213 (1)	0.47	513	185 (3)
Ocean perch	190	163 (19)	0.52	190	169 (19)
Pink ling	1144	913 (306)	5.22	1154	1036 (297)
Ribaldo	355	88 (49)	0.31	355	95 (40)
TOTAL (GH&T +CTS)	20,095	8681 (773.5)	46.42	19,382	8631 (642.6)
Source: [1] Patterson et al (2017); Patterson et al (2018) * Stock can also be caught by the Commonwealth Trawl Sector. Number in brackets reflects the GH&T contribution to the total catch					

Table 3-28: GH&T Total TAC and Catch 2011-12 to 2015-16

Year	Total Allowable Catch (tonnes)	Total Catch (t) (CTS and GHaT – all species)	Fishing in Duntroon OA
Shark Hook & Gillnet Sector			
2011-2012 [1]	2 208	1 914	Yes (<5 vessels) (Hook & Gillnet)
2012-2013 [2]	2 182	1 876	Yes (< 5 vessels) (Hook & Gillnet)
2013-2014 [3]	2 499	1 955	Yes (< 5 vessels) (Hook & Gillnet)
2014-2015 [4]	2 619	2 005	Yes (< 5 vessels) (Hook & Gillnet)
2015-2016 [5]	2696	2233	Yes (< 5 vessels) (Hook & Gillnet)
Scalefish Hook Sector			
2011-2012 [1]	16,642	12,447	Nil
2012-2013 [2]	17.662	11,785	Yes (< 5 vessels)
2013-2014 [3]	18,088	10,677	Yes (< 5 vessels)
2014-2015 [4]	18,892	8,264	Yes (< 5 vessels)
2015-2016 [5]	14,468	6,329	Yes (< 5 vessels)
References: [1] Woodhams et al, 2012; [2] Woodhams et al, 2013; [3] Patterson et al, 2015 [4] Patterson et al, 2016 [5] Patterson et al, 2017			

Table 3-29: GHTS Target Species –Spawning Details

Target Species	Spawning Details
Shark Gillnet and Shark Hook Sector	
Gummy shark (*Mustelus antarcticus*)	Adults are demersal on the continental shelf from inshore to approximately 80 m although sometimes found on the slope to 350m (Last & Stevens, 2009). Species is broadly distributed around southern coastline between Geraldton and Townsville. Records show long distance movements across southern Australia. Pupping frequency in SE Australia occurs every two years. Species does not have well defined nursery areas. Pups are generally born in shallow coastal areas. (Bruce et al. 2002). Species is viviparous giving birth to up to 14 pups in December (Last & Stevens, 2009).
Elephantfish (*Callorhinchus milii)*	Species distributed throughout continental shelf areas (cool and temperate regions) to depths of at least 200m and distributed from Sydney to Esperance. Adult elephant fish migrate to shallower waters (generally <40m) of estuaries and bays in spring to breed (Bruce et al. 2002). Egg cases are large (about 25 cm long by 10 cm wide) (Last & Stevens, 2009).

Target Species	Spawning Details
Sawshark (*Pristiophorus cirratus, P. nudipinnus)*	Species is distributed demersal on continental shelf from Caloundra (Qld) to Jurien Bay (WA) along the southern coastline and occurs in depths between 40-630m. (Bruce et al. 2001). Gestation/embryo development occurs between October & January. No details are available on breeding locations (Kailola et al. 1993). Viviparous with litters of 11 pups biennially (Last & Stevens, 2009).
School shark (*Galeorhinus galeus*)	Species has widespread distribution in temperate waters from Brisbane to Perth mostly on the continental shelf to 800 m. Remains at depths of around 500 m during the day and moving up to around 100 m at night (TSCC, 2009). Pupping areas have been confirmed in certain habitats of Victoria, eastern and southern Tasmania (Bruce et al. 2002) and inshore coastal areas in parts of South Australia (TSCC, 2009). Viviparous with litters of 30 pups in December/January (Last & Stevens, 2009).
Scalefish Hook Sector	
Blue-eye trevalla (*Hyperoglyphe Antarctica*)	Species has a normal depth range between 200-900 m. Spawning appears correclated with water temperature and nutrient upwellings. Blue eye spawn as early as February-March in Tasmanian waters, from April to June off mainland Australia and later than June off northern NSW. It appears that mature fish move up the continental slope to shallow depths (320-400m) and aggregate in specific grounds for spawning (Kailola et al, 1993).
Blue grenadier (*Macruronus novaezelandiae*)	The main spawning ground for blue grenadier is centred of Cape Sorell on the west coast of Tasmania. The species is thought to migrate to main spawning grounds from all regions of the species distribution in winter and spring where spawning onset varies according to difference in water temperatures. Single release of eggs during spawning season (Kailola et al, 1993).
Flathead (several species) (*Platycephalus* species)	Sand flathead is predominantly caught by trawl in southern Australian waters. They are most abundant in southern NSW, Victorian and Tasmania (Bruce et al, 2002). Spawning is regionally variable. It is protracted in Tasmanian waters occurring form October to March, peaking between October and December in waters of the inner continental shelf (Bruce et al, 2002).
Gemfish (western zone) (*Rexea solandri*)	Mature gemfish undergo an annual migration with the fish spawning to the west of the GAB during summer (AFMA, 2018).
Jackass morwong (*nemadactylus macropterus*)	Timing of spawning varies regionally (Bruce et al, 2002). Species spawn from late summer to autumn (February to May). Jackass morwong are serial spawners and probably spawn through their Australian distribution (Kailola et al, 1993).
Ocean perch (*Helicolenus* species)	Species is viviparous with spawning occurring in late winter/early spring (Bruce et al, 2002). Studies in New Zealand have shown that female ocean perch produce between 150,000 and 200,000 eggs during the breeding season and may brood 40,000 to 50,000 larvae at any one time (Kailola et al, 1993).
Pink ling (*Genypterus blacodes*)	Spawning aggregations of species has been reported off Strahan (Tas), Lakes Entrance (Vic) and Gabo Island (NSW) during spring although the presence of larvae suggests a more protracted spawning period (Bruce et al, 2002).
Ribaldo (*Mora moro*)	Spawning occurs in late winter and early spring. Species is not thought to form large spawing aggregations (AFMA, 2018).

Specific Species Details:

School shark: The school shark (*Galeorhinus galeus*) is listed under the EPBC Act as a 'conservation dependent' species. In Australian waters, school sharks are widespread and found in offshore temperate waters from Moreton Bay (Qld) to Perth (WA) including the offshore waters of Tasmania and Lord Howe Island. School sharks move extensively throughout the waters of southern Australia (TSSC, 2009). The species is not endemic to Australia and is long-lived with low fecundity (every 2-3 years) reproducing in December and January off southern Australia (TSSC, 2009). The species is primarily demersal on continental shelves but also on the upper slope and well offshore (Last & Stevens, 2009). Individuals have been recorded undertaking daily vertical migrations, remaining at depths of around 500 m during the day and moving up to 100 m at night (McLoughlin, 2007 in TSSC, 2009). Females and juveniles utilise inshore coastal areas around Victoria, Tasmania and parts of South Australia for nursery areas (Pogonski et al., 2002 in TSSC, 2009).

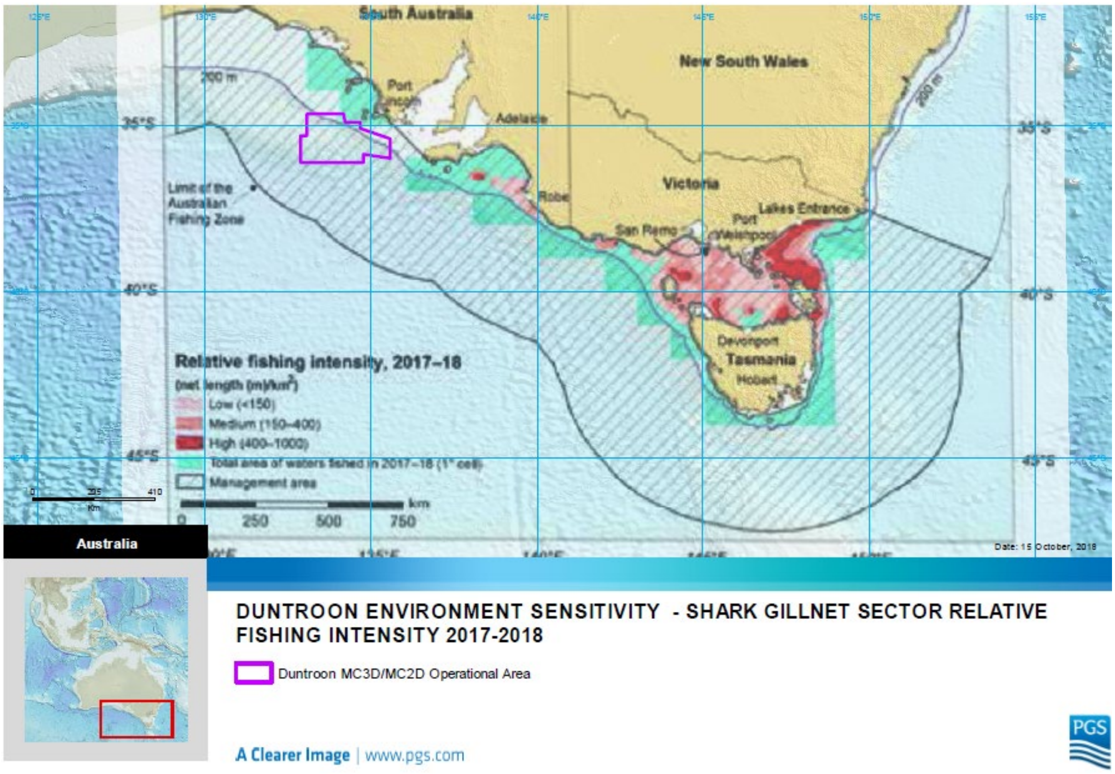
The species is predatory feeding primarily on bony fish and cephalopods. They migrate significant distances with individual migration recorded up to 1400 km, thought to be associated with reproduction (Last & Stevens, 2009). The species is viviparous (Last & Stevens, 2009). Threats to the species is fishing pressure (over-fished). Sound is not identified as a threat to species recovery (TSSC, 2009).

Southern dogfish (gulper shark) & fishing closure areas: Fishery closures exist over portions of the Duntroon OA to protect and allow rebuilding of the over-fished Gulper Shark or Southern Dogfish (*C. Zeehaani*) between 133º45'E and 134º45'E (60 nm) and at depths between 200-850 m (Williams et al. 2012). This fishing closure is centred on a 30 nm area where the southern dogfish is concentrated, and mature females are observed (for breeding). Buffers of 15 nm lie to the east and west of this area to allow for edge effects (mortality due to sharks leaving the closure and being captured by fishers) (Williams et al. 2012). The Gulper Shark GAB closure area (60 miles) is provided in **Figure 3-63** and protects an estimated 10.6% of the central population of southern dogfish (TSSC, 2013). The frequency of detections near the eastern and western margins of the closure area are eight times lower than near the centre, indicating the edge effects of fishing activity to the east and the west of the closure is low (Williams et al. 2012).

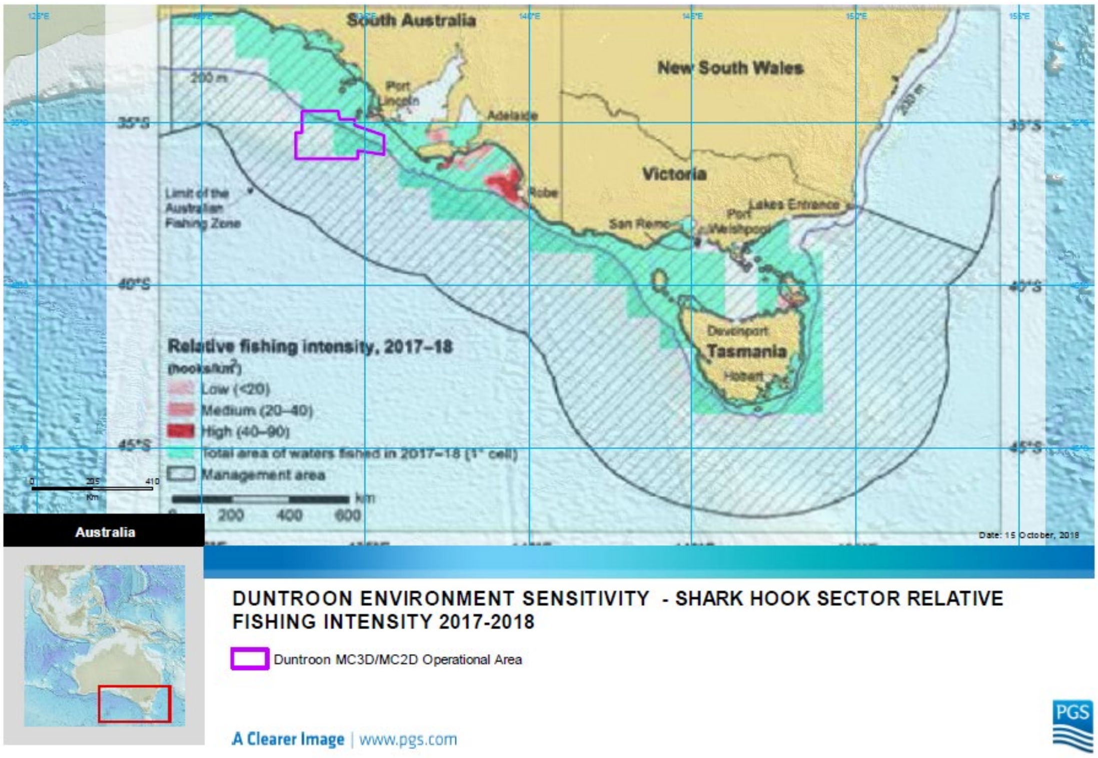
The gulper shark has three distinct stocks – eastern (NSW/Vic/Tas), central (Vic/SA) and western (WA) (TSCC, 2013). The central stock has a core range from near Warrnambool to south of Ceduna. The area of occupancy is assessed as 7,269 km^2 (TSCC, 2013).

Figure 3-62: GHTS Relative Fishing Intensity in (a) the Shark Gillnet Sector, (b) the Shark Hook Sector and (c) Scalefish Hook Sector, 2017-18 fishing season (Patterson et al, 2018)

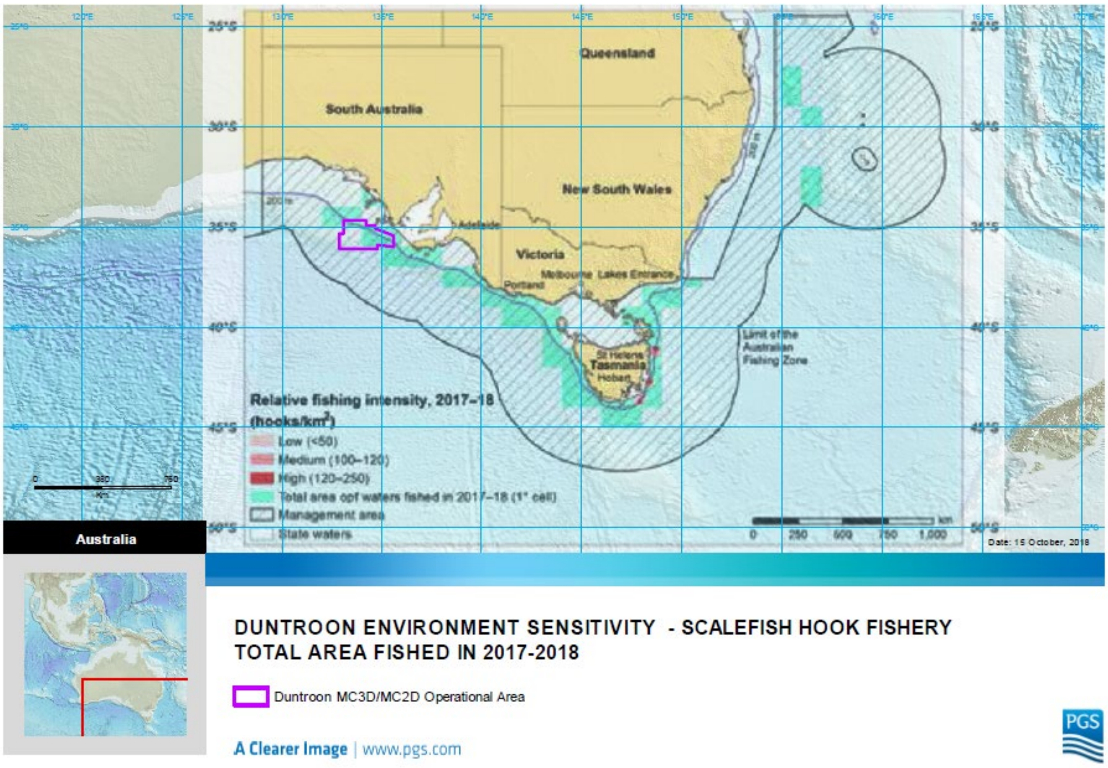
(a)



(b)



(c)

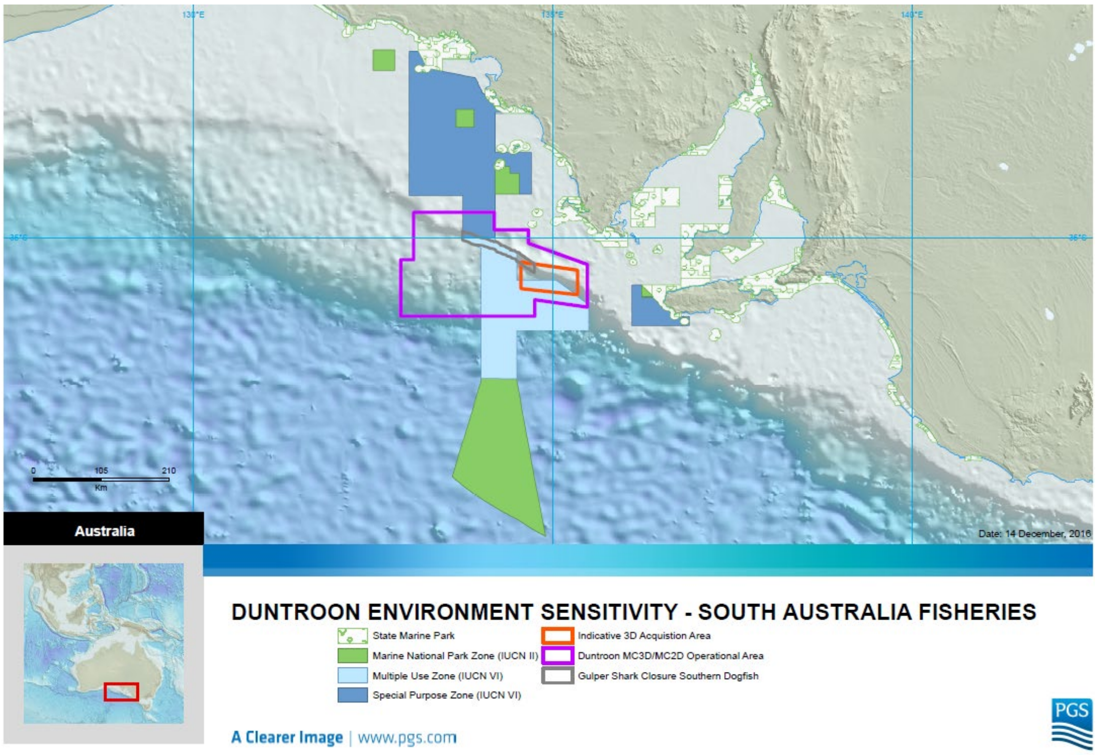


The demersal gulper shark inhabits upper to middle continental slope and some offshore seamounts in southern and eastern Australia mainly in depths between 350-800 m but with an overall depth range of 200-1000 m. The species undertakes day-night migrations across their depth range from a relatively deep daytime residence depth (1000 m) to shallower night time feeding depths (to 200 m) (Williams et al, 2012). Water column range extends to the surface although vertical movements are infrequent. The distances that southern dogfish can travel are not known. A study using acoustic tags recorded a related species, the greeneye dogfish (*Squalus chloroculus*), travelling up to 480 km from the first capture location (Daley et al., 2009). Electronic tagging found that 70% of southern dogfish have home range larger than 10 nm along the slope and estimated foraging range up to 50 nm based on acoustic telemetry data (Williams et al., 2012).

The gulper shark's diet consists of fish, cephalopods and crustaceans. The species is viviparous (Last & Stevens, 2009) and has a low fecundity of one-two pups per 2-3 years (Graham, 2013) which makes the species susceptible to rapid stock depletion from over-fishing. Reproduction is continuous and non-seasonal. Sound is not identified as a threat to species recovery (TSSC, 2013).

The southern dogfish is listed under the EPBC Act as 'conservation-dependent'. Shark gillnet and hook methods are banned from use in depths below 183 m in 2007 (TSSC, 2013).

Figure 3-63: GAB Closure Area and Survey Area locations (Williams et al. 2012)



- **Southern Bluefin Tuna Fishery (SBTF):** The SBTF lies in the AFZ and extends around the entire Australian coastline with the principal target species - Southern Bluefin Tuna (*Thunnus maccoyli*). SBT are listed under the EPBC Act as 'conservation-dependent' and the main threat to the fishery is ongoing fishing pressure (TSSC, 2010). **Table 3-32** provides the spawning details for this target fish species.

  The main features, target species, sustainability and catch statistics of the SBT Fishery are provided in **Table 3-30**. The TAC and catch figures for the SBT fishery (2011-12 to 2017-18) and its fishing history in the Duntroon OA are provided in **Table 3-31**. While some years have only shown less than 5 vessels operating in the fishery (catch confidential), in recent years active fishing has occurred adjacent to the Duntroon OA on shelf areas and in 2015-16, active fishing occurred on a confidential basis (< 5 licencees) within the Duntroon OA.

  Most of the Australian catch is taken by purse-seine vessels in the GAB and waters off South Australia. Approximately 95% of the SBT caught in the GAB are located on the continental shelf near the shelf-break (DEWHA, 2007). The species actively feed on pilchards present within the area (PIRSA, 2005).

Table 3-30: Main Features and Statistics of the SBT Fishery

Feature	Description				
Primary Landing Port	Port Lincoln (SA)				
Management Methods	Managed under international convention for conservation of SBT (Bali Procedure) used to set global TAC. Bali Procedure aims to rebuild stock to its initial unfished biomass by 2035. Global TAC is allocated to members and AFMA sets TAC for SBT fishery in accordance with Australia's allocation.				
Industry Representation	Represented by the Australian Southern Bluefin Tuna Industry Association (ASBTIA). ASBTIA has concerns with the Duntroon survey commencing prior to April in any year including issues with stock assessment surveys which are undertaken in certain years in the January to March timeframe [**Consultation Record 6**].				
Fishing Season	1 December – 30 November. Length of the fishing season is dependent on water temperatures in the region. Usually season commences in December and pontoons have left the continental shelf for Port Lincoln by April 1.				
Encounter Rate	Based on fishing status reports and consultation, encounter with SBT fishermen is possible on shelf areas between December and April.				
Fishing Permits (15/16): Fishing Permits (16/17):	89 Statutory Fishing Rights (2015-16) based on quota (TAC) 85 Statutory Fishing Rights (2015-16) based on quota (TAC)				
Active Vessels (16/17):	Purse Seine (6); Longline (16)				
Total Area Fished in 2015-16 (km^2) Total Area Fished in 2016-17(km^2)	54,273 km^2 (SA Purse Seine Total) 51,354 km^2 (SA Purse Seine Total)				
OA overlap with Fishery 15/16 (km^2) OA overlap with Fishery 16/17 (km^2	6,704 km^2 (Duntroon OA) or 12.4% of active purse seine fishing area 2,975 km^2 (Duntroon OA) or 5.8% of active purse seine fishing area				
Catch Effort in Duntroon OA	No Catch recorded. Confidential < 5 Licencees in the area during year.				
Fishng Statistics	2015-16 Fishing Season			2016-17 Fishing Season	
Stock (Target species)	TAC (Tonnes)	Catch (tonnes)	Real Value ($M)	TAC (tonnes)	Catch (tonnes)
Southern Bluefin Tuna (Purse Seine)	5,703	4,900	31.09	5,697	4,684
Southern Bluefin Tuna (Pelagic Longline) (East Coast)	-	733	5.3	-	650
TOTAL	5703	5633	36.45	5697	5334
Source: Patterson et al (2017); Patterson et al (2018)					

Table 3-31: TAC and Catch 2011-12 to 2015-16

Year	Total Allowable Catch (tonnes)	Catch (t)	Fishing in Duntroon OA
2010-2011	3 939	3 958	Yes (< 5 vessels)
2011-2012	4 509	4 543	Yes (<5 vessels) including areas of high effort
2012-2013	4 663	4 539	Yes (< 5 vessels), Adjacent area has high effort
2013-2014	5 312	5 420	Yes (< 5 vessels)
2014-2015	5 557	5 519	No

Table 3-32: SBTF Target Species – Spawning Details

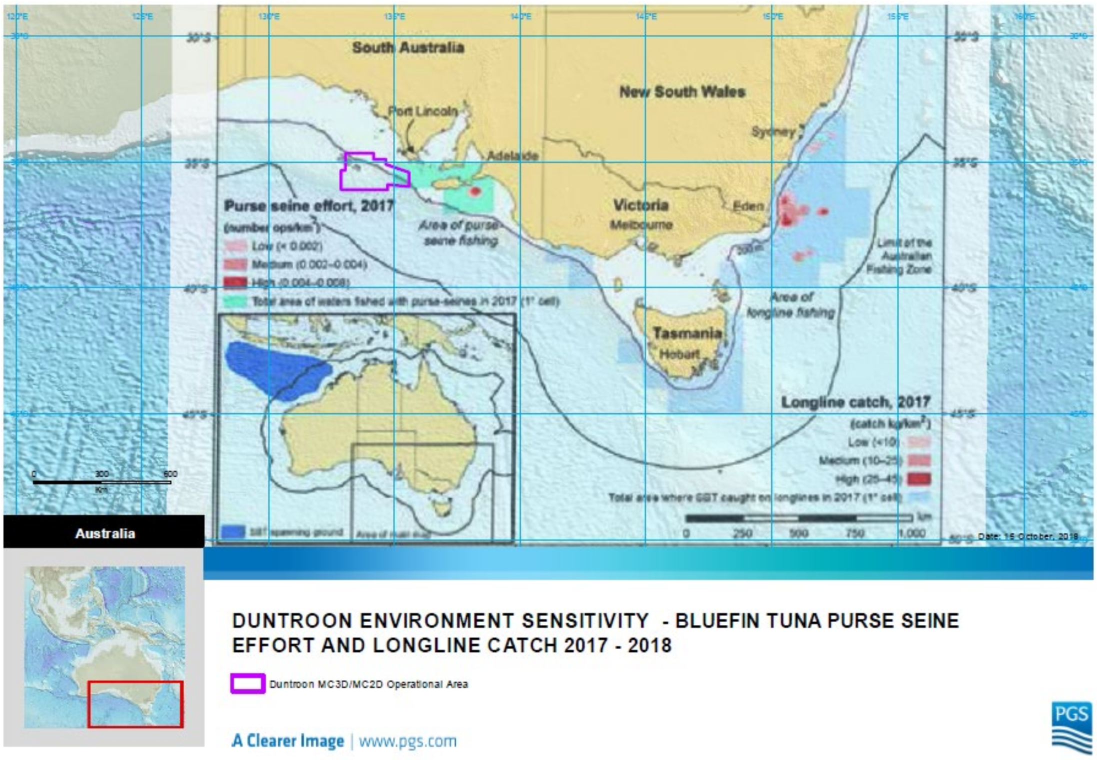
Species	Spawning Details

Species	Spawning Details
Southern Bluefin Tuna (*Thunnus maccoyli*)	Species is highly migratory and enters the tropical waters of the eastern Indian Ocean south of Java to spawn. Spawning occurs in every month except July but predominantly from September to March (Bruce et al, 2002; Kailola et al. 1993). No spawning activity in southern Australian waters

Each year, in November spotter planes identify the location of SBT as they enter the GAB from the Indian Ocean and direct a vessel to the location of schooling fish where deckhands cast baitfish into the sea and lead the SBT to a towing pontoon. Once the school is close to the pontoon a purse seine vessel encircles the school and leads the SBT into the tow pontoon net. A single purse seine shot normally captures 10-50 tonnes of SBT with an average fish weight of 15 kg. After sufficient quantities of SBT have been caught (3-5 shots) and transferred to the tow pontoon, the fish are transported back to Port Lincoln at a maximum speed of 1 knot with tows lasting up to 3 weeks (pending weather and in-water conditions) (ASBTIA, 2012).

SBT caught in the GAB are juveniles (2-4 years old) and in Port Lincoln are 'grown-out' in floating sea cages for ~3-7 months predominantly on local sardines and imported baitfish, depending on market requirements, prior to export (McClatchie et al. 2006). In 2009 and in 2011 to 2015, the catch was taken in the east of the GAB closer to Port Lincoln resulting in shorter towing distances to the grow-out cages (refer **Figure 3-64**). The number of longlining vessels fishing for SBT off the east coast have been more variable over time.

Figure 3-64: SBTF Total Catch 2017 (Patterson et al, 2018)



Stock Assessment Surveys:

The CSIRO undertakes SBT stock assessment aerial surveys from 1st January to 31st March in certain years along 15 evenly-spaced transect lines that run north-south from the coast to about the 800 m contour off the continental shelf. These transects run from Port Lincoln (SA) to beyond the WA border (CSIRO, 2010). The Duntroon survey area overlies the five most easterly survey lines, however given the proposed timing of the Duntroon survey (September to November), survey activities are not expected to affect these stock assessment activities.

- **Western Tuna and Billfish Fishery (WTBF) (southern section):** The WTBF operates in Australia's Exclusive Economic Zone and high seas of the Indian Ocean. In recent years this has concentrated off south-west Western Australia and South Australia. The southern section of the WTBF lies in AFZ waters south of 34°S and west of 141°E. Figure 3-65 provides details of the relative fishing intensity in 2017 (Patterson et al, 2018) with a small amount activity recorded in the Duntroon OA for 2017 and no activity recorded for the years 2012, 2013, 2015 and 2016 (ABARES, 2011; 2012; 2014; 2015; 2016; Patterson et al, 2017). During 2014 and 2017, some low-level effort (less than 5 vessels) was present in the Duntroon OA area. Historically, the main pelagic long-lining effort in this fishery has been concentrated off the Western Australian coast west of 117°E (ABARES, 2010).

  The main features, target species, sustainability and catch statistics of the WTBF are provided in Table 3-33. The TAC and catch figures for the WTBF fishery (2011 to 2017) and its fishing history in the Duntroon OA are provided in Table 3-34. Spawning details for the target species are provided in Table 3-35.

Table 3-33: Main Features and Statistics of the WTBF Fishery (southern section)

Feature	Description				
Primary Landing Port	Fremantle, Geraldton (WA)				
Management Methods	TACC are made in accordance with Australian domestic policies.				
Industry Representation	CFA [**Stakeholder Record 11**] contacted. No consultation representative identified for fishery (AFMA website, 2018)				
Fishing Season	1 February – 31 January.				
Encounter Rate	Low.				
Licences:	95 Statutory Fishing Rights (2017) based on quota (TAC)				
Active Vessels:	Pelagic Longline (3); Minor line (1)				
Total Area Fished in 2017 (km²)	425,670 km²				
OA overlap with Fished Area (km²)	14,468 km² (or 3.4% of the fishery)				
Catch Effort in Duntroon OA	No catch available.				
Fishery Statistics	2016 Fishing Season			2017 Fishing Season	
Stock (Target species)	TAC (Tonnes)	Catch (tonnes)	Real Value ($M)	TAC (tonnes)	Catch (tonnes)
Striped Marlin *(Tetrapturus audax)*	125	1	Confidential	125	1
Swordfish (*Xiphias gladius*)	3000	147	Confidential	3000	166
Albacore	-	23	Confidential	-	16
Bigeye Tuna (*Thunnus obesus)*	2000	75	Confidential	2000	67
Yellowfin Tuna (*Thunnus albacares),*	5000	74	Confidential	5000	72
TOTAL	10125	320	-	10,125	322
Source: ABARES (2016); Patterson et al (2017)					

Table 3-34: TAC and Catch 2011 to 2016 (& presence in Duntroon OA)

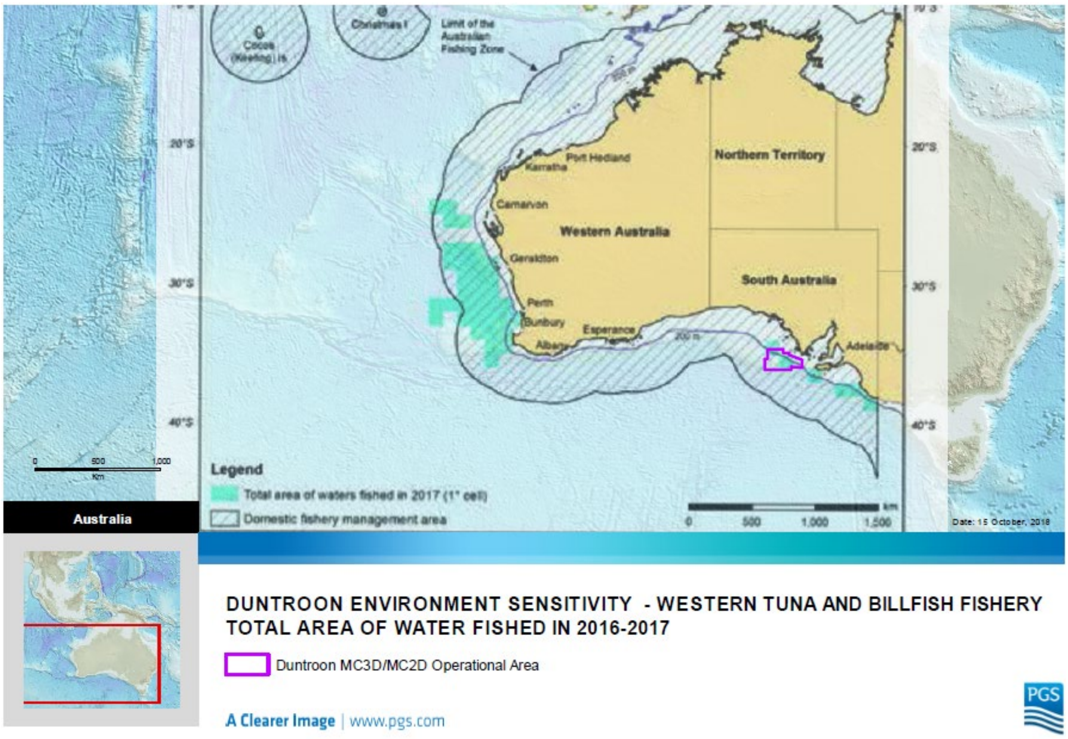
Year	Total Allowable Catch (tonnes)	Catch (t)	Fishing in Duntroon OA
2011	16000	263	No
2012	10,125	415	No

2013	10,125	352	No
2014	10,125	361	Yes (< 5 vessels)
2015	10,125	440	No
2016	10,125	320	No

Table 3-35: WBTF Target Species – Spawning Details

Species	Spawning Details
Striped Marlin	Striped marlin spawns between 10ºS and 30ºS in the south-west Pacific in November and December and between 10ºS and 20ºS in the north-eastern Indian Ocean from October to December (Kailola et al., 1993).
Swordfish	The distribution of larval swordfish in the Pacific Ocean indicates that spawning occurs mainly in waters with a temperature of 24oC or more. Spawning appears to occur in all seasons in equatorial waters but is restricted to spring and summer at higher latitudes (Kailola et al., 1993).
Albacore	In southern hemisphere oceanic waters between 5ºS and 25ºS albacore spawn at least twice each summer (October to March) with peak activity during December and January (Kailola et al., 1993).
Bigeye Tuna	Bigeye tuna spawn throughout tropical waters of the eastern Indian Ocean, the eastern and western Pacific Oceans. In Australian waters, reproductively active bigeye tuna has been reported from south of Indonesia, north of Australian and from the north-western Coral Sea. Aggregations are associated with frontal regions where sea surface temperatures are 25-26ºC (Kailola et al., 1993)
Yellowfin Tuna	Yellowfin tuna spawn throughout the tropical and equatorial waters of major oceans. In Australian waters, reproductively active yellowfin tuna has been reported in the north-western Coral Sea and NWS. Off eastern Australia, the species probably do not spawn south of 25ºC (Kailola et al. 1993)

Figure 3-65: Area of the Western Tuna and Billfish Fishery 2017 (Patterson et al, 2018)



- **Southern Squid Jig Fishery (SSJF):** The SSJF Fishery lies in AFZ waters extending from the Queensland/NSW border to the SA/WA border (excluding coastal waters) targeting arrow squid by squid jig methods. Fishing is carried out in continental shelf waters in depths of between 60-120 m between January and June with highest catches traditionally concentrated in March and April. Squid are also caught by the Commonwealth Trawl Sector (CTS) and the GABTS and in recent years more squid has been landed by these fisheries than the SSJF. Most fishing takes place off Portland (March to June) (Patterson et al, 2017) (refer **Figure 3-66**).

The main features, target species, sustainability and catch statistics of the SSJF are provided in **Table 3-36**. The TAC and catch figures for the SSJF fishery (2011-12 to 2016-17) and its fishing history in the Duntroon OA are provided in Table 3-37. **Table** 3-38 provides the spawning details for this target species.

Table 3-36: Main Features and Statistics of the SSJ Fishery

Feature	Description				
Primary Landing Port	Portland, Queenscliff (Vic); Hobart (Tas)				
Management Methods	Input controls – gear statutory fishing rights, number of jig machines				
Industry Representation	No consultation feedback has been obtained from the CFA (**Stakeholder No: 11 Records**) who represents the SSJF regarding any issues or concerns associated with the Duntroon survey.				
Fishing Season	1 January to 31 December. Actual fishing January and June (highest catch generally March and April)				
Encounter Rate	Not expected.				
Licences:	4900 Gear Statutory Fishing Rights (2017)				
Active Vessels:	8				
Total Area Fished in 2015 (km²)	Not relevant to Duntroon survey				
OA overlap with Fished Area (km²)	No current overlap				
Catch Effort in Duntroon OA	No catch recorded.				
Fishery Statistics	2016 Season (excludes CTS and GABTS)			2017 Season (Excludes CTS and GABTS)	
Stock (Target species)	TAE (Total Allowable Effort)	Catch (tonnes)	Real Value ($M)	TAE (Total Allowabel Effort)	Catch (tonnes)
Goulds Squid	550 jigging machines	384	1.05	550 jigging machines	213
TOTAL	-	384	1.05		213
Source: Patterson et al (2017); Patterson et al (2018)					

Table 3-37: TAC and Catch 2011 to 2016 (& presence in Duntroon OA)

Year	Total Allowable Effort (tonnes)	Catch (t)	Fishing in Duntroon OA
2011	560 jigging machines	650	No
2012	560 jigging machines	832	Yes (< 5 vessels)
2013	550 jigging machines	166	No
2014	550 jigging machines	2	No
2015	550 jigging machines	330	No
2016	550 jigging machines	384	No

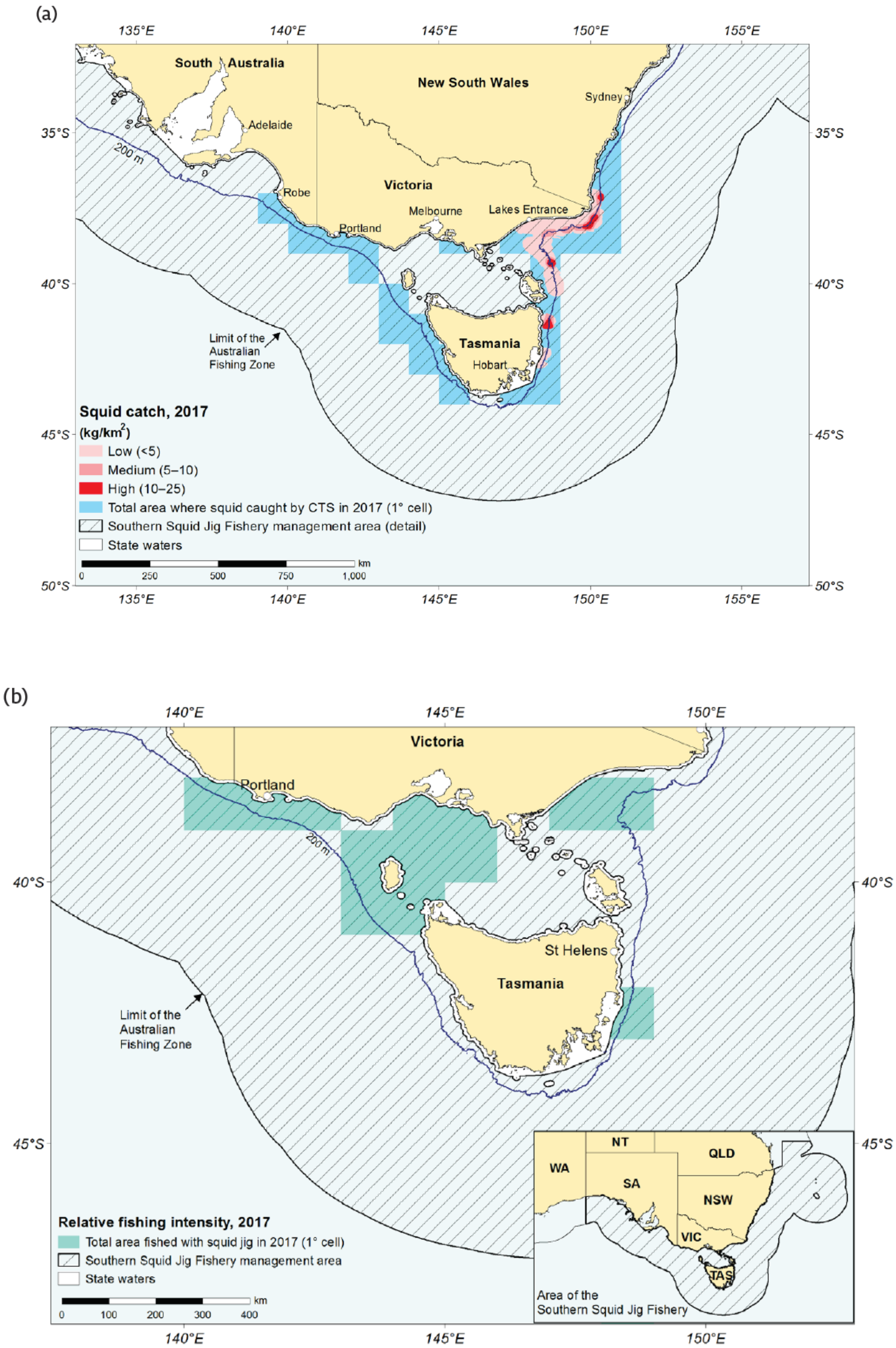
Table 3-38: SSJF Target Species – Spawning Details

Species	Spawning Details

Species	Spawning Details
Gould's squid (*Nototodarus gouldi)*	Species (including larvae) is most abundant on the continental shelf between depths of 50-200 m. Spawns multiple times during the species lifespan of 12 months (Woodhams et al. 2013)

Based on available fisheries status reports, encounter with SSJ fishermen in the survey area is not expected. This fishery is not considered further in this EP.

Figure 3-66: (A) Commonwealth Trawl Sector squid catch and (b) relative fishing intensity of the Southern Square Jig Fishery 2017 (Patterson et al, 2018)



3.8.3.2 South Australian fisheries

The following SA-state managed fisheries also may operate within the proposed Duntroon survey area:

- **South Australian Rock Lobster Fishery (Northern Zone):** This fishery extends from the low water mark of the South Australian coastline to the edge of the AFZ and from the River Murray mouth to the Western Australian border. The South Australian rock lobster fishery is a primarily single species, single method fishery, based on the capture of southern rock lobster (SRL), *Jasus edwardsii*. This species inhabits a depth range of 0-200 m and are capture via pots (PIRSA, 2007). They are primarily found on limestone reef systems or isolated granite formations with provide habitat in the form of protective crevices or ledges (Linanne et al, 2016). Tag-recapture studies identify the species does not undertake extensive movements with 68% of lobsters recaptured within 1 km of release and 85% within 5 km of release (Linnane et al, 2015).

  The main features, target species, sustainability and catch statistics of the NZRLF are provided in **Table 3-39**. The TAC and catch figures for the SA Rock Lobster Fishery (2011-12 to 2016-17) is provided in **Table 3-40**, it's catch by depth range is provided in **Figure 3-67** and its fishing history in the Duntroon OA by relevant Marine Fishing Area (MFA) is provided in **Table 3-41**. The seasonal distribution of catch is provided in **Figure 3-69**.

  Figure 3-69 shows the location of the Duntroon OA with respect to the South Australian MFAs and the respective catch and effort for each of the MFA areas for the 2015/16 Rock Lobster fishing season. Note that from 2015/16, catch and effort has been reported based upon an inner zone (blue MFAs) and outer zone (green MFAs). Prior to 2015, catch was not classified according to this zoning, only by MFA.

Table 3-39: Main Features and Statistics of the SA Rock Lobster Fishery

Feature	Description				
Primary Landing Port	Port Lincoln				
Management Methods	Licences (limited entry)/TACC				
Industry Representation	South Australian Rock Lobster Advisory Council (SARLAC)				
Fishing Season	1 November to 31 May. Majority of the catch taken in first four-five months of the season. Highest catch taken in January and the lowest in November.				
Encounter Rate	Not expected.				
Method	Lobster Pots				
Licences:	68 Licenced (northern zone)				
Active Vessels:	38				
Total Area Fished in 2016 (km^2)	Not relevant to Duntroon survey				
OA overlap with Fished Area (km^2)	No overlap.				
Catch Effort in Duntroon OA	No catch recorded.				
Fishing Statistic	2015/16 Fishing Season			2016/17 Fishing Season	
Stock (Target species)	TAC (Tonnes)	Catch (tonnes)	Real Value ($M)	TAC (tonnes)	Catch (tonnes)
Southern rock lobster (SRL) *Jasus edwardsii*	360	332	22.5	360	302.71 (to May)
TOTAL	-	332	22.5	360	302.71
Source: PIRSA (2002); Linnane et al., 2015; Linanne et al (2016); Linnane et al (2017)					

Table 3-40: TAC and Catch 2011 to 2016 (SARDI, 2017; Linane et al, 2017)

Year	Total Allowable Commercial Catch (tonnes)	Catch (t)
2011	310	288
2012	345	311
2013	345	318
2014	345	326
2015	360	342
2016	360	302.7 (November to May – 5 months of season remaining)

Figure 3-67: Percentage of catch from four depth classes in the NZRLF (Linnane et al., 2015)

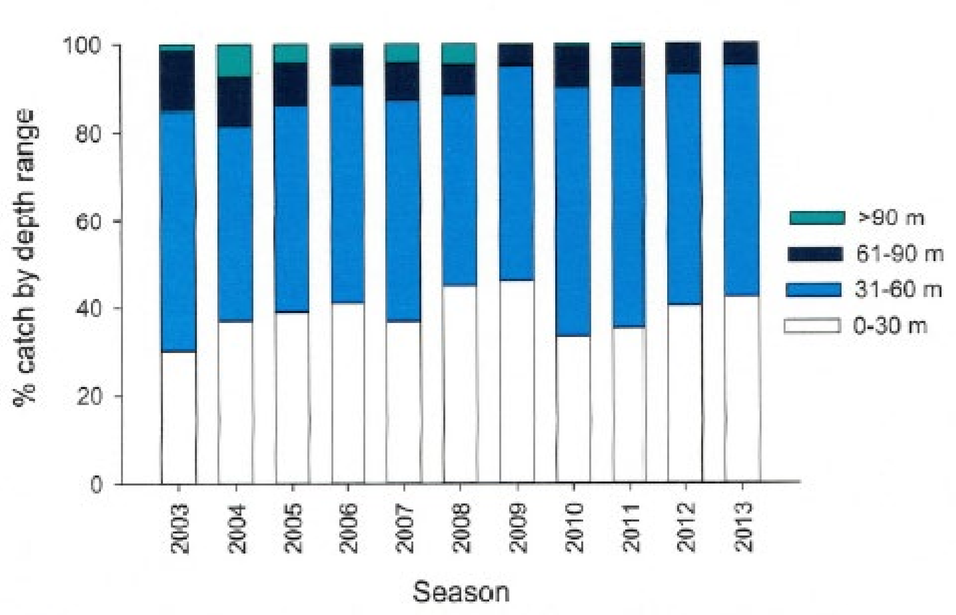


Figure 3-68: Season Trends in Catch and Effort in the NZRLF (2016) (Linnane et al., 2017)

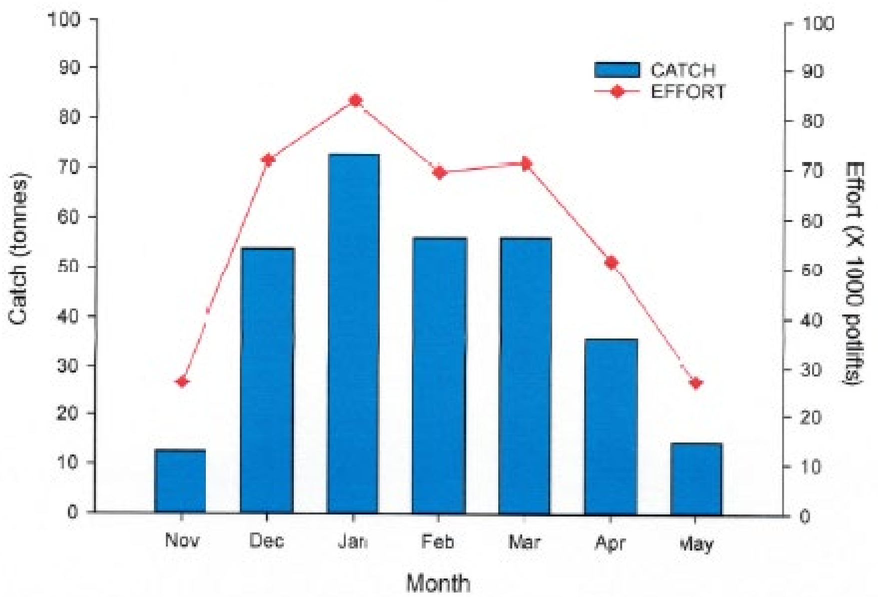


Table 3-41: Rock Lobster Catch Data (kg) (2011-2015) (SARDI, 2017)

<table>
<tr><th>MFA</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>Average (relevant MFAs)</th></tr>
<tr><td>24</td><td>0</td><td>n/a</td><td>n/a</td><td>0</td><td>0</td><td>0/na</td></tr>
<tr><td>25</td><td>0</td><td>n/a</td><td>n/a</td><td>n/a</td><td>0</td><td>0/na</td></tr>
<tr><td>26(O)</td><td rowspan="2">13974.87</td><td rowspan="2">4999</td><td rowspan="2">6192</td><td rowspan="2">6901</td><td>0</td><td rowspan="2">8301</td></tr>
<tr><td>26 (I)</td><td>9439</td></tr>
<tr><td>28</td><td>67277.07</td><td>79298</td><td>64087</td><td>73958</td><td>58474</td><td>68619</td></tr>
<tr><td>37</td><td>N/A</td><td>0</td><td>0</td><td>n/a</td><td>0</td><td>0/na</td></tr>
<tr><td>38 (O)</td><td rowspan="2">7700.85</td><td rowspan="2">4582</td><td rowspan="2">3102</td><td rowspan="2">6520</td><td>0</td><td rowspan="2">6293</td></tr>
<tr><td>38 (I)</td><td>9560</td></tr>
<tr><td>39</td><td>63096.95</td><td>46094</td><td>71217</td><td>67581</td><td>56703</td><td>60938</td></tr>
<tr><td>47</td><td>N/A</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0/na</td></tr>
</table>

Legend:

	MFAs within Duntroon MSS OA
	MFAs adjacent to Duntroon MSS OA

This data indicates that the Duntroon MSS OA does not overlap or lie in an area which contributes to the NZRLF catch. The percentage of catch taken from water depths in the NZRLF, particularly in recent years, is very small with most catch occurring to 60 m water depths (refer **Figure 3-67**) (Linnane et al. 2015).

Review of the NZRL Fishery Status Report (2015/16 & 2015/16), identifies that the Duntroon MSS OA overlaps the outer subzone of the South Australian Rock Lobster Fishery. The TAC for the fishery for 2015/16 was 360 tonnes, with an outer zone contribution of 60 tonnes (Linnane et al. 2016). The fishery was classified as “sustainable” by the Commonwealth Government. The 2015/16 fishery biomass estimate is 2,073 tonnes and the fishery had an exploitation rate of 16 % (i.e. 360 tonnes per annum) and for 2016/17 was 1872 tonnes with an exploitation rate of 17% (Linnane et al. 2016; 2017). Linnane et al (2016) estimated biomass in three spatial sub-regions of the SA fishery – Inner Region (66%), West Coast 28%) and Deepwater (6%) (location of the Duntroon OA). Corresponding exploitation rates within those regions since 2009 have been - Inner Region (32% biomass), West Coast (3% biomass) and Deep Water (4% biomass). The West Coast and Deep-water regions have been combined into the ‘outer region’. The harvest strategy is managed through TACCs underpinned by spatial biomass targets of 21% and 10% exploitation rates in the Inner and Outer regions respectively (Linnane et al, 2016).

The value of the fishery has fluctuated between $15M and $23M since 2003/4 and was valued at $22.5M in 2014/5 (Econsearch, 2016).

Figure 3-69 provides the spatial trend in catch by depth for 2015/16. All lobsters taken in the outer zone lie to the south of Kangaroo Island and not within the Duntroon OA. Linnane et al (2017) identifies for the 2016/17 season that the annual catch is consistently taken from water depths < 60 m with no obvious evidence of a shift in fishing effort. Linnane et al (2017) report approximately 3% of TACC is taken in water depths greater than 90m which are comparable depths to the shallower regions of the Duntoon OA. Catch taken at these depths are attributable to MFA39, FA48, and MFA49 (Linnane et al 2017) – areas which have no spatial overlap with the Duntroon OA.

Based on SARDI catch and effort information and the latest fishery status report, the Duntroon OA lies in the NZRLF outer zone where there is no recorded catch. Encounter with NZSRL fishermen is possible but unlikely in the Duntroon OA.

Spawning/Recruitment: The spawning season for the SRL is June to November (PIRSA, 2015). The SRL lifecycle is complex – after mating in autumn, fertilized eggs are carried under the tail of the female for approximately three months before hatching typically between September and November/December (DPI, 2009; Kailola et al., 1993). The eggs hatch into larvae (or *phyllosoma*) which undergo eleven developmental stages over a period of 12-24 months in pelagic environments while being dispersed and distributed by oceanic currents to distances at least 1100 km from land (Kailola et al., 1993). Given the long-lived nature of the SRL larval phase, there can be up to two cohorts of larvae present in shelf waters at any one time. Larval distribution is initially in shelf waters with currents quickly dispersing larvae along shore and into offshore waters. Mixing of larvae and loss of larvae regional integrity is prevalent in southeast SA, Tasmania and eastern Victoria. Additionally, *phyllosoma* are found over a variety of water depths and are assumed to have no affective horizontal swimming capacity in the marine environment (Bruce et al., 2007). The long larval duration of the SRL is believed to provide ample opportunity for the transport of larvae from the source to distant regions. During metamorphosis juvenile rock lobsters shift from the planktonic (*phyllosoma*) phase to a benthic existence (termed *puerulus*) (DPI, 2009) settling into coastal and shelf habitats. The highest *puerulus* settlement rates in South Australia occur during July and August, 8-9 months after hatching.

Species recruitment and growth can vary from year to year depending on environmental changes including water temperature and movement of oceanic currents. The species presence within New Zealand and Australian waters has been demonstrated to comprise of a single stock (Ward et al., 2002). Transport of larvae in southern Australia is dominated by an easterly displacement from western natal spawning sites by currents running parallel to the coast from south-west WA to the east coast of Tasmania. A complex field of eddies and currents in offshore waters in southern Australia serve to isolate some larvae from the predominant easterly flow with localized westerly displacement in some areas (particularly SA waters) (Bruce et al., 2007). Except southwest WA, all regions receive more stock from outside their own boundaries than from self-recruitment (Bruce et al. 2007) with the Southern Zone Fishery in SA having the highest level of egg production in southern Australia and is an important source of *puerulus* for the overall south–eastern fishery (Linnane and Walsh, 2011).

- **Giant Crab Fishery:** The Giant Crab Fishery encompasses the waters of the NZRLF and the fishing season timing is coincident with the timing of that fishery (PIRSA, 2002). The species is mainly targeted in Commonwealth waters in depths greater than 50 m with the highest concentrations occurring on the outer shelf at depths between 140 to 270 m (Levings et al, 2005; cited in Levings 2008). The giant crab fishery utilises pots to capture giant crab which inhabit waters between 20-600 m in depth (Currie & Ward, 2009). The two specialised operator's fish at depths exceeding 110 m on predominantly soft substrate (CoA, 2004). Most crabs are caught in depths less than 110 m on rocky reefs (predominantly by-catch to lobster fishery) and are males (PIRSA, 2002; CoA, 2004). Females are captured in greater abundance at depths greater than 120 m with males caught over a broader depth range than females (Levings, 2008). Giant crabs move along the shelf into the current with journeys of up to 400k recorded of Western Australia and Victoria/South Australia. Movement into the current means millions of larvae flow in the opposite direct to replenish the fishing grounds to the east (Levings, 2008).

  The fishery catch is not large and is relatively stable totalling 17-22.1 tonnes per annum, however in 2013 only 17.3 tonnes (2014/15) and 16.8 tonnes (2016/17) were landed by commercial fishers (McLeay, 2016; McLeay, 2018). The fishery is divided into two zones (southern and northern). The Duntroon MSS OA is in the northern zone fishery.

  The main features, target species, sustainability and catch statistics of the Giant Crab Fishery are provided in **Table 3-42**. Information contained in the most recent 'Status of South Australian Fisheries Report' (PIRSA, 2015) has identified that the Duntroon OA area does not contribute significantly to commercial catches of giant crab (i.e. no recorded catch). As shown in Figure 3-70, catch is classified as confidential (i.e. areas where catch relates to less than five licences) or not present in the Duntroon OA.

  The production value of the fishery was valued at $1.4M in 2015/16 (PIRSA, 2018). Catch within the fishery for the past five years is provided in Table 3-43.

Table 3-42: Main Features and Statistics of the SA Giant Crab Fishery

Feature	Description
Primary Landing Port	Port Lincoln, Adelaide
Management Methods	Licences (limited entry)/TACC

Industry Representation	None Identified				
Fishing Season	1 November to 31 May.				
Encounter Rate	Low encounter rate.				
Licences:	2 Licencees (northern zone under “Miscellaneous Licence”); 5 NRLFZ entitlements (giant crab quota)				
Active Vessels:	2				
Method	Crab Pots.				
Total Area Fished in 2013 (km^2)	109,816 km^2				
OA overlap with Fished Area (km^2)	MFA-38: 3,703 km^2				
Catch Effort in Duntroon OA	Confidential < 5 Licencees in the area during year. Seasonality: Main catch is November to January, with smaller catch in Autumn (Feb-April) (Currie and Ward, 2009).				
Fishery Statistic	2015/16 Fishing Season			2016/2017 Fishing Season	
Stock (Target species)	TACC(Tonnes)	Total Catch (tonnes)	Real Value ($M)	TACC (Total Fishery) (tonnes)	Total Catch (tonnes
Giant crabs (Pseudocarcinus gigas)	22.1	16.0	1.4	22.1	16.8
TOTAL	22.1	16.0	1.4	22.1	16.8
Source: [1] SARDI (2017); [2] Flood et al., (2014); PIRSA (2018)					

Figure 3-69 : South Australian Rock Lobster Fishery Rock Lobster Catch 2015 (SARDI, 2017).

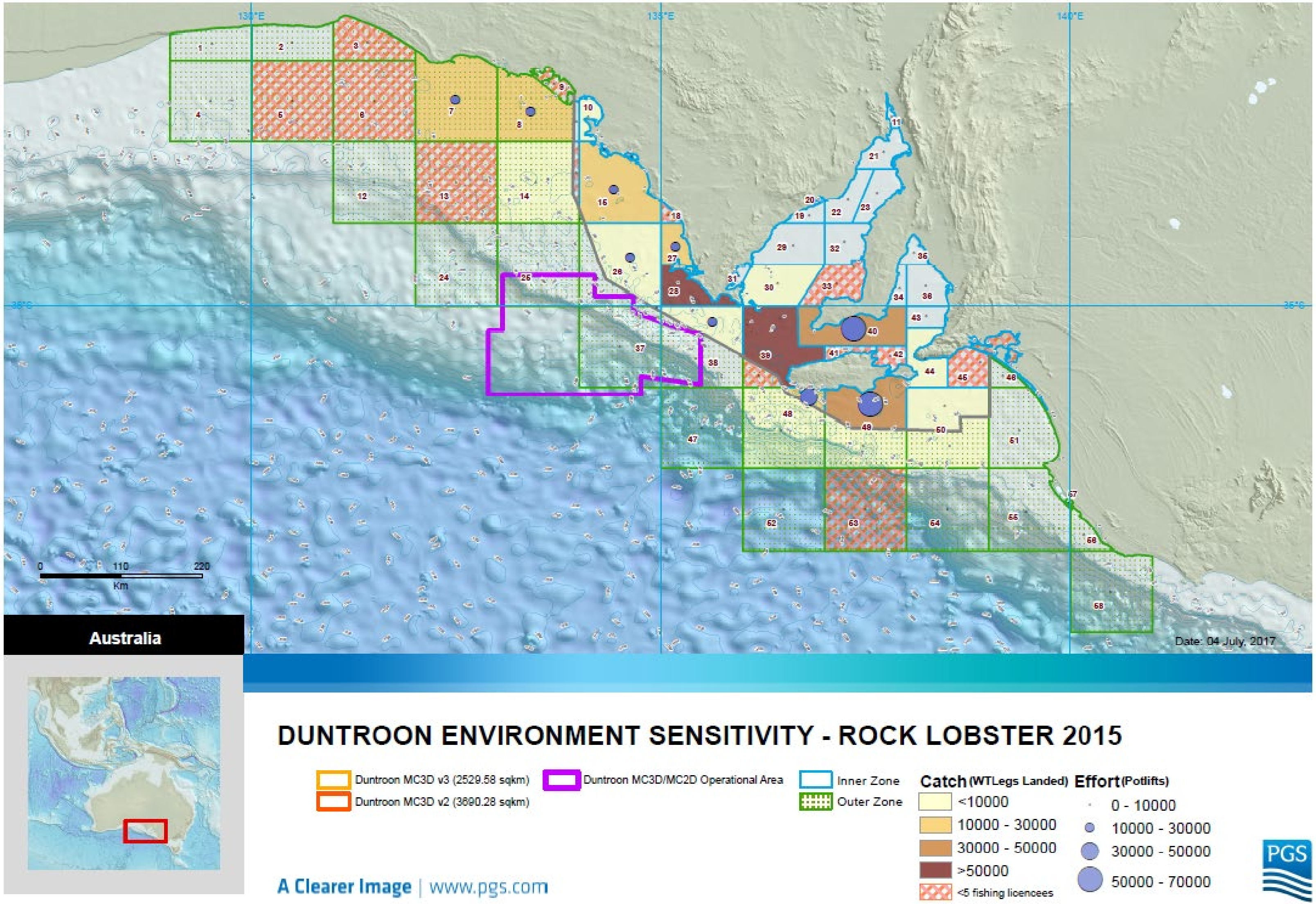


Table 3-43: TAC and Catch 2011 to 2016 (SARDI, 2017; McCleay, 2018)

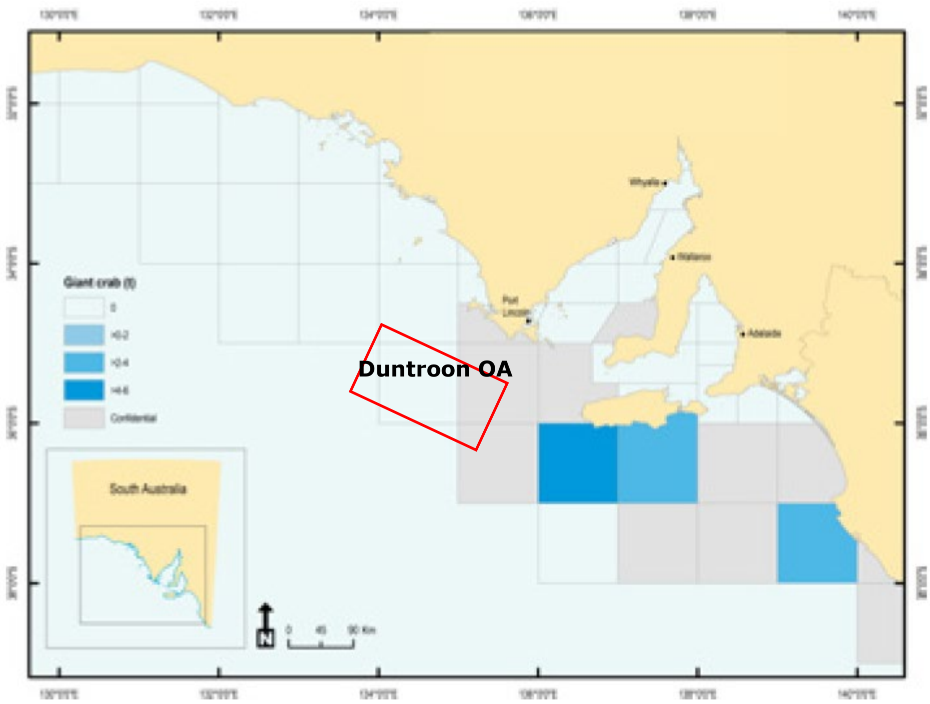
Year	Total Allowable Commercial Catch (tonnes) (whole Fishery)	Northern Zone/Southern Zone Allowable Commercial Catch (tonnes)	NZ/SZ TOTAL Catch (t)
2011	22.1	13.4 / 8.7	11.46 / 8.86
2012	22.1	13.4 / 8.7	13.18 / 9.15
2013	22.1	13.4 / 8.7	10.48 / 6.82
2014	22.1	13.4 / 8.7	11.35 / 5.94
2015	22.1	13.4 / 8.7	15.0 (Total)
2016	22.1	13.4/8.7	16.8 (Total)

Giant crab, from Western Australia to Tasmania, is considered a single biological stock because the species occurs in a continuous distribution across this range. The non-Tasmanian part of the biological stock is not considered to be recruitment overfished, and current levels of fishing mortality are unlikely to cause this part of the biological stock to become recruitment overfished (i.e. stock is sustainable) (FRDC, 2017).

Spawning: Females bear eggs in non-moulting years with clutch size ranging from approximately 0.5 to 2.0 million eggs per year. Mating occurs in June-July and females carry eggs for approximately four months. As hatching approaches (October to November), females are thought to migrate to the shelf-break. The larval duration is around 50 days with dispersal larval release occurring at the edge of the continental shelf (FRDC, 2017). There is a strong capacity for larval dispersal over large spatial scales prior to settlement (PIRSA, 2002).

Giant crabs feed on a range of slow-moving benthic organisms including gastropods, asteroids and decapods including other crabs (PIRSA, 2002).

Figure 3-70: Distribution of commercial catch of Giant Crab in 2013 (PIRSA, 2015)



Legend:

0 tonnes

>0-2 tonnes
>2-4 tonnes
>4-6 tonnes
Confidential

Based on fishing status reports, encounter with giant crab fishermen is possible but unlikely given the small nature of this fishery.

- **Marine Scale-fish Fishery (MSF):** The MSF operates from the SA coastline (including gulf areas) seaward to 200 nautical miles and is managed by SA through an Offshore Constitutional Settlement (OCS) with the Commonwealth Government. The fishery extends from the WA border (Longitude: 129ºE) to the Victorian border (Longitude: 141ºE). Most MSF vessels are small (< 8m) and operationally are restricted to "restricted waters" due to marine transport survey requirements limiting the area where they can operate (mainly to gulfs and embayments) (PIRSA, 2016). Fishing methods engaged in this fishery include hook and line, longline, haulnets, meshnets and jigs (PIRSA, 2016).

  The main features, target species, sustainability and catch statistics of the MSF (primary and secondary species) are provided in Table 3-44. Table 3-44 provides details the primary and secondary species, 2016 catch, catch value and known overlap of individual species within the Duntroon OA based upon the recent Assessment of the South Australian Marine Scalefish Fishery in 2016 (Steer et al, 2018).

  The MSF consists of over 60 species of marine scalefish however most fishing effort is concentrated on four primary species – King George whiting (*Sillaginodes punctata*), southern garfish (*Hyporhampus melanochir*), snapper (*Pagrus auratus*) and southern calamari (*Sepioteuthis australis*). Together these four species accounts for >50% of the total fishery production and 70% of the fishery value with secondary species accounting for approximately 30% of the fishery production (Steer at al, 2018). Most catch originates from the Spencer Gulf and Gulf of St Vincent, except King George whiting where areas west of Spencer Gulf have historically accounted for over 40% of the total commercial catch (PIRSA, 2014).

  Catch within the MSF fishery for the primary target species for MFAs within or surrounding the Duntroon OA over the past five years is provided in Table 3-45 (King George whiting), Table 3-46 (snapper), Table 3-47 (southern garfish) and Table 3-48 (southern calamari). Figure 3-72, Figure 3-73, Figure 3-74 and Figure 3-75 provides the 2016 catch and effort for the primary target species of King George whiting, snapper, southern garfish and southern calamari respectively relative to the Duntroon OA. This data indicates that only low-level effort in the King George whiting and snapper fishery is undertaken in the eastern section of the survey area (MFA-38). There is no overlap of the Duntroon OA with the southern garfish, southern calamari or secondary species fishing grounds. These trends have been consistent for the past 5 years.

  The MSF management arrangements do not operate on a Total Allowable Catch (TAC) basis, instead operating to reference performance indicators (total catch range, greatest percentage interannual change, greatest 5-year trend and decreases over 5 consecutive years) which act as triggers for management review of fishery arrangements. For key target species (King George Whiting and Snapper), biological performance indicators are measured and include fishable biomass, harvest fraction, recruitment and age composition parameters (Steer et al, 2018).

  MSF species are accessed by both commercial and recreational fisheries which are allocated a percentage of the total catch to maintain fish stock sustainability under the *Management Plan for the South Australian Commercial Marine Scalefish Fishery* (PIRSA, 2013). Tertiary species, which have a low to medium value, only make a minor contribution to the total MSF production value and have not been allocated within the MSF Management Plan. Table 3-51 provides a summary of the King George Whiting and snapper fishery's current performance indicators. Spawning details on key target species is provided in Table 3-49. Both gulfs contain significant areas of seagrass meadows, salt marshes and mangroves which are all recognised nursery areas for key commercial species such as King George whiting, southern garfish, blue swimmer crabs and western king prawns (PIRSA, 2013). Primary production in the more sheltered parts of the gulfs, as well as embayment's off the west coast of the

Eyre Peninsula and the north coast of Kangaroo Island, is dominated by seagrass species that occur at depths of about 20 m (in clear waters) and 10 m (in gulf waters). Key habitats types associated with the life history stages of primary MSF species is provided in Table 3-50.

Table 3-44: Main Features and Statistics of the Marine Scalefish Fishery

Feature	Description		
Primary Landing Port	Ceduna, Port Lincoln, Kingscote, Ellison, Coffin Bay, Cape Jervis, Yankalilla, Port Pirie, Port Broughton, Adelaide, Ardrossan, Moonta, Thevenard, Port Hughes Historically the fishing effort has been concentrated in the Gulf of St Vincent and Spencer Gulf		
Management Methods	Licences (limited entry), gear restrictions, spatial and temporal closures, legal minimum size limits, individual transferrable quotas (some species). Licences issued for 10 years.		
Industry Representation	Marine Fishers Association of South Australia (MFASA)		
Fishing Season	1 July to 30 June (Quota year)		
Encounter Rate	Low encounter rate.		
Licences:	TOTAL: 308 Marine Scalefish and 6 Restricted Scalefish Licences (2016)		
Active Vessels:	King George Whiting Fishery: 280 (2015) Snapper Fishery: 150 (2015) Southern Garfish Fishery: 98 (landing) (2015) Southern Calamari Fishery: NS		
Method	King George Whiting Fishery: Handline Snapper Fishery: Handline/longline Southern Garfish Fishery: Haulnet/dabnet (haulnets limited to water depths < 5m) Southern Calamari Fishery: Jig/haulnet Note: There is a diverse range of gear type across the fishery (21). Dominant gear types are hook and line, longline, haulnets, mesh nets and jigs. Different regulations and licence conditions govern use of fishing gear for different species.		
OA overlap with MFA 38 Fished Area (km^2) Area of MFA38 – 10,063.75 km^2	King George Whiting Fishery: 3,703 km^2 (OA): Snapper Fishery: 3,703 km^2 (OA) Southern Garfish Fishery: Nil Southern Calamari Fishery: Nil		
Catch Effort in Duntroon OA	King George Whiting: Confidential < 5 Licencees in the area during year Snapper Fishery: Confidential < 5 Licencees in the area during year Southern Garfish Fishery: Nil Southern Calamari Fishery: Nil		
Fishery Statistics	2016 Fishing Season		
Stock (Target species – Primary/Secondary)	Total Commercial Catch (Tonnes)	Real Value ($M)	Presence in Duntroon OA /Primary Fishing period (Steer et al, 2018)
Primary Target Species			

King George whiting (Primary)	287	4.6	Spatial overlap in MFA38. Fishing Effort Confidential < 5 Licencees. Adjacent MFA39 had annual effort of 49 mandays. *Peak Fishing Season (Winter – May to September, peaking in July)*
Snapper (Primary)	382	3.8	Spatial overlap in MFA38. Fishing Effort Confidential < 5 Licencees. Adjacent MFA28 had annual effort of 40 mandays *Relatively high levels of fishing effort throughout the year peaking in autumn and late spring.*
Southern calamari (Primary)	444	4.7	No spatial overlap with Duntroon OA
Southern garfish (Primary)	155	1.4	No spatial Overlap with Duntroon OA.
Secondary Target Species (PIRSA, 2013), Spatial Overlap Data (Steer et al, 2018)			
Shark (Bronze Whaler & Dusky)	50	0.2	No spatial overlap with Duntroon OA
Australian Salmon (TAC 1100t)	370	0.8	No spatial overlap with Duntroon OA
Sand Crab	48.4	0.35	No spatial overlap with Duntroon OA.
Yellowfin whiting	114.6	0.85	No spatial overlap with Duntroon OA.
Blue Swimmer crabs	31.2	0.29	No spatial overlap with Duntroon OA.
Australian herring	93.5	0.35	No spatial overlap with Duntroon OA.
Vongole (Mud cockle)	66.1	0.87	No spatial overlap with Duntroon OA.
Snook	53.5	0.6	No spatial overlap with Duntroon OA.
Yelloweye mullet	12.5	0.15	No spatial overlap with Duntroon OA.
Mulloway	<6	<1	No spatial overlap with Duntroon OA.
Other	30.1	-	
TOTAL	2143.9	-	
Source: SARDI (2017); PIRSA (2016), Fowler et al (2014), Fowler et al (2016), Fowler et al (2015), Econosearch (2016), PIRSA (2013), Steer et al (2016); Steer et al (2018)			

Figure 3-71: Catch of selected major Marine Scalefish species SA, 2000/01-2014/15 (Econsearch, 2016)

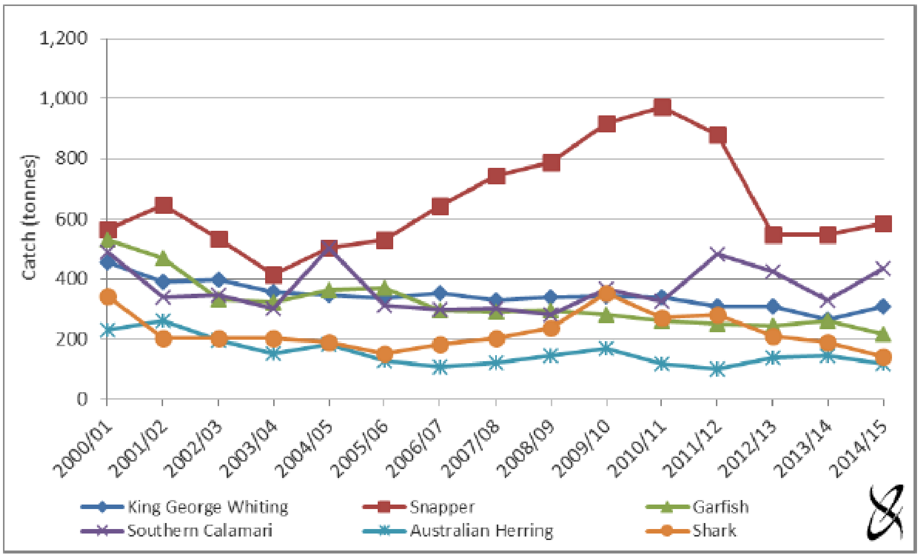


Table 3-45: King George Whiting Catch Data (kg) (2012-2016) (SARDI, 2017)

MFA	2012	2013	2014	2015	2016	Average (relevant MFAs)
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0
28	65	n/a	233	n/a	n/a	149/na
37	0	0	n/a	0	0	0/na
38	n/a	0	n/a	n/a	n/a	0/na
39	214	n/a	n/a	593	886	564/na
47	0	0	0	0	0	0

Table 3-46: Snapper Catch Data (kg) (2012-2016) (SARDI, 2017)

MFA	2012	2013	2014	2015	2016	Average (relevant MFAs)
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	n/a	n/a	n/a	0	0	0/na
28	n/a	533	n/a	580	1036	716/na
37	0	0	0	0	0	0
38	n/a	0	n/a	0	n/a	0/na
39	n/a	341	n/a	n/a	n/a	341/na
47	0	0	0	0	0	0

Table 3-47: Southern garfish Catch Data (kg) (2012-2016) (SARDI, 2017)

MFA	2012	2013	2014	2015	2016	Average (relevant MFAs)
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0
28	n/a	n/a	n/a	n/a	0	0/na
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	n/a	n/a	0/na
47	0	0	0	0	0	0

Table 3-48: Southern calamari Catch Data (kg) (2012-2016) (SARDI, 2017)

MFA	2012	2013	2014	2015	2016	Average (relevant MFAs)
24	0	n/a	0	0	n/a	0/na
25	0	0	0	0	0	0
26	n/a	n/a	0	0	0	0/na
28	n/a	n/a	n/a	n/a	n/a	na
37	0	0	0	0	0	0
38	n/a	0	n/a	0	0	0/na
39	n/a	n/a	0	n/a	0	0/na
47	0	0	0	0	0	0

Legend:

	MFAs within Duntroon MSS OA

MFAs adjacent to Duntroon MSS OA

Table 3-49: MSF Primary Target Species – Spawning Details

Species	Spawning Characteristics
King George whiting (*Sillaginodes punctata*)	Juveniles are found in shallow waters to 20m water depths, whilst adults are found in a variety of habitats to depths of 50m or greater. Nursery areas are shallow protected bays where post-larvae arrive during winter and spring each year. Spawning (multiple) occurs at offshore reefs, shoals and mounds in relatively deep water (~40 m water depths) in exposed localities that experience medium/high wave energy (Steer et al, 2018). The key spawning areas lie within the entrance to the SA gulfs which can reach 60 m water depth and experience periodic fishing closures (pers.com M. Steer, February 2018). The eggs and larvae are advected to nursery areas in shallow protected bays located in the northern gulfs, bays and Kangaroo island (Steer et al., 2018). Spawning typically occurs between late February and June with peaks in mid-April (PIRSA, 2013).
Southern garfish (*Hyporhampus melanochir*),	Schooling species found in shallow inshore marine waters and are abundant in the two gulf regions of South Australia. Spawning throughout the SA gulfs extends from October to March (PIRSA, 2013).
Snapper (*Pagrus auratus*)	Snapper are multiple batch spawners which spawn over consecutive days (Fowler et al, 2016). Spawning occurs in the northern Spencer Gulf in late November, peaks in December and finishes in early February. A 1-month lag in these spawning dates occurs in the southern Spencer Gulf and occurs in waters less than 50m (PIRSA, 2013).
Southern calamari (*Sepioteuthis australis*).	Species is found in coastal waters usually in depths less than 70m. Females are serial spawners and spawning occurs throughout the year. Eggs are preferentially attached to seagrass and macro-algae however they are also known to lay eggs on low rocky reefs and sand. Species follows a generalised anti-clockwise pattern of spawning within the Gulf of St Vincent with spawning occurring in late spring (Kangaroo Island) continuing in a clockwise direction to Edithburgh where spawning occurs in late winter (PIRSA, 2013).
Vongole (*Katelysia scalarine, K. peronei & K. rhytiphora*)	A clam species found in sheltered, sandy sub-tidal sediments of estuaries and tidal flats. *No expected presence in Duntroon OA*.
Australian herring (*Arripis georgianus*)	Species are usually found in bays and estuaries over seagrass beds or near areas of seaweed (kelp) on rocky reefs and ocean beaches. Spawning commences in April and continues into June in WA (Kailola et al., 1993). *No expected presence in Duntroon OA*
Australian salmon (*Arripis truttaceus*)	Species inhabit continental shelf waters including estuaries, bays and inlets. They school in shallow open coastal waters and can move over reefs in depths just sufficient to cover their bodies but have also been caught in water depths to 80m. Spawning areas for the species occur in eastern Bass Strait (November to February) and Albany-Busselton (February to June) (Kailola et al., 1993). *No expected presence in Duntroon OA*
Yellowfin whiting (*Sillago schomburgkii*)	Species generally frequents inshore sandbanks and sandbars and the mouths of estuaries in shallow water (1-10m depth). Juveniles inhabit warmer water, mangrove –lined creeks and inshore areas. Spawning occurs between December and February (Kailola et al., 1993). *No expected presence in Duntroon OA*

Table 3-50: Key Habitats associated with Life History Stages of Primary MSF Species (PIRSA, 2013)

Life Stage	King George Whiting	Snapper	Southern Garfish	Southern Calamari
Early Juveniles (0+ age group) Nursery Areas	Sheltered Bays, tidal creeks with seagrass patches	Fine mud substrate, deeper gulf waters	Sheltered bays, tidal creeks, seagrass beds of both gulfs	Bare sand substrate in deeper waters of both gulfs
Sub-adults	Seagrass beds (patchy to dense)	Natural and artificial reefs	NA	NA
Adults (i.e. spawning or feeding areas)	Offshore low profile reefs, sponge/bare sand	Natural and artificial reefs, inshore mud substrate	Seagrass and algal beds	Seagrass and algal beds, low profile reefs

Table 3-51: MSF Fishery Performance Indicators (State Indicators[25])

Performance Indicator	Type	Trigger Reference Point	King George Whiting [1]	Snapper [1] [2]
Total Catch	G	3rd Highest and 3rd Lowest Values	2nd Lowest Lowest Catch in 2014: 281 t	Lowest [26]
	G	Greatest % inter-annual variation over reference period[27]	×	×
	G	The greatest rate of change over a 5-year period[28]	×	×
	G	Decline over the most recent 5 consecutive years	×	×
Fishable Biomass	B	3-year average is ± 10% of previous year	16.7% above	23% above
Harvest Fraction	B	>28% (Int.Std – KGW) >32% (Int. Std – Snapper)	×	× (5.1%)
Recruitment	B	± 10% of average of previous 5 years	× (+5.6%)	
Age Composition	B	Change in long-term or previous 5 years	×	
Recruitment	B	3 yr average ± 10% of average of historical mean		+37%
Recruitment	B	3 yr average ± 10% of average of previous 6 yr ave.		+19%
Age Composition	B	Proportion >10 years <20% fished population		× (19%)

Legend:
X – Indicates that Performance indicator has not been triggered.
References:
1. Steer et al (2018)
2. Fowler et al (2016)

- **South Australian Sardine Fishery (SASF):** The sardine fishery operates in all SA waters adjacent to the edge of the 200 nm AFZ targeting *Sardinops sagax* (pilchards) (98% of the catch). Sardines are the dominant clupeid off SA occurring in the southern portions of the Gulf of St Vincent and Spencer Gulf and over the continental shelf. The species feeds on phytoplankton and zooplankton (Ward et al., 2017)

  The fishery is defined in two spatial management zones – the outside zone (OZ) and Gulf zone (GZ). This definition is provided in Figure 3-76. The intra-annual sardine catches for fishing regions according to the OZ/GZ is provided in Figure 3-76. Since 2010, catch from the GZ has been capped at 27,000 tonnes of 30,000 tonnes (Ward et al, 2017). This data identifies that most of the catch is taken from within the GZ all years. However, since 2010 when additional quota was allocated outside Spencer Gulf, catch has been taken from Investigator Strait, Gulf St Vincent and waters between Anxious Bay and Flinders Island (near Elliston on the Eyre Peninsula) (Ward et al. 2015). Catches from the OZ since 2014 have ranged between 6,500-8,000 tonnes (refer Figure 3-77) (Ward et al, 2017).

  In SA, the movement pattern of sardines are largely unknown however there is evidence that older fish mostly inhabit the shelf waters and smaller younger fish are mainly found in embayments including Spencer Gulf (Ward et al., 2012).

  The sardine catches and effort data for MFAs adjacent to or within the Duntroon MSS OA for 2016 is provided in Figure 3-79. Sardine fishing has been present, on a low effort basis, in MFA 26 during 2015

[25] The Duntroon OA is not located in any of the specific stock status regions separately assessed within stock assessment reports for King George Whiting and snapper. State statistics have been used where available or consolidated based upon status regions (Fowler at al. 2016).
[26] Previous Total Catch: 2nd Lowest (2003: ~420 t); 3rd Lowest (004: ~440t)
[27] Greatest % Interannual: King George Whiting (1998/99); Snapper (2011/12) (Steer et al, 2018)
[28] Greatest Rate of Change over 5-year period: King George Whiting (1998-2002); Snapper (2010-2015) (Steer et al, 2018)

and 2016 where there is a small spatial overlap with the Duntroon MSS OA. The Duntroon MSS OA also overlaps MFA 38, in the eastern portion of the Duntroon MSS OA, where low level fishing (<5 licences) occurs based upon fishing data in Table 3-53. The main features of the sardine fishery are provided in Table 3-52. Figure 3-80 provides a more granulated representation of spatial fishing trends. Data within this figure identifies that 50 tonnes of sardines were catught within the Duntroon OA in 2016.

The harvest strategy for the fishery based on the size of the spawning biomass and the levelof monitoring and assessment (Ward et al, 2017). The fishery TACC is maintained within a spawning biomass target range. The spawning biomass (SpB) is the primary biological performance indicator managing TACCs and maintaining sustainability within the fishery. A SpB target reference point (TRP) of > 150,000 t is considered 'sustainable'. This TRP has been selected because historically the stock has been shown to be stable above this level; and in consideration of ecosystem impacts, any impacts would be relatively minor on ecologically dependent species (such as marine mammals and seabirds) at this level (Goldsworthy et al, 2013 in PIRSA, 2014). The limit reference point (LRP)[29] has been set at 0.5 TRP (75,000 t). Sardine stock has been shown to recover twice from mass mortality events that drove the fishery to an estimated biomass lower than 75,000 t. In these instances, the fishery recovered from this level relatively quickly. This has provided the evidence that the LRP has been set at a conservative level. The fishery also operates under a maximum harvest exploitation rate of 25% established by examining historical rates within the fishery. Correspondingly, TACCs within the sardine fishery can vary on an annual basis between 47,500 t (SpB > 190,000 t) to 10% SpB for 100,000 t > SpB > 75,000 t, however the Management Plan sets limits on the level of increase in TACC which can occur between sequential years (PIRSA, 2014). Based on fisheries assessments, TACCs have increased from 30,000 t (2007-09), to 34,000 t (2010-2014), to 38,000 (2015 to 2016) and 42,750 t (2017) (Ward et al., 2017). The TACC for 2007 of 42,750 tonnes includes 30,000 tonnes from the GZ and 12,750 tonnes from the OZ (Ward et al, 2017).

The estimates spawning biomass for 2017 of 305,000 tonnes[30] (95% CI 177,000-521,000) is the largest obtained for the southern stock of sardines. Utilising an age structure model, the spawning biomass is approximately 236,000 tonnes (Ward et al, 2017). Accordingly, the spawning biomass for 2017 is above the target reference point of 15,000 tonnes and above the upper reference point of 190,000 tonnes detailed in the harvest management strategy for the SASF (Ward et al, 2017).

[29] LRPs define the values of a performance indicator for a stock that are not considered acceptable and where a stock has become recruitment overfished.

[30] Obtained using the Daily Egg Production Method.

Figure 3-72: Distribution of, and total commercial catch of King George Whiting in 2016 (SARDI, 2017)

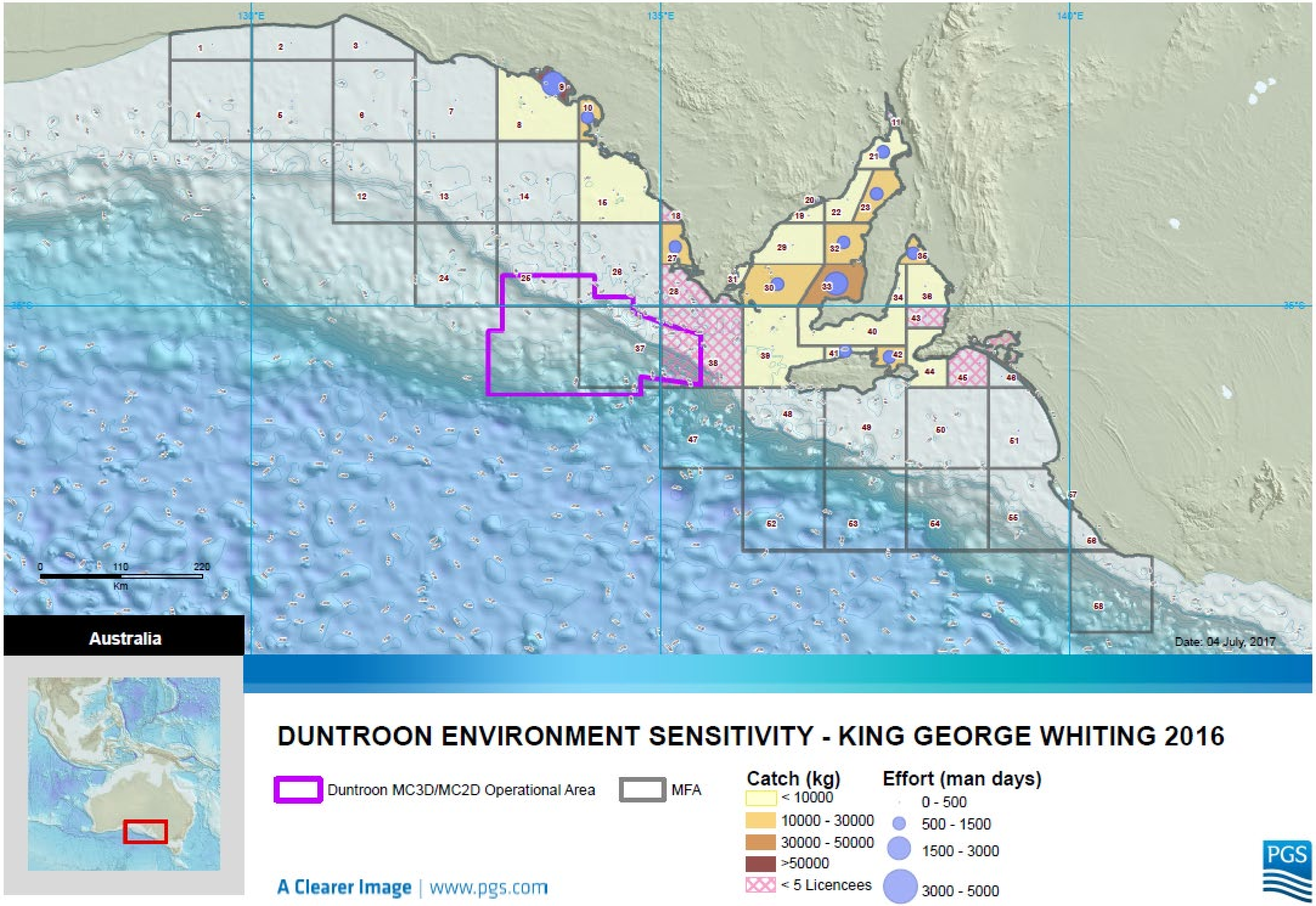


Figure 3-73: Distribution of, and total commercial catch of snapper in 2016 (SARDI, 2017)

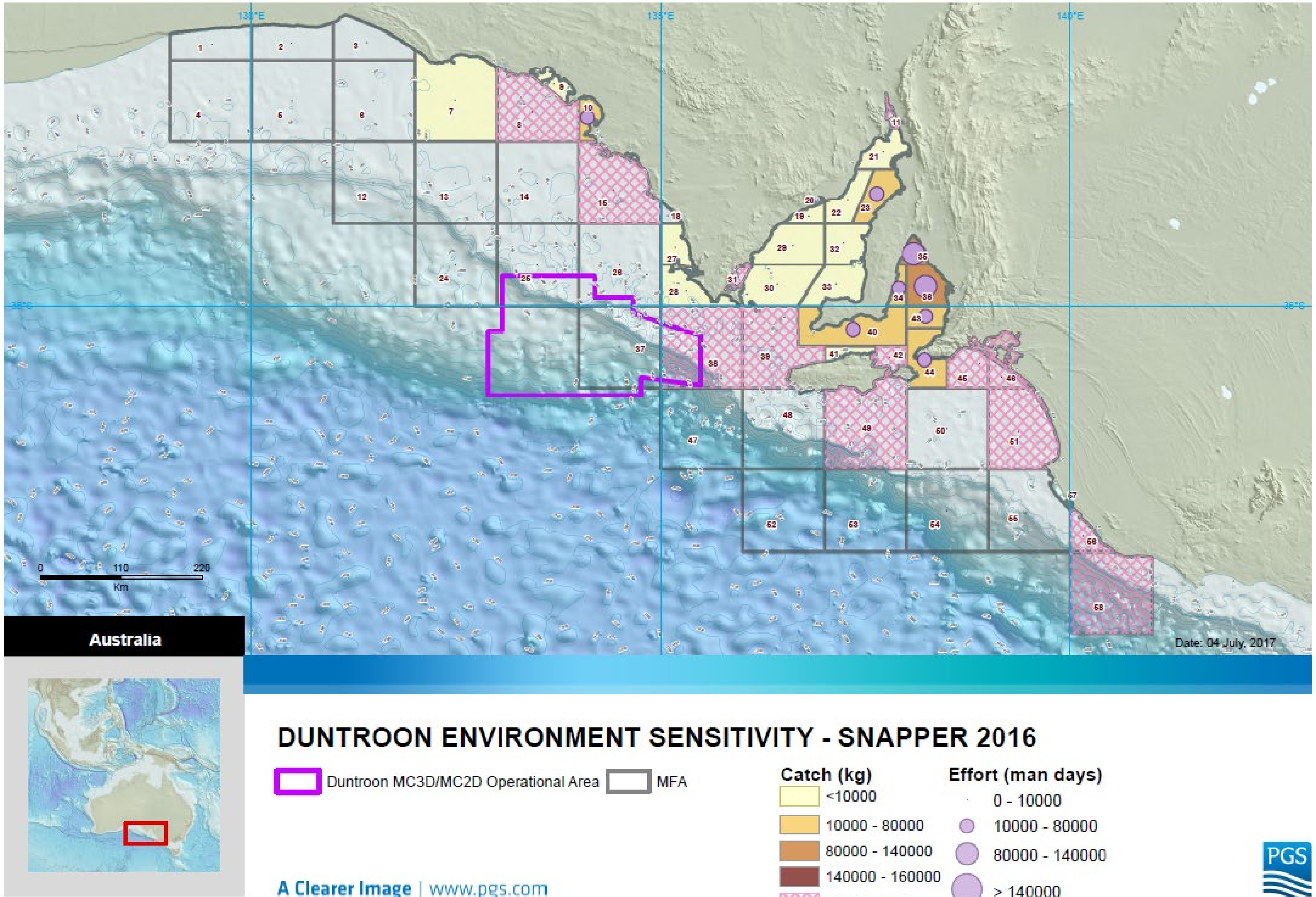


Figure 3-74: Distribution of, and total commercial catch of southern garfish in 2016 (SARDI, 2017)

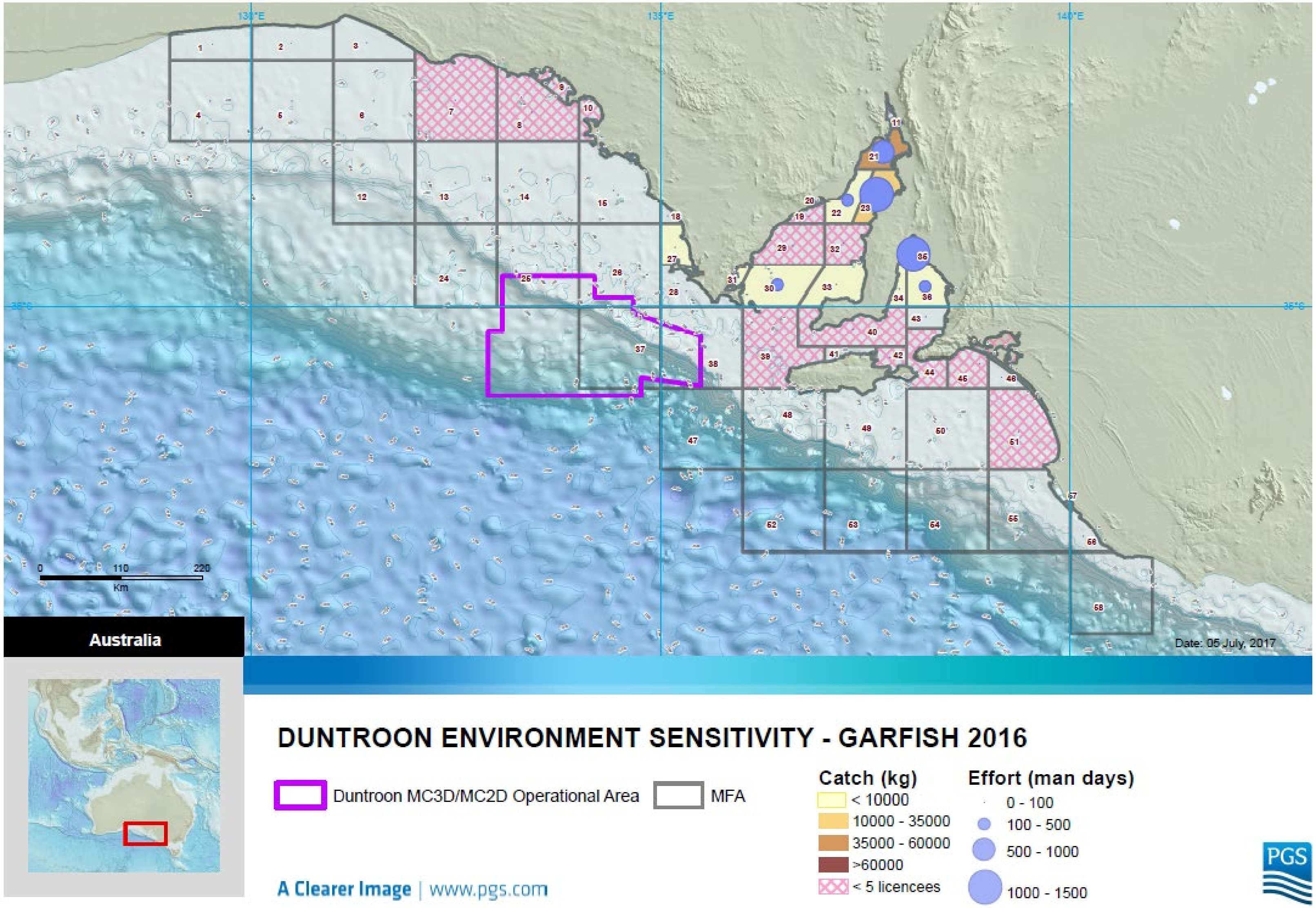


Figure 3-75: Distribution of, and total commercial catch of southern calamari in 2016 (SARDI, 2017)

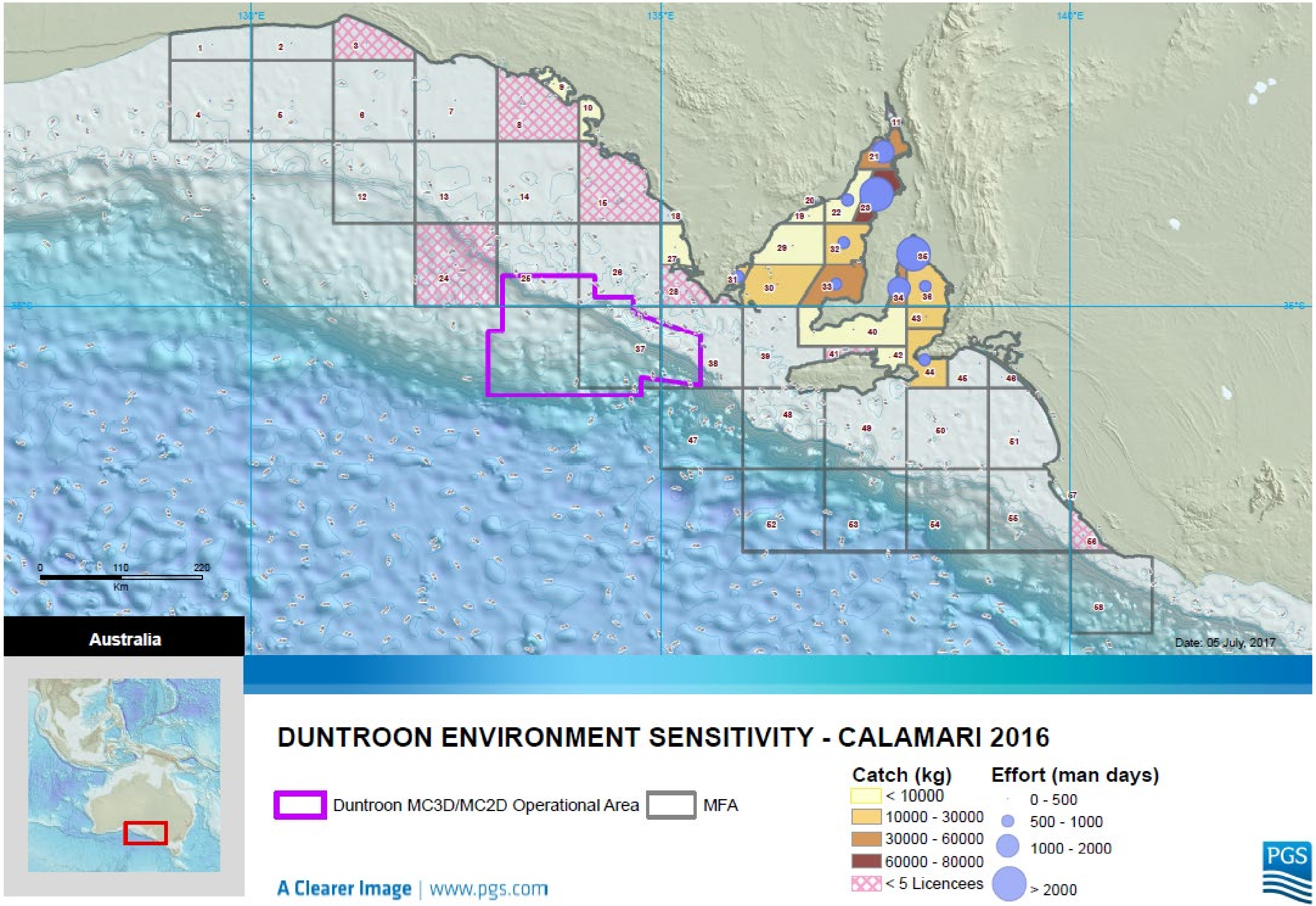


Table 3-52: Main Features and Statistics of the Sardine Fishery

Feature	Description
Primary Landing Port	Port Lincoln
Management Methods	Limited entry fishery (Licences)/TACC/Gear Restrictions
Industry Representation	South Australian Sardine Industry Association (SASIA)
Fishing Season	1 January to 31 December (Quota year). Seasonality: Relatively little fishing is usually conducted between August to October. Effort and catch begins to increase in November/December and continues to increase during January-February and usually peaks in March to June (Ward et al, 2017).
Encounter Rate	Low encounter rate.
Licences:	14 Licence Holders
Active Vessels:	Not Available
Method	Purse Seine or pilchard net
Total Area Fished in 2016 (km^2)	55,622 km^2 ***Note:*** *Sardine catch (tonnes) in the Duntroon OA from the latest sardine stock assessment identified 50 tonnes caught in the OA area (Ward et al, 2017) (refer* Figure 3-80*)*
OA overlap with Fished Area (km^2)	1,237 km^2 (MFA-26). MFA 26 has a total area of 10,184 km^2. 3,703 km^2 (MFA-38). MFA 38 has a total area of 10,063.75 km^2.
Catch effort in Duntroon OA	MFA26 – 75 shots per annum (minor effort) MFA38 – Confidential < 5 licencees per annum (Adjacent MFA 39 Effort) – 157 shots per annum (low effort)

Fishing Statistics	2014/15 Fishing Season			2015/16 Fishing Season	
Target Species	TAC (Tonnes) (Calendar Year)	Catch (tonnes)	Real Value ($M)	TAC (tonnes)	Catch (tonnes)
Sardines/pilchards (*Sardinops sagax)*	34,000	32,690	21.6	38,000	36,410
TOTAL	-	32,690	21.6	38,000	36,410
Source: SARDI (2017); Econsearch (2016b); Ward et al (2015); FRDC (2018); Ward et al (2017)					

Figure 3-76: Two spatial management zones defined in the harvest strategy for the SASF (Ward et al., 2015)

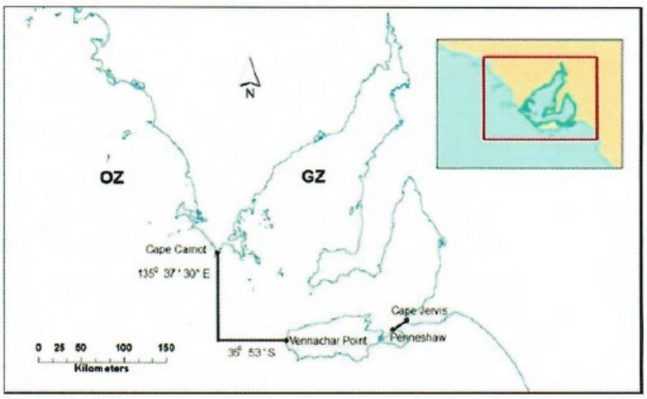


Figure 3-77: Annual Sardine Catch (tonnes) by zone between 1992 and 2016 (Ward et al, 2017)

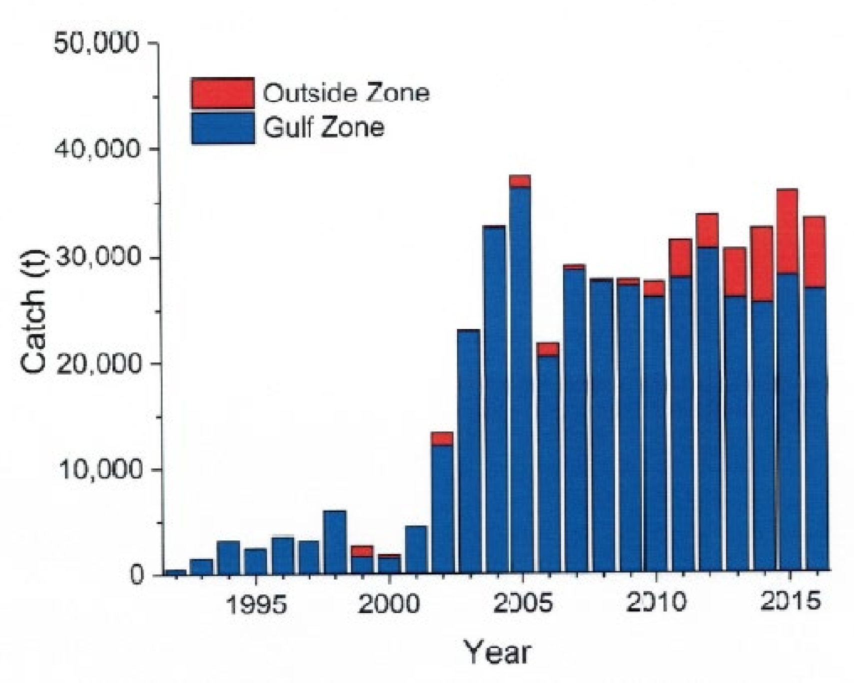


Table 3-53: Sardine Catch Data (tonnes) (2012-2016) (SARDI, 2017)

MFA	2012	2013	2014	2015	2016	Average (relevant MFAs)
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	n/a	n/a	n/a	2568	3162	2865/na
27/28	508	1960	3682	3482	1786	2284
37	0	0	0	0	0	0
38	n/a	n/a	n/a	0	n/a	0/na
39	2936	5471	1612	1137	8206	3872
47	0	0	0	0	0	0

Legend:

	MFAs within Duntroon MSS OA
	MFAs adjacent to Duntroon MSS OA

Spawning: Sardines are serial spawners in open waters between the coast and shelf break (mid-shelf waters) and in proximity to gulf areas during summer-autumn coinciding with upwellings (January to March). During this period females spawn 10,000-30,000 pelagic eggs each week. Eggs are abundant in the southern gulf and shelf waters over this period each year as observed in Figure 80 and Figure 81 which provides the distribution and abundance data for eggs collected in January to March for the periods 2014 and 2016 (Ward et al., 2012; Ward et al. 2014). The eggs hatch approximately 2 days after spawning and then undergo a relatively long larval period of 1-2 months. In SA, sardine eggs and larvae are usually abundant at temperature and salinity fronts that form near the mouths of two gulfs during summer and autumn (Bruce and Short, 1990) and in mid-shelf waters off the southern Eyre Peninsula. Egg abundance figures identifies the Duntroon MSS OA does not lie in an area of significant levels of spawning.

Figure 3-78: Intra-annual patterns in sardine catch by region and effort in the South Australian sardine fishery for the period 1999-2016 (Ward et al., 2017)

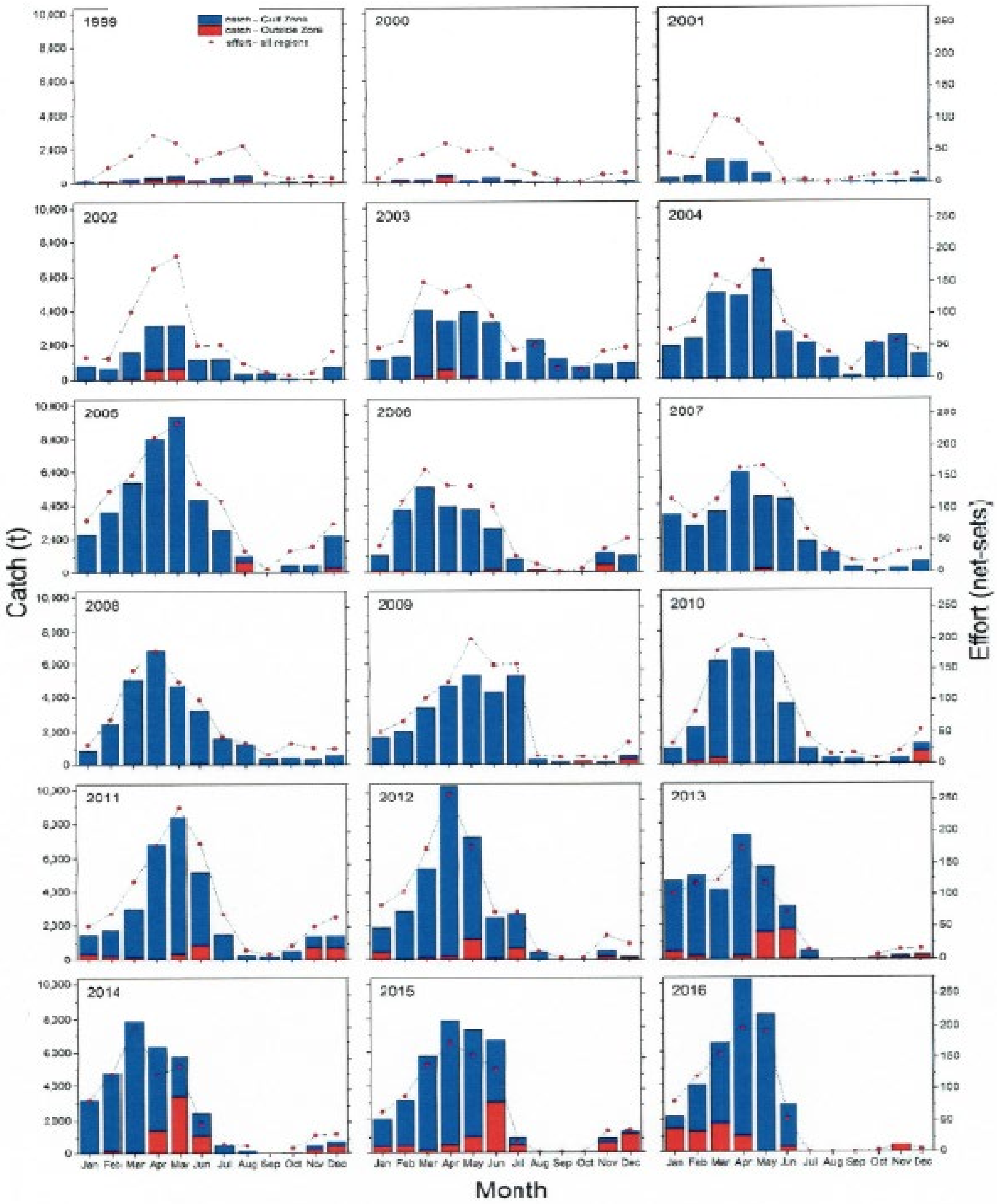


Figure 3-79: Distribution of commercial catch of Australian sardine in 2016 (SARDI, 2017)

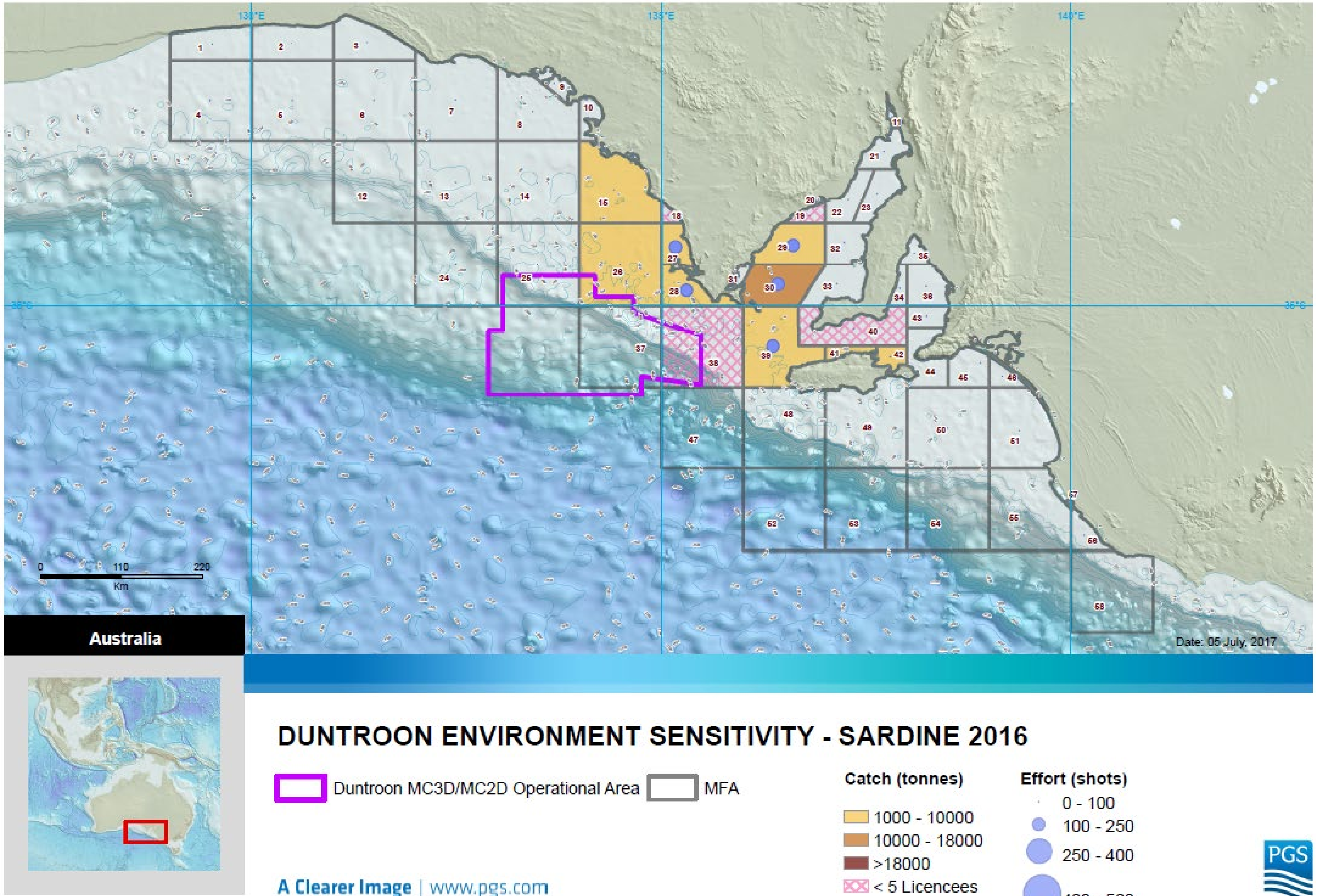


Figure 3-80: Spatial trends in sardine catch (tonnes) between 2008 and 2016 (Ward et al, 2017)

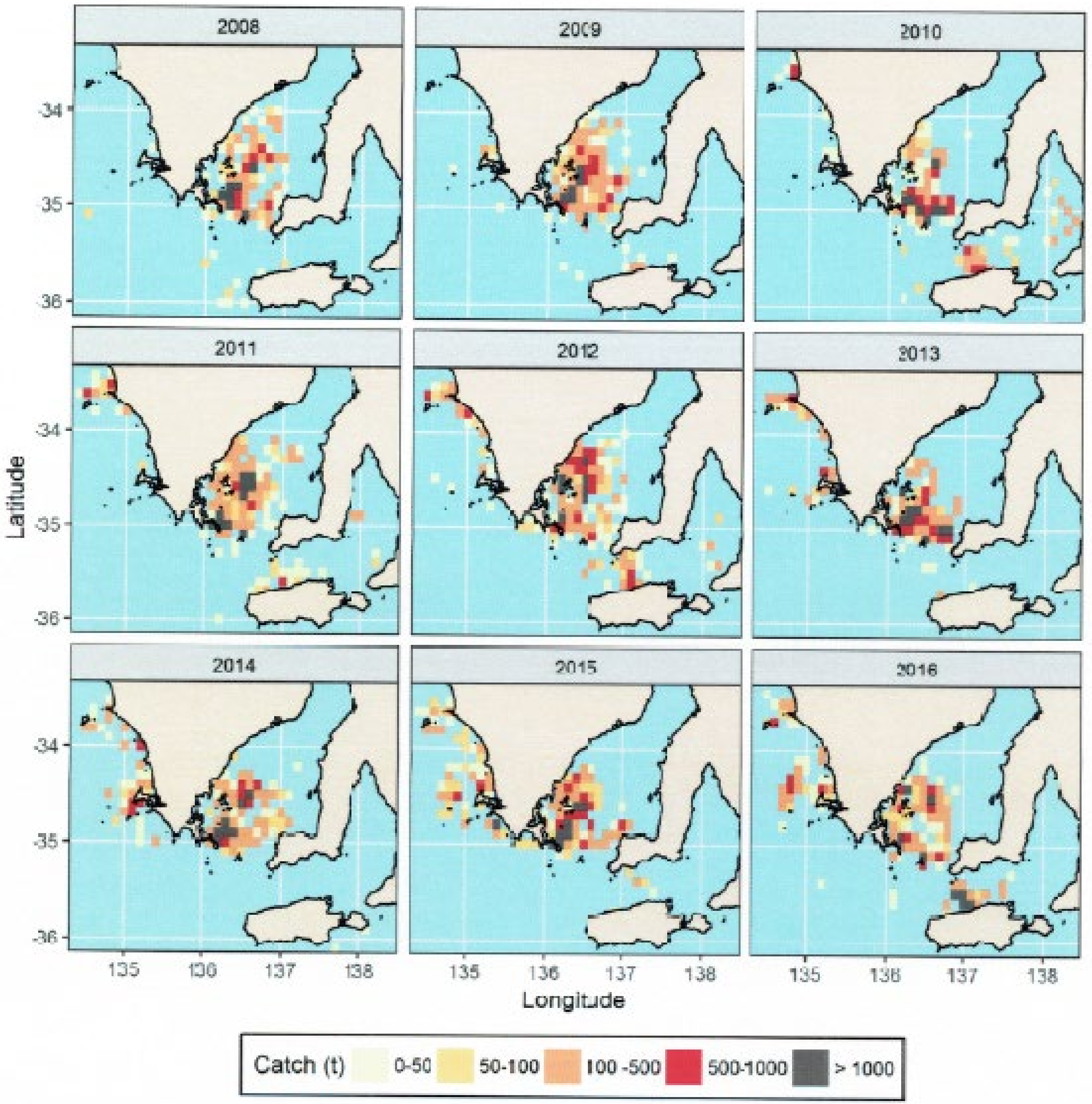


Figure 3-81: Distribution and abundance of live sardine eggs between February and April 2014 (Ward et al., 2014)

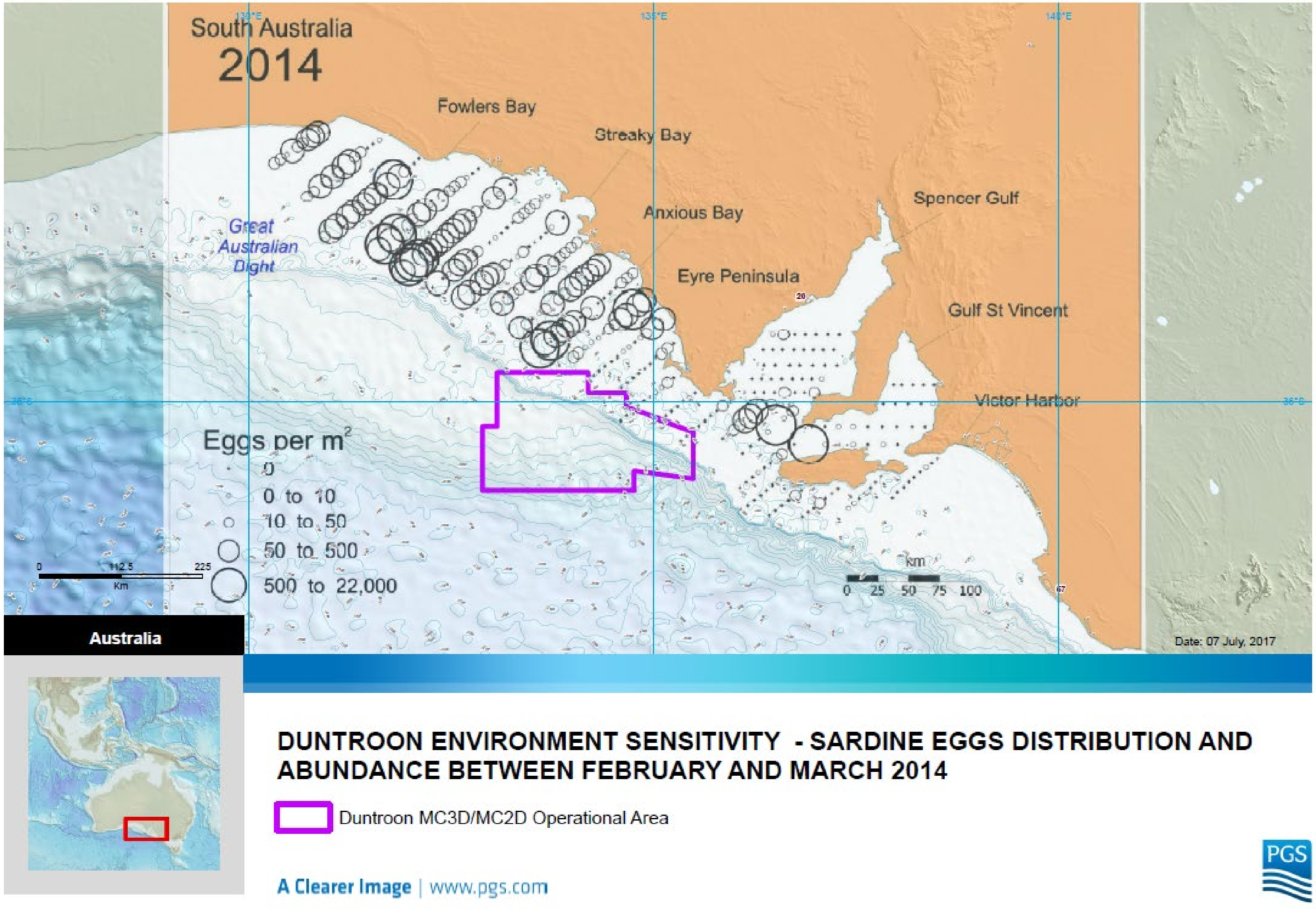
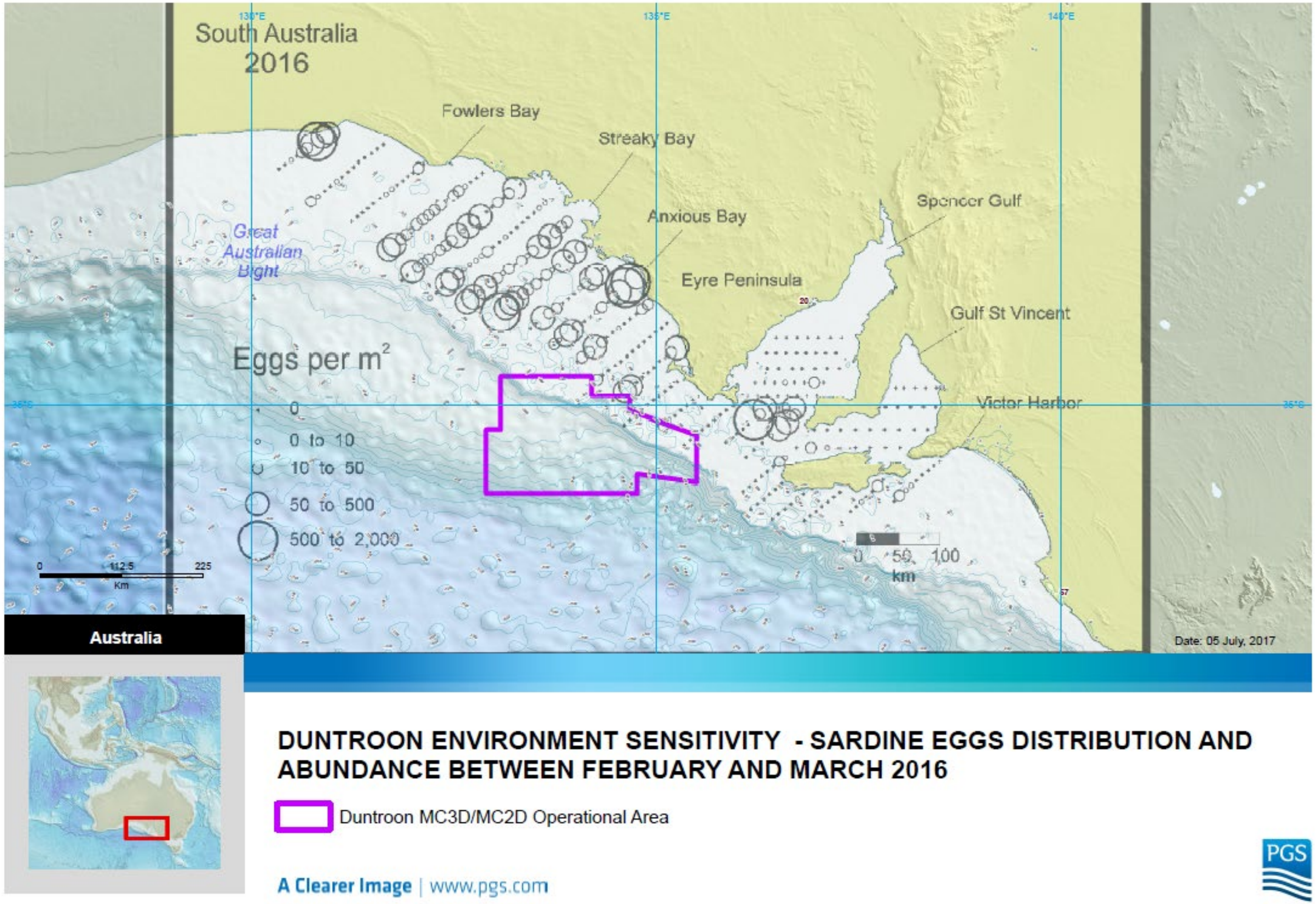


Figure 3-82: Distribution and abundance of live sardine eggs between February and March 2016 (Ward et al., 2016)



- **South Australian Abalone Fishery**: This fishery consists of three regions – the southern, central and western fishery. The Duntroon survey OA overlaps the western fishery zone (refer Figure 3-83). Abalone is a univalve marine gastropod that inhabits near-shore reefs throughout the waters of South Australia. Abalone are found in a range of habitats, but prefer cold water masses ranging between 9-14°C.

  The main features of the SA abalone fishery are provided in Table 3-54.

Figure 3-83: South Australian Abalone Fishery Zones (PIRSA, 2012)

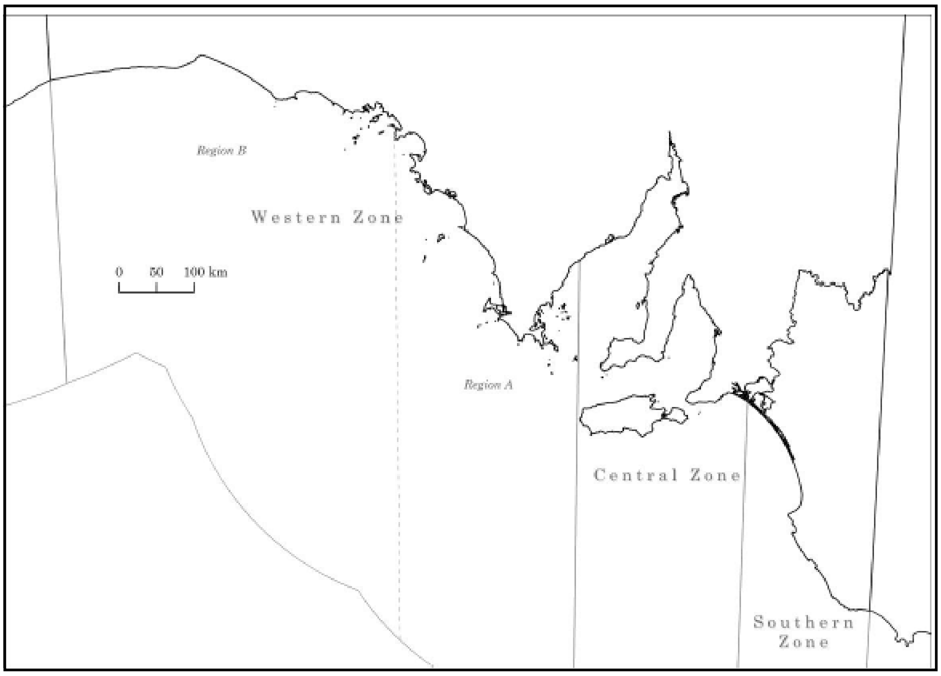


Table 3-54: Main Features and Statistics of the Western Zone Abalone Fishery

Feature	Description			
Primary Landing Port	Port Lincoln, Streaky Bay, Elliston			
Management Methods	Limited Entry Fishery / Annual TACC			
Industry Representation	Abalone Industry Association of SA			
Fishing Season	1 January to 31 December (Quota season).			
Encounter Rate	No encounter expected			
Licences:	22 Licence Holders			
Active Vessels:	22			
Method	Small boats using Hookah (a long hose delivering air to the diver from a deck-mounted compressor).			
Total Area Fished in 2017 (km²)	Not Applicable to Duntroon survey			
OA overlap with Fished Area (km²)	Nil			
% Catch in Duntroon OA	Nil			
Fishery Statistics (Western Zone)				
Year	TAC (Tonnes) (Blacklip/Greenlip)	Catch (tonnes)	Real Value ($M)	Stock Sustainability (Exploitation Rate (TAC) as % spawning biomass)
2011/12	-	-	30.8	Sustainable

2012/13	89.93/73.37	89.04/72.36	30.9	Sustainable
2013/14	84.08/73.01	82.41/71.74	22.4	Sustainable
2014/15	84.08/73.01	65.85/68.88	25.2	Sustainable
2015/16	74.58/73.01	66.83/69.64	-	Transitional Depleting (blacklip)/ Sustainable (greenlip)
Source: Econsearch (2016c), Stobart et al. (2012), Stobart et al (2017)				

The fishery is present along the coast of the Eyre Peninsula (refer Figure 3-83). In 2011:

- Most of the blacklip abalone catch was harvested from Drummond (24%), Sheringa (16.3%), Reef Head (9.2%), Avoid Bay (6.6%), Point Westall (6.6%) Searcy Bay (6.3%) and Anxious Bay (5.7%) (Stobart et al., 2012); and
- Most of the greenlip abalone catch was harvested from Anxious Bay (13.5%), The Gap (10.5%), Point Avoid (8.3%), Reef Head (8.3%), Avoid Bay (6.5%), Drummond (6.4%), Taylor Island (5.9%) and Flinders Island (5.8%) (Stobart et al., 2012).

The closest abalone area to the Duntroon OA is Four Hummocks Island located 36 km from the nearest Duntroon OA boundary.

Figure 3-84: Abalone spatial assessment units in Region A of the Western Zone South Australian Abalone Fishery (Stobart et al., 2012)

Spawning: Greenlip abalone is found throughout southern Australia from Corner Inlet (Vic) to Cape Naturaliste (WA), with the bulk of the population found in SA (Shepherd 2008). For most of their distribution, they occur in two types of habitats. One type consists of low reef areas (often in a part sand/ part rock environment) at depths ranging from 5 to 40 metres. Such areas, with reef outcropping from the sand, are common off the central and west coasts of SA and provide the main commercial fishing grounds. Abundance in this type of habitat is usually highest on the leeward side of reefs, headlands, and islands, where the abalone is protected from the full force of wave action. Drift algae (preferably red algae) also tends to gather in these locations and provides a good supply of food. Greenlip abalone also occurs in rough water at the base of steeply sloping granite cliffs, and usually along the sides of gutters or clefts from depths of 10 to 25 metres. In areas of calm water, they may occur in shallower water on rocky habitat near seagrass beds. In SA, greenlip abalone tends to spawn in a short synchronous period from late spring to early summer probably driven by fluctuations in water temperature (Stobart et al, 2012).

Blacklip abalone is found throughout southern Australia from Coffs Harbour (NSW) to Rottnest Island (WA). They are typically found on sheltered reefs, hidden in caves, fissures and narrow crevices, generally in waters ranging between 5 and 20 metres in depth. Unlike the single spawning season of greenlip abalone, blacklip abalone have two seasonal spawning periods, one in spring (October to December) and the other in autumn between February and April (PIRSA, 2012). Spawning is driven by water temperature. Abalone are dioecious broadcast spawners (i.e. eggs and sperm are released into the water column where fertilisation takes place (Shepherd, 2008 in PIRSA, 2012).

The duration of the larval phase typically lasts 4 to 7 days and is predominantly influenced by water temperature. During this period, the free-swimming larvae (veliger) do not feed and are transported by water currents. Larval dispersal studies have shown that larvae can drift many kilometres from their natal site however concluded that larvae were often retained in the same bay or reef system and often limited in spatial scales of less than one kilometre (Miller et al, 2008 in PIRSA, 2012). . In their review, Morgan and Shepard (2006) concluded that larvae of shallow-water species such as Blcaklip and Greenlip abalone tended to be philopatric (i.e. they settle near their parental reefs), whereas larvae of deeper water species were dispersed far more widely (PIRSA, 2012). When a larva is ready to settle, it tests different demersal surfaces until it encounters the surface of encrusting coralline algae upon which it forages and uses for protection. The diet then shifts to drift algae in adult algae (Stobart et al., 2012) and sexual maturity is reached at approximately 3 years (PIRSA, 2009).

No feedback to the Duntroon multi-client survey has been provided by the Central Zone Abalone Fishery (**Stakeholder Record No: 53**) or Abalone Association of South Australia (**Stakeholder Record No: 54**).

- **Charter Boat Fishery (CBF)**: The CBF is a commercial platform for recreational fishing and is managed through a licencing and registration system. As such, all catch from the fishery is considered as recreational catch and falls under recreational catch statistics for SA (PIRSA, 2011).

  The CBF operates throughout the coastal marine environment off SA and in a variety of different habitat areas. Most activities occur around reef, seagrass meadows, unvegetated soft bottom, sheltered beaches and tidal flats (PIRSA, 2011). The primary target species of the fishery are snapper (*Pagrus auratus*) and King George whiting (*Sillaginodes punctatus*). Secondary targets include Western Australian salmon (*Arripis truttacea*), Bight redfish (*Centroberyx gerrardi*), snook (*Sphyraena novaehollandiae*), yellowtail kingfish (*Seriola lalandi*) and samsonfish (*Seriola hippos*) (PIRSA, 2011). During 2016/17, ten of the 34 species taken accounted for the majority (89%) of the nominal catch

  The CBF has a strong association with tourism in regional communities and is a drawcard for visitors who may wish to experience fishing in offshore areas (PIRSA, 2011). On average, 20,000 passengers utilise charter fishing operations in SA undertaking approximately 2800 fishing trip days every year (PIRSA, 2011).

  The CBF does not operate under a formal harvest strategy and instead utilises catch ratios between recreational/CBF and commercial/recreational as triggers for the adjustment of allocations between fishing sectors. The *Management Plan for Recreational Fishing in SA* (PIRSA, 2017) integrates with the fish species performance indicators and limit reference points for species which are also commercially important. Many of the CBF target species are also commercial species monitored as part of the MSF management arrangements. An assessment of reference performance indicators (total catch range, greatest percentage interannual change, greatest 5-year trend and decreases over 5 consecutive years) based upon available catch data for these recreational species on a recreational basis[31] which are present in the Duntroon OA are provided in Table 3-56 (Steer et al, 2018). Table 3-51 provides a summary of the King George Whiting and snapper fishery's current fishery management performance indicators (not repeated in Table 3-56). The main features of the SA charter boat fishery are provided in Table 3-55.

Table 3-55: Main Features and Statistics of the Charter Boat Fishery

Feature	Description			
Primary Landing Port	Port Lincoln, Kangaroo Island, Mt Gambier, Cape Jervis			
Management Methods	Size and catch limits (individual species). Catch ratios between recreational and CBF catch and recreational/and commercial catch. CBF does not operate under a formal harvest strategy. SARDI identify best technique to determine sustainability of the fishery is to apply MSF general indicators to the catch history (pers.com M. Steer SARDI, February 2018).			
Industry Representation	Charter Boat Fishing Association, SA Fish			
Fishing Season	1 July to 30 June (Quota season). Number of clients and trip days per month peak in December/January and are lowest in July/August.			
Encounter Rate	Low Level Encounter			
Licences:	100 Licence Holders (2016/17)			
Active Vessels:	59			
Method	Rod & line; hand net; lift net; hand spear			
CBF Total Area Fished in 2016 (km^2)	142,817 km^2			
OA overlap with Fished Area (km^2)	1,237 km^2 (MFA-26). MFA 26 has a total area of 10,184 km^2. 3,703 km^2 (MFA-38). MFA 38 has a total area of 10,063.75 km^2.			
Catch Effort in Duntroon OA	MFA 26 & MFA38: Confidential < 5 Licencees in the area during year MFA39 (adjacent): 15,297 fishing hours per year (637 days) Most CBF effort in the November to April period (refer Figure 3-85).			
Fishery Statistics	CBF – 2016/17 Catch Data (Rogers et al, 2017)			
Species Type per Management Plan (PIRSA, 2011) (P): Primary Target (S): Secondary Target (H): High CBF Catch	2016/17 CBF Species Catch (Fish No. (weight) (t))	2016/17 Catch in Outer Zone (CBF)[32] (Fish No./ tonnes)	2016/17 Catch in Duntoon OA[33] (CBF) (Fish No./ tonnes)	Habitat in Duntroon OA

[31] Linear interpoloation methodology between known recreational points confirmed by M Steer (SARDI) for recreational fisheries (pers.com. M. Steer, 2018).
[32] Outer zone catch (location of the Duntroon OA) has been calculated from 'Total CBF' catch statistics for 2016/7 deducting fish catch numbers all other zones. For catches in these zones which are confidential no deduction from the total was made. On this basis the fish numbers allocated to the outer zone are conservative.
[33] The outer zone confidential catch area is coincident with MFA26 and MFA 38 for 2016. Outer zone catch effort is assumed to be distributed across these two MFAs. The Duntroon OA overlap with these two MFAs is 24.4% of the MFA area.

Snapper (P)*	14,946 (23.8)	421 (0.67)	103 (0.16)	✓
King George whiting (P)*	34,125 (8.5)	923 (0.23)	225 (0.06)	✓
Australian Salmon (S)	3,566 (1.35)	17 (0.006)	4 (0.002)	× [1]
Bight Redfish (S)	8,970 (5.48)	1,852 (1.13)	451 (0.28)	✓
Snook (S)	3,841 (2.78)	0 (0)	0 (0)	× [2]
Yellowtail kingfish (S)	138 (3.54)	0 (0)	0 (0)	× [1]
Samsonfish (S)	30 (0.65)	30 (0.65)	7 (0.16)	× [1]
Silver Trevally (H)	3,933 (1.05)	106 (0.027)	26 (0.007)	✓
Southern Calamari (H)*	2,364 (0.77)	49 (0.016)	12 (0.004)	× [3]
Southern Bluefin Tuna (H)[34]	1,866 (22.6)	465 (6.72)	113 (1.64)	✓
Garfish (H)*	1,620 (0.147)	0 (0)	0 (0)	× [1]
Blue Crab (H)*	1,514 (0.01)	0 (0)	0 (0)	×
Other	9,545 (NA)			
TOTAL (2016/17)	86,458 (NA)	3863 (9.45)	941 (2.31)	
Total (2015/16)	98,001	Gross value of Production (2015/16) (Econsearch, 2016)	$4.05M	
Source: Econsearch (2016), (Tsolos and Boyle, 2015 – PIRSA); SARDI (2017); Giri & Hall (2015) * Commercially important species under separate Management Plans				

References:

1. Fishes of Australia (2018): West Australian Salmon Depth (0-30 m); Yellowtail kingfish (0-50m); Samson fish (0-100m); Southern Garfish (0-20m).
2. Fishbase (2018): Snook Depth (0-20 m)
3. Australian Museum (2018): Southern Calamari (0-10m); Blue Crab (inter-tidal estuaries)

Table 3-56: CBF General Fishery Performance Indicators (Recreational Fishery) (Steer et al, 2018)

CBF Fish Species	Recreational Catch (2000/1) (No. fish/tonnes)	Recreational Catch (2007/8) (No. fish/tonnes)	Recreational Catch (2013/14) (No. fish/tonnes)	Recreational Proportion of Total Catch (%) (2013/14)	Total Recreational Fishery Catch (State) Basis: 3rd Highest and 3rd Lowest Values for reference period	Greatest % inter-annual change	Greatest rate of change over a nominated period	Decrease over 5 consecutive years
Snapper	269,150 (~430)	110,164 (176)	207,809 (332)	38	×	×	×	×
KGW	1,527,584 (382)	1,135,691 (284)	1,467,601 (367)	58.1	×	×	×	×
Bight Redfish	Not Available	24,572 (15.3)	31,124 (19)	24.0	×	×	×	×
Silver Trevally	70,447 (18)	45,595 (11.65)	57,140 (14.6)	67.6	×	×	×	×

[34] Recreational SBT quota allocation is 250 t (pers. Com K. Cullen AFMA, February 2018).

Southern Bluefin Tuna	1576 [35] (19.1)	3,649 (44.2)	10,427 (126.3)	Not Applicable	Not Applicable Recreational Catch TAC – 250 t

Figure 3-86 provides locational details of the fishing catch and effort for 2016 within the Charter Boat Fishery. There is a minor overlap of fishing effort in MFA 38 (3,167km^2) and MFA 28 (1,237 km^2). Table 3-57 provides the total catch in the fishery for the years 2011/12 to 2015/16 and Table 3-58 and Table 3-58 details catch data for MFAs within and adjacent to the Duntroon MSS OA between 2011/12 and 2015/16. During 2012/13 and 2013/14, MFA38 within the Duntroon OA recorded fishing catch (1.7% and 0.6% of total catch respectively). Most effort in The CBF is within the gulf areas or Investigator Strait.

Table 3-57: Charter Fishery (fish retained) annual catch (2011/12-2016/17) (Rodgers et al. 2017)

Year	Total Catch (Fish Retained)
2011/12	153,468
2012/13	132,721
2013/14	113,842
2014/15	94,891
2015/16	98,001
2016/17	86,458

Table 3-58: Charter Fishery (fish retained) Data (2011/12-2015/16) (SARDI, 2017)

MFA	2011/12	2012/13	2013/14	2014/15	2015/16	Average (relevant MFAs)
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	n/a	n/a	n/a	n/a	n/a	na
28	2896	n/a	n/a	n/a	n/a	2896/na
37	n/a	n/a	n/a	n/a	0	0/na
38	n/a	2005	599	n/a	n/a	1302/na
39	23644	25975	16773	11467	14464	18464
47	0	0	0	0	0	0

Table 3-59: Charter Fishery (fishing hours) Data (2011/12-2015/16) (SARDI, 2017)

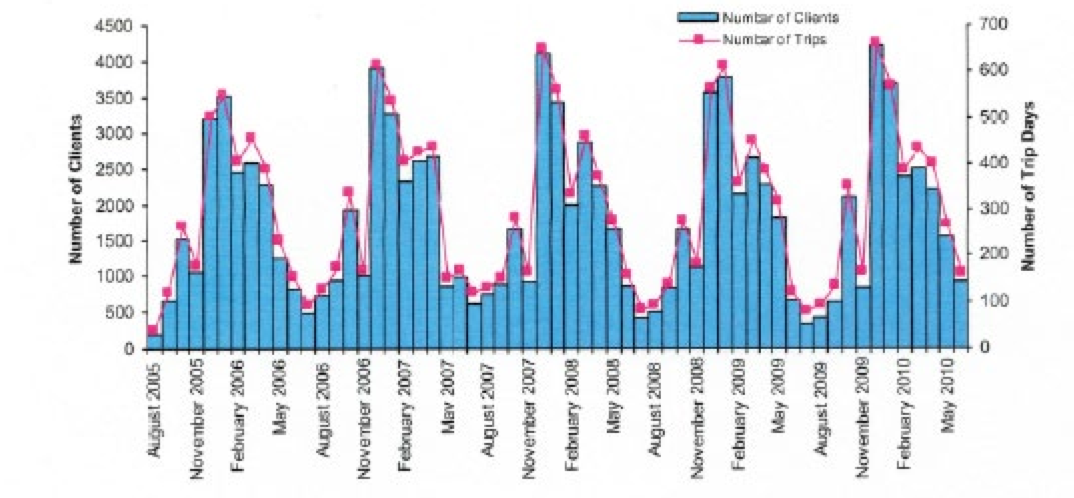
MFA	2011/12	2012/13	2013/14	2014/15	2015/16	Average (relevant MFAs)
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	n/a	n/a	n/a	n/a	n/a	na
28	3231	n/a	n/a	n/a	n/a	3231/na
37	n/a	n/a	n/a	n/a	0	0/na
38	n/a	1435	853	n/a	n/a	1144/na
39	18342	20198	16465	12047	15297	16470
47	0	0	0	0	0	0

Legend:

(shaded)	MFAs within Duntroon OA
(unshaded)	MFAs adjacent to Duntroon OA

[35] Includes all tuna taken in SA waters (Henry & Lyle, 2003)

Figure 3-85: Number of Charter Boat Clients and Trip Days per month (PIRSA, 2011)



Summary of Commercial Fishing Activities:

Table 3-60 provides an overall summary of the commercial fishing with management areas within the Duntroon OA.

Figure 3-86: Distribution of catch and effort of the Charter Boat Fishery in 2016 (SARDI, 2017)

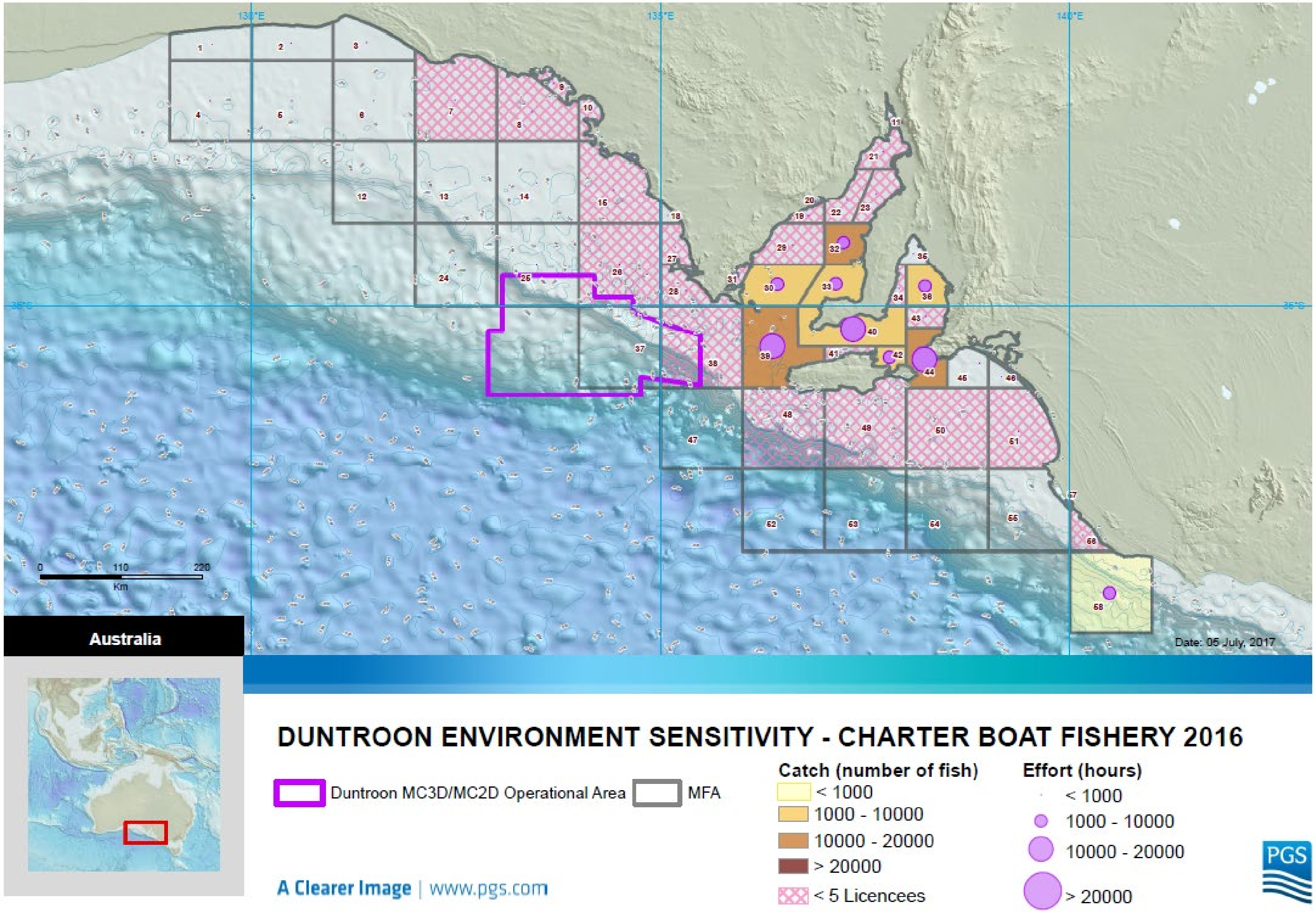


Table 3-60: Commercial Fishery Summary – Duntroon OA

Fishery	Management Area within OA	Recorded Fishing Activity in OA	Effort Recorded in OA (2016 Catch Data)	Duntroon OA Overlap with active Catch areas (km ^{2})	Total area of active fishing within fishery (km ^{2}) or adopted catch (t)	Duntroon OA (% total fishery area fished)	Target Species TAC (Actual Fishery Catch) (tonnes)	Catch possibly affected by Duntroon Survey (tonnes)
COMMONWEALTH								
Skipjack (Western) Tuna (Fishery)	Yes (Fishery not active)	No	Nil	No	NA	-	Skipjack Tuna - Nil	No overlap
Small Pelagic Fishery	Yes	No	Confidential (< 5 licencees)	0	135,022	-	Sardine: 9550 (97) Blue Mackerel: 15,320 (2858) Jack Mackerel: 19,800 (2748) Redbait: 4230 (10)	No Overlap
GAB Trawl Sector	Yes	Yes	Confidential (< 5 licencees)	12,183	127,872	9.5	Bight Redfish: 800 (308) Deepwater Flathead: 1150 (548) Ocean Jacket: 0 (193)	Bight Redfish: 29 t Deepwater flathead: 52 t Ocean Jacket: 18 t
Gillnet Hook and Trap Fishery (Shark) (based on shark hook fishery)	Yes	Yes	Confidential (< 5 licencees)	14,847	385,974	3.8	Elephantfish: 122 (27) Gummy Shark: 1916 (1604) Sawshark: 481 (98) School shark: 215 (181)	Elephantfish: 1.04 t Gummy Shark: 61 t Sawshark: 3.8 t School Shark: 7 t
Gillnet Hook and Trap Fishery (Scalefish Hook)	Yes	Yes	Confidential (< 5 licencees)	14,847	344,834	4.3	Blue-eye trevalla: 458/327* (276) Blue grenadier: 8765/1625*(5) Deepwater Shark: 272/80* (0.6) Flathead: 2712/2436* (1) Gemfish: 199/77* (<1) Jackass mowong: 513/185* (3) Ocean perch: 190/169* (19) Pink ling: 1154/1036* (297) Ribaldo: 355/95* (40)	Blue-eye trevalla: 11.8 t Blue grenadier: 0.2 t Deepwater shark: 0.02 t Flathead: 0.04 t Gemfish: <0.04 t Jackass morwong: 0.13 t Ocean perch: 0.8 t Pink ling: 12.8 t Ribaldo: 1.72 t

Fishery	Management Area within OA	Recorded Fishing Activity in OA	Effort Recorded in OA (2016 Catch Data)	Duntroon OA Overlap with active Catch areas (km ^{2})	Total area of active fishing within fishery (km^2) or adopted catch (t)	Duntroon OA (% total fishery area fished)	Target Species TAC (Actual Fishery Catch) (tonnes)	Catch possibly affected by Duntroon Survey (tonnes)
Southern Bluefin Tuna Fishery	Yes	Yes	Confidential (< 5 licencees)	2,975	51,354	5.8	Southern Bluefin Tuna: 5697 (4684)	Thisis a migratory species with possible presence in the western/ central GAB during November. Fish stock are not expected to be affected by Duntroon activities in eastern GAB
Western Tuna and Billfish Fishery	Yes	No	Nil	14,468	425,670	3.4	Striped Marlin: 125 (1) Swordfish: 3000 (166) Albacore: 0 (16) Bigeye Tuna: 2000 (67) Yellowfin Tuna: 5000 (72)	Striped Marlin: 0.03 t Swordfish: 5.7 t Albacore: 0.5 t Bigeye Tuna: 2.3 t Yellowfin Tuna: 2.5 t
Southern Squid Jig Fishery	Yes	No	Nil	0	NA	-	Gould squid: 550 jig machines (330 jig machines)	No Overlap

* Total actual catch in the fishery from all sectors

Fishery	Management Area within OA	Recorded Fishing Activity in OA	Effort Recorded in OA (2016 Catch Data)	Duntroon OA Overlap with active Catch areas (km ^{2})	Catch within Overlap area (adopted or actual) (t)	Duntroon OA Overlap with MFA (%)	Target Species TAC (Actual Fishery Total Catch or Fishery Performance KPIs) (tonnes)	Catch possibly affected by Duntroon Survey (tonnes)
SOUTH AUSTRALIA								
Rock Lobster Fishery	Yes	No	Nil	0	NA	-	Rock Lobster: 360 (342)	No Overlap
Giant Crab Fishery (part of Misc. Fishery)	Yes	Yes	Confidential (< 5 licencees)	3,703 (MFA38)	>4-6 t (assumed 5 t – adjacent MFA-48 catch)	37	Giant Crab (North Zone): 13.4 (11.35 t)) (latest reported NZ catch assumed on a conservative basis)	Giant Crab (1.85 t)

Fishery	Management Area within OA	Recorded Fishing Activity in OA	Effort Recorded in OA (2016 Catch Data)	Duntroon OA Overlap with active Catch areas (km ^{2})	Catch within Overlap area (adopted or actual) (t)	Duntroon OA Overlap with MFA (%)	Target Species TAC (Actual Fishery Total Catch or Fishery Performance KPIs) (tonnes)	Catch possibly affected by Duntroon Survey (tonnes)
Marine Scalefish Fishery								
King George Whiting (KGW)	Yes	Yes	Confidential (< 5 licencees)	3,703 (MFA38)	0.886 t (adjacent MFA39 catch)[36]	37	KGW: Refer Table 3-51 for KPIs (287)	KGW: 0.32 t [37]
Southern Garfish	Yes	No	Nil	0	NA	0	Not Applicable	No Overlap
Snapper	Yes	Yes	Confidential (< 5 licencees)	3,703 (MFA38)	1.036 t (adjacent MFA28 catch)	37	Snapper: Refer Table 3-51 for KPIs (382)	Snapper: 0.38 t[38]
Southern Calamari	Yes	No	Nil	0	NA	0	No Overlap	Nil
Sardine Fishery								
Sardine Fishery (*by Spatial Assessment*)	Yes	Yes	MFA38 – Confidential < 5 Licencees	3,703 (MFA38)	8,206 t (adjacent MFA39 catch)	37	TACC: 34,000 (32,357)	Sardine (MFA38): 3,036 t
			MFA26: Low	1,237 (MFA26)	3160 t	12.2		Sardine (MFA26): 385 t TOTAL: 3,420 t (spatial)[39]
Sardine Fishery (***by recorded catch Assessment***)			Yes	-	50 tonnes (refer Figure 3-79)	NA	TACC: 34,000 (32,357)	TOTAL: 50 t (actual)
Charter Boat Fishery (Species not present are not shown)								
Snapper	Yes	Yes	Confidential < 5 licencees	3,703 (MFA38) 1,237 (MFA26)	Outer Zone: 0.67 t	24.4	Snapper: Refer Table 3-51 for KPIs (23.8)	Snapper: 0.16 t
KGW	Yes	Yes			Outer Zone: 0.23 t	24.4	KGW: Refer Table 3-51 for KPIs (8.5)	KGW: 0.06 t

[36] Assessment to adopt adjacent MFA39 catch data. MFA39 catch data is pro-rated based upon OA spatial overlap with MFA38 or 37% of catch.

[37] Incremental catch will not lower the total catch into the next threshold to trigger fishery management review. No impacts to fishery.

[38] This incremental catch would cause the management parameters of the fishery to fall below its minimum total catch level and represents 0.1% of the lowest catch or one manday of catch withinthe fishery. This is not considered significant by SARDI (pers.com. Mike Steer, February 2018) and not expected to result in fishery allocation management review.

[39] On a spatial basis, the sardine catches affected by the Duntroon survey (3,420 t) together with the actual catch (32,357 t) exceeds the TACC by 1777 t (i.e. total take 35,777 t). This falls significantly below the SpB target reference point (TRP) of > 150,000 t which is considered 'sustainable' and the limit reference point (LRP)[39] of 75,000 t. Management arrangements would not be revised as a result of sardine stock affected by the Duntroon survey on a spatial basis. Note that on an actual catch basis (i.e. 50 t within the Duntroon OA) there is no TACC exceedance.

Fishery	Management Area within OA	Recorded Fishing Activity in OA	Effort Recorded in OA (2016 Catch Data)	Duntroon OA Overlap with active Catch areas (km ^{2})	Catch within Overlap area (adopted or actual) (t)	Duntroon OA Overlap with MFA (%)	Target Species TAC (Actual Fishery Total Catch or Fishery Performance KPIs) (tonnes)	Catch possibly affected by Duntroon Survey (tonnes)
Bight Redfish	Yes	Yes	Confidential < 5 licencees	3,703 (MFA38) 1,237 (MFA26)	Outer Zone: 1.13 t	24.4	Bight Redfish: 2,358 (5.48 t)	Bight Redfish: 0.28 t
Silver Trevally	Yes	Yes			Outer Zone: 0.027t	24.4	Silver Trevally: Refer Table 3-56 for KPIs (1.05t)	Silver Trevally: 0.007 t
SBT	Yes	Yes			Outer Zone: 6.72 t	24.4	SBT: 250 t (27 t)	SBT: 1.64 t
Abalone Fishery								
Abalone Fishery	Yes	No	Nil	0	NA	-	Blacklip Abalone Greenlip Abalone	Nil

3.8.4 Aquaculture

The following aquaculture activities are present along the Eyre Peninsula (refer Figure 3-87):

- **Abalone**: In addition to the marine-based abalone (refer Section 3.8.3), land-based abalone hatcheries operate on the Eyre Peninsula (west coast and Port Lincoln) where broodstock is sourced from the wild and juvenile abalone are grown in land-based hatchery complexes. The stock is then transferred to sea-cages or benthic structures where the abalone are grown until harvest. This aquaculture sector produced 236 tonnes of abalone in 2012-13 values at $8.6M. In 2014, there were 15 land-based aquaculture sites and 15 marine sites licenced to farm abalone in South Australia (PIRSA, 2014).

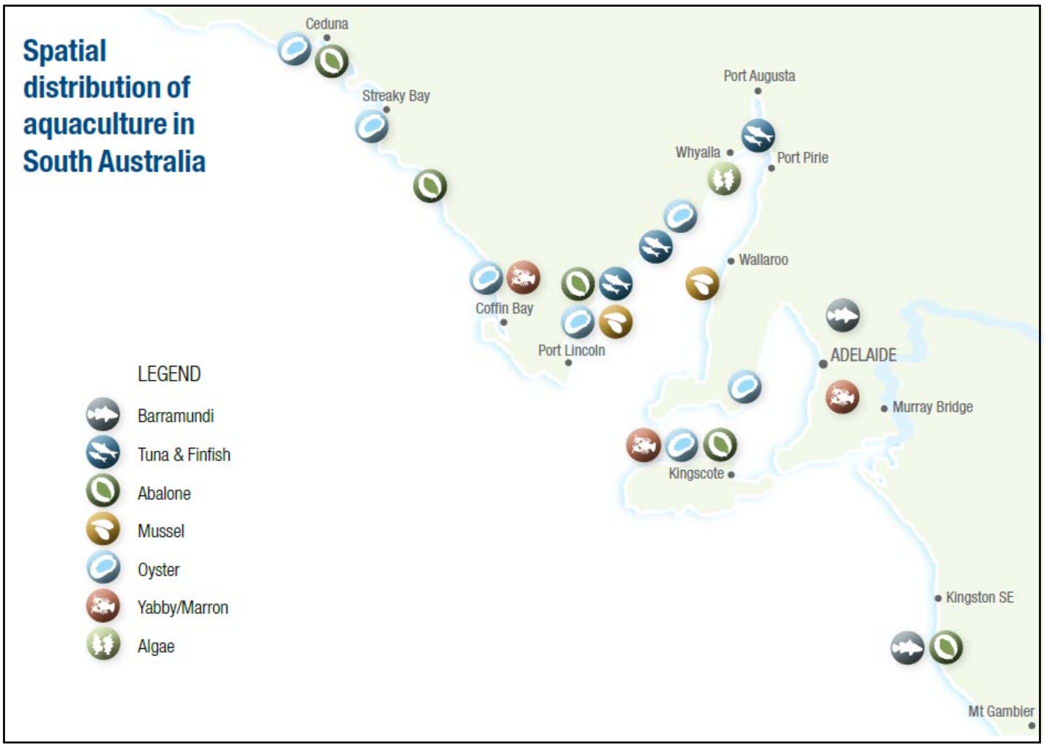
- **Oysters:** Pacific oysters can be found on the adjacent Eyre Peninsula at Coffin Bay (75 km NE from nearest OA boundary) Streaky Bay (205 km north from nearest OA boundary) and Ceduna (283 km NNW from nearest OA boundary). Oyster production on the Eyre Peninsula was 3,200,000 dozen (oysters) and contributed $21.5M (2013/14) (67% of state) of economic value to the region (Econsearch, 2015). South Australian oysters are grown in inter-tidal and subtidal waters using several methods including the traditional rack and rail systems, longline systems and hybrid systems. In 2014, there were 332 licences in SA with a total leased area of 940,107 Ha (PIRSA, 2014).

- **Southern Bluefin Tuna:** SBT are caught in the Southern Ocean, transferred to Port Lincoln (80 km NNE from nearest OA boundary) and placed in sea cages to grow under controlled feeding techniques. Pontoons and nets are designed to hold the tuna. All tuna farming activity is located in the western Spencer Gulf between 6 and 20 km offshore from Port Lincoln. In 2014, the SA tuna industry comprised of 15 companies operating 20 aquaculture licences over approximately 1983 Ha (PIRSA, 2014). Production is expected to grow as a result of restrictions on wild catch SBT. SBT aquaculture generates the highest farm-gate sales $153.5M in SA's aquaculture industry. In 2012-13 the tuna industry produced 7486 tonnes (PIRSA, 2014).

- **Finfish:** The marine finfish aquaculture industry comprises of species including Yellowtail Kingfish, Mulloway and Snapper. Yellowtail Kingfish is the predominant species farmed in South Australia. In 2012-13 Yellowtail Kingfish generated farm-gate sales of AUD$11.26 million and 889 tonnes of fish. All South Australia's marine finfish farming activity is located in Spencer Gulf with the majority of farming concentrated in Boston Bay, near Port Lincoln. In 2014, the South Australian finfish industry comprises two companies, who operate 22 aquaculture licences over approximately 1,983 hectares. Fingerlings are hatched in land-based facilities and transferred to sea-cages to grow under controlled feeding techniques. Pontoons and nets are used and designed to hold the finfish (similar to Tuna) (PIRSA, 2014).

- **Mussels:** The South Australian mussel aquaculture industry is based on the production of the Blue Mussel (Mytilus galloprovincialis). In 2012-13 total commercial production was 1,480 tonnes and worth AUD$2.94 million. In 2014, 38 subtidal (mussel) licences over 573 hectares in Boston Bay and Louth Bay in lower Spencer Gulf. All Australian farmed blue mussels are grown using long-line culture techniques. Long-lining involves a system of horizontal ropes with buoys to provide flotation, to which vertical droppers are attached every 1–4 m, depending on site conditions (PIRSA, 2014).

Figure 3-87: Aquaculture in South Australia (PIRSA, 2014)



3.8.5 Defence

Commonwealth Department of Defence training areas do not extend into the offshore waters of the GAB. The closest training area lies in Investigator Strait (between the Yorke Peninsula and Kangaroo Island) used for military flying and firing and waters off Port Lincoln used for firing and naval operations.

Defence restricted air space areas lying on the adjacent coast are Thistle Island (R246), Dangerous Reef (R245) and North Eastern Rocks (R254). When activated by a Notice to Airmen (NOTAM) these restricted airspace areas can operate down to low altitudes including sea level and may affect any survey-related helicopter operations.

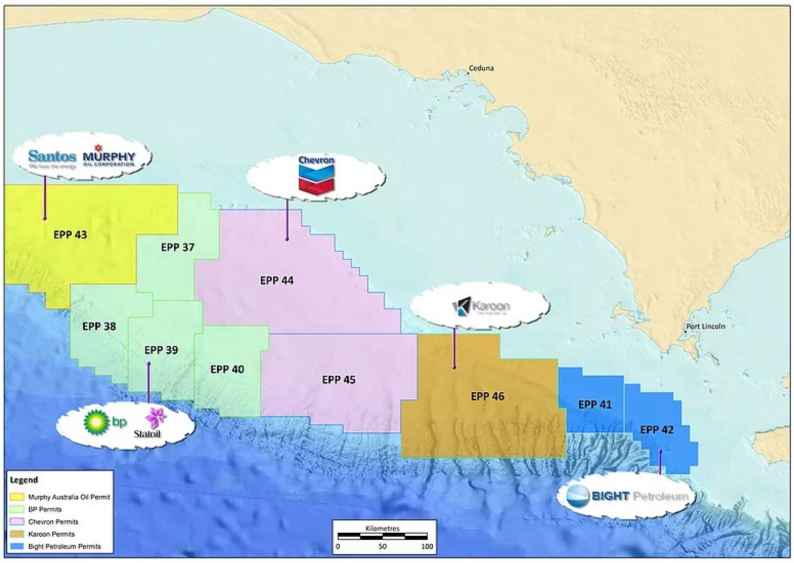
Consultation feedback has been obtained from the Department of Defence regarding advice on survey activities to ensure there are no conflicts with defence training activities (**Stakeholder No: 7 records**). This has been incorporated into notification triggers in Section 9.

3.8.6 Petroleum Activity

Petroleum tenements within the GAB are all currently exploration licences. No petroleum production infrastructure is present in the region. Current permit holders include (refer Figure 3-87):

- EPP-37/40: BP Exploration Limited;
- EPP-41/42: Bight Petroleum;
- EPP-43: Murphy Australia Oil Pty Ltd & Santos Offshore Pty Ltd;
- EPP-44/45: Chevron Australia; and
- EPP-46: Karoon Gas.

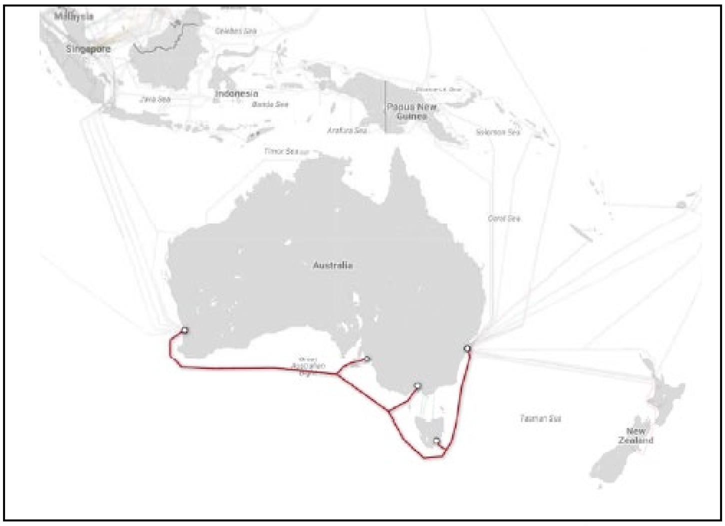
Figure 3-88: GAB Tenements



3.8.7 *Submarine Cables*

The Duntroon multi-client survey lies in proximity to the proposed APX-central submarine cable (refer Figure 3-89). Consultation with Sub-Partners (cable installer) is continuing (**Stakeholder No: 19 Records**) to identify any temporal and/or spatial conflicts in activities.

Figure 3-89: APX Central Submarine Cable Location



3.9 Cultural Heritage

Figure 3-90 provides details of shipwrecks present within coastal waters of South Australia and adjacent to the Duntroon MSS OA.

Review of the National Shipwreck Database (DOEE, 2016) identified that no shipwrecks lie within the Duntroon MSS OA. The closest registered shipwreck is the *Lord Roberts* (1902) located approximately 40 km northeast of the survey area; the *Gypsy Rose* (1988) and *St. Michele* (1965) located approximately 68 km northeast at the Neptune Islands; and the *Vale* (1900), *Mermaid* (1914); *Atalanta* (1860) and *Loch Vennachar* (1905) located ~ 90 km east on the west coast of Kangaroo Island (refer to **Section 3.7.2** for the heritage trail information).

Figure 3-90: Shipwrecks within the Southwest Marine Region (Gardner et al. 2006)

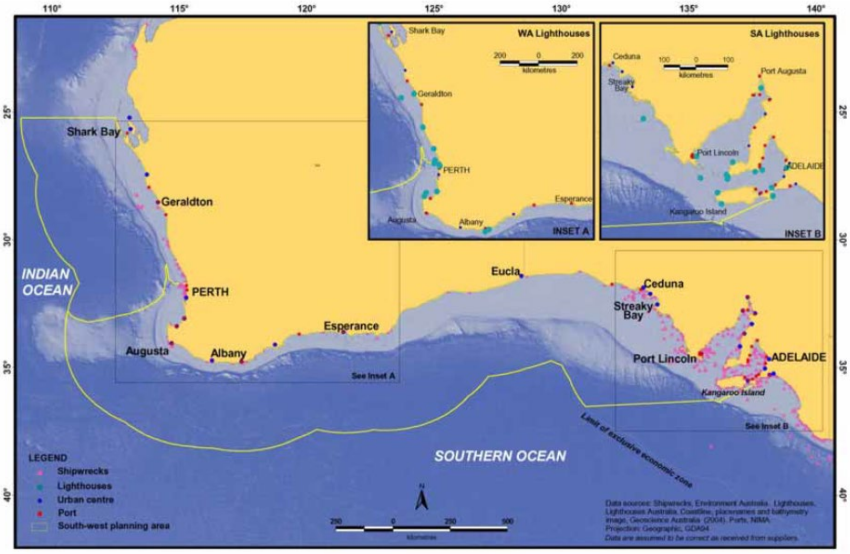


Figure 3-91: Temporal (seasonal) Summary of Key Environmental Sensitivities in the Duntroon OA.

Receptor Type	Receptor	Location	Context	January	February	March	April	May	June	July	August	September	October	November	December
Physical	Kangaroo Island Upwelling	Shelf	High Productivity, Intermittant (2-4 episodes per season)												
Whales	Pygmy Blue Whale (foraging BIA)	Shelfbreak	BIA (High abundance foraging area) Intensity Figures - Survey (Year:sightings)	Gill (2004:0, 2005:0, 2015:0) PGS (2011:0) TGS (2014:0)	Gill (2002:0, 2006:0, 2012:0) PGS (2011:0) TGS (2014:0)	Gill (2003:0, 2005:0, 2006:0, 2012:0, 2015:0) PGS (2011:0) TGS (2014:0)	Gill (2002:0, 2004:0, 2007:0) PGS (2011:0) IFAW (2013:0) TGS (2014:0)	TGS Survey (2014:1) Gill (2002:0) PGS (2011:0) IFAW (2013:0)	Bilgmann (2014:0) TGS (2014:0)	Bilgmann (2014:0)	No Survey	No Survey	No surveys	PGS Survey (2011:12) Gill (2004:2, 2011:1)	Gill (2002:0, 2003:135, 2004:0, 2005:33, 2011:3, 2015:0) Anecdotal (25) PGS (2011:0)
	Humpback Whale	Shelf (from observation)	No BIAs within OA, migratory only. Intensity Figures – whales/1000 km	0	0	0	0	0.11	0.99	1.0			0	0.05	0.07
	Southern Right Whale	Coastal	BIA (Coastal Areas – Breeding/Breeding Buffer) else migratory. Intensity Figures – whales/1000 km	0	0	0	0	0	0.8	3.1	6.8	8.8	0	0	0
	Fin Whale	Shelf (from observation)	No BIAs within OA, possible foraging. Intensity Figures – whales/1000 km of survey line	0.07	0.08	0	0	0	0	0	0	0	0	0.1	0.14
	Sei whale	Shelf (from observation)	No BIAs within OA, possible foraging. Intensity Figures – whales/1000 km	0.04	0.08	0.19	0	0.21	0	0	0	0	0	0.25	0.07
	Sperm Whale	KI Canyon Area	BIA (Foraging likely – abundant food sources). Intensity Figures – whales/1000 km	0.53	0.08	0.13	0.75	0.85	0	0	0	0	1.7	1.2	0.23
Pinnipeds	Australian Sea Lion	Shelf Areas	BIA (male and female – all year). Breeding asynchronous across region. Presence all year.												
	Australian fur seal	Shelf Area	No BIA. Presence all year											Breeding	Breeding
	New Zealand fur seal	Shelf/deep water	No BIA. Presence all year	Breeding										Breeding	Breeding
Turtles	Leatherback	Shelf/Slope	No BIA. Could be present at any time.												
Sharks	White Shark	Shelf	BIA (foraging adjacent to pinniped colonies – coastal). Present at any time												
	Shortfin Mako	Mainly Shelf	No BIA – migratory. Present at any time												
	Porbeagle	Shelf/Slope	No BIA – migratory. Present at any time												
	Southern Dogfish	Slope	No BIA. Fishing closure (breeding). Breeding all year												
	School Shark	Shelf/slope	No BIA. Present at any time												
Fish Spawning	Sardines/Anchovies	Shelf	No BIA. Cinincides with Upwellings												
	King George Whiting	Shelf	Deeper waters around seabed features (reef, mounds)												
	Giant Crab	Shelf													
	Rock Lobster	Shelf													
Birds	Little Penguin	Shelf	BIA (Foraging/Provisioning for young) adjacent to OA				Moulting	Moulting	Moulting				Breeding		
	Caspian Tern	Shelf	BIA (Foraging/Provisioning for young) adjacent to OA												
	Black-faced Cormorant	Shelf	BIA (Foraging) adjacent to OA												
	Fairy Tern	Shelf	BIA (Foraging) adjacent to OA												
	Pacific Gull	Shelf	BIA (Foraging) adjacent to OA												
	Short-tailed Shearwater	Shelf	Migratory. BIA foraging.												
Fishing	Southern Bluefin Tuna	Shelf													
	Rock Lobster	Shelf	Shelf areas outside OA. Highest catch first 4 months. Potlifts from (Linnane et al. 2014)	75,000 pots	65,000 pots	50,000 pots	30,000 pots	10,000 pots						65,000 pots	65,000 pots
	Giant Crab	Shelf	Potlifts based upon 2007/8 year (Currie & Ward, 2009)	6,000 pots	3,000 pots	5,000 pots	4,500 pots	2,000 pots						4,000 pots	3,000 pots
	Sardine Fishery	Shelf	Netset data obtained from the 2012 Sardine Fishery Stock Assessment Report (PIRSA)	70 netsets	70 netsets	100 netsets	175 netsets	230 netsets	175 netsets	75 netsets			20 netsets	50 netsets	70 netsets
Fishing Surveys	CSIRO (Tuna)	Shelf/Slope	Not confirmed for 2019												
	Sardine (Egg Count)	Shelf	Early to Mid March												

4 Applicable Environmental Legislation

4.1 Regulatory Framework

This section provides a summary of the legal framework applicable to the Duntroon MSS together with a register of relevant environmental legislation for the survey activity.

The proposed survey area is situated in Commonwealth waters and falls under Commonwealth legislation (between 3 to 200 nautical miles from territorial baseline). The supply base for the survey is expected to be located at Port Lincoln (SA) and as such SA legislation will apply to those activities. Additionally, although the OA is located entirely within Commonwealth waters, in the unlikely event of a hydrocarbon spill entering state waters, SA legislation will be triggered.

The proposed seismic activity is primarily governed by the *Offshore Petroleum and Greenhouse Gas Storage Act (OPGGSA) 2006* and its associated legislation however other Commonwealth legislation is also applicable. The Commonwealth OPGGSA is administered by a Joint Authority which consists of the South Australian Department of State Development (DSD) and the Commonwealth Department of Industry, Innovation and Science (DOIIS) on advice from the National Offshore Petroleum Titles Administrator (NOPTA). The offshore exploration permits involved in the Duntroon MSS have been awarded to the following titleholders under the Commonwealth OPGGSA:

- EPP-41/42: Bight Petroleum Pty Ltd;
- EPP-45: Chevron Australia (EPP-45) Pty Ltd; and
- EPP-46: Karoon Gas Browse Basin Pty Ltd.

PGS has applied for a SPA and will apply for access authorities from NOPTA to undertaken survey activities within these permits and ingress into adjacent non-permit areas. For the purposes of the Duntroon MSS, PGS is the titleholder for the petroleum activity in the OA.

Petroleum activities in Commonwealth waters are undertaken in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (OPGGSER) Regulation 31. The OPGGSER are administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). In accordance with this legislation, this MSS cannot proceed, and must be undertaken in accordance with a NOPSEMA-accepted Environment Plan (EP).

The Duntroon OA spatially overlaps the Western Eyre CMP. Activity within this CMP is controlled by the South-west Marine Parks Network Management Plan 2018 (DNP, 2018). The Duntroon MC3D survey area spatially overlaps the Western Eyre Multiple Use Zone (IUCN VI) by 2060 km^2 (13% of Multiple Use Zone [no overlap with special purpose zone]). The MC2D survey area spatially overlaps the Multiuse Zone by 5533 km^2 (or 35% of the zone) and the Special Purpose Zone (IUCN VI) by 640 km^2 (2.6% of the Special Use Zone). In accordance with that plan, activities must be consistent with the objectives within the plan, objectives of the zone in which the activity is being conducted and the applicable reserve management principles (Schedule 8 of the EPBC Regulations) (DNP, 2018).

Petroleum activities are allowable in Multiple Use Zones and Special Use Zones (IUCN category VI) in accordance with Class Approvals (Mining Operations). This includes:

- For the South-west marine Region – Class Approval for Mining Operations and Greenhouse Gas Activities (25/06/18); and
- For south-east marine region – Class Approval – Mining Operations (applicable to oil spill response only) (15/12/17).

Management plans allow in the South-west Network of Marine Reserves actions required to respond to unplanned oil pollution incidents, including environmental monitoring and remediation in all zones without an authorisation issued by the DMP. This is provisional on actions being undertaken in accordance with this EP and the DMP being notified in the event of oil pollution in a marine park or where an oil spill response action must be undertaken (DNP, 2018).

In the south-east marine park network, oil pollution response, environmental monitoring and remediation activities are allowable under existing authorisations in IUCN VI zones in accordance with an accepted EP. If an oil pollution incident affects other IUCN Category VI zones, consultation is required with the DNP (DNP, 2013).

These management plans give effect to reserve management principles, objectives and prescribe what and how activities are allowed to occur within each marine park and zone. An assessment of the management principles and objectives for these marine reserves against the Duntroon survey activities is provided in **Appendix M**.

Relevant Commonwealth and State legislation as it applies to the Duntroon survey is provided in Table 4-1 (Commonwealth) and Table 4-2 (South Australia) as required by OPGGSER Regulation 13(4).

4.2 Government Policy and Administrative Guidelines

This EP has been developed in accordance with the NOPSEMA Guidance Notes issued at 1st August 2017. Other legislative guidelines, regulator plans, conservation plans, and threat abatement plans which have been reviewed as part of the preparation of this EP include:

- Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, 2015);
- Advisory Note for Offshore Petroleum Industry Consultation with Respect of Oil Spill Contingency Plans (AMSA, 2012);
- National Plan for Maritime Environmental Emergencies (AMSA, 2014);
- National Biofouling Management Guidance to the Petroleum Production & Exploration Industry (Commonwealth of Australia, 2009);
- Australian Ballast Water Management Requirements (Revision 7) (DAWR, 2017);
- Offshore Installations – Biosecurity Guide (DAWR, 2016);
- EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance (DoE, 2013);
- EPBC Act Policy Statement 2.1- Interaction between offshore seismic exploration and whales (DEWHA, 2008);
- National Recovery Plan for Threatened Albatross and Giant Petrels (SEWPC, 2011d);
- Blue Whale Conservation Management Plan (DoE, 2015);
- Conservation Management Plan for the Southern Right Whale (SEWPC, 2012);
- Threat Abatement Plan for Impacts of marine debris on vertebrate marine life (DEWHA, 2009);
- Recovery Plan for the Australia Sea Lion (SEWPC, 2013);
- Recovery Plan for the Great White Shark (SEWPC, 2013c);
- Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017);
- Marine Bioregional Plan – Southwest Region (SEWPC, 2012);
- Australian IUCN Reserve Principles for Commonwealth Marine Protected Areas (EA, 2002b);
- Australian Marine Parks –South-west Commonwealth Marine Reserves Network Management Plan 2018 (Director of National Parks, 2018);
- South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (DNP, 2013);
- Threatened species conservation advices for the following:
    - Humpback whale (TSSC, 2015c);
    - Sei whale (TSSC, 2015e);
    - Fin whale (TSSC, 2015d);

- Southern Bluefin Tuna (TSSC, 2010);
- School Shark (TSSC, 2009);
- Southern Dogfish (Gulper shark) (TSSC, 2013);
- Red Knot (TSSC, 2016a);
- Curlew Sandpiper (TSSC, 2015a);
- Great Knot (TSSC, 2016b);
- Lesser Sand Plover (TSSC, 2016c);
- Blue Petrel (TSSC, 2015g);
- Bar-tailed Godwit (West Alaskan) (TSSC, 2016d);
- Bar-tailed Godwit (Siberian) (TSSC, 2016e);
- Eastern curlew (TSSC, 2015b);
- Fairy prion (southern) (TSSC, 2015f);
- Soft plumage petrel (TSSC, 2015h)
- Fairy tern (TSSC, 2011); and Hooded Plover (TSSC, 2014).

4.3 Industry Codes of Practice

This EP has been developed with guidance from the following industry guidelines:

- Australian Petroleum Production and Exploration Association's (APPEA) Code of Environmental Practice (2008). This code gives guidance on the outcomes to be achieved when managing environmental impacts associated with petroleum exploration and production activities (including seismic surveys). It includes four basic recommendations to APPEA members undertaking activities:
  - Assess the risks to, and impacts on, the environment as an integral part of the planning process;
  - Reduce the impact of operations on the environment, public health and safety to as low as reasonably practicable (ALARP) and to an acceptable level by using the best available technology and management practices;
  - Consult with stakeholders regarding industry activities; and
  - Develop and maintain a corporate culture of environmental awareness and commitment that supports the necessary management practices and technology and their continuous improvement.
- The International Association of Oil and Gas Producers (OGP) have developed guidelines for Environmental Management in Oil and Gas Exploration and Production (1997). This provides an over-view of environmental issues and the technical and management approaches to achieving high environmental performance in oil and gas exploration and production.
- The International Association of Geophysical Contractors (IAGC) have collated an Environmental Manual for Worldwide Geophysical Operations (2013) which provides guidance on how to undertake geophysical field operations in an environmentally sensitive manner (including the marine environment.

PGS applies these industry guidelines when planning and managing offshore exploration activities.

Table 4-1: Key Commonwealth Legislation

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Offshore Petroleum & Greenhouse Gas Storage Act 2006 & OPGGS (Environment) Regulations 2009	The OPGGSA addresses all **licensing, health, safety, environmental** and royalty **issues for offshore petroleum exploration and development operations** extending beyond the 3-nautical mile limit. The OPGGS (Environment) Regulations 2009 ensures that petroleum activities are undertaken in an ecologically sustainable manner and in accordance with an environmental plan which has appropriate environmental performance outcomes, standards and criteria. ***Relevance:*** *Petroleum activity requires the preparation and acceptance of an Environment Plan prior to undertaking the activity. The EP must be in accordance with the requirements of the legislation and demonstrate impacts and risks are ALARP and acceptable.*	Not applicable	Department of Industry (DOIIS)/NOPSEMA
Environment Protection & Biodiversity Act 1999	This Act focuses on environmental matters of National Environmental Significance (NES), streamlines the Commonwealth environmental assessment and approval process and provides an integrated system for biodiversity conservation and management of protected areas. **Matters of NES** are world heritage properties; RAMSAR wetlands; listed threatened species and communities; migratory species under international agreements; nuclear actions; the Commonwealth marine environment; activities in the Great Barrier Reef Marine Park and water triggers for coal seam gas and coal mining developments. Schedule 8 of the EPBC Regulations outlines the IUCN Reserve Management Principles which will be observed by this activity. ***Relevance:*** *Relevant items of NES and species contained within the international conventions enacted by this legislation have been identified within this EP (refer Section 3).*	• 1992 Convention on Biological Diversity & Agenda 21 • Convention on International Trade in Endangered Species of Wildlife and Flora 1973 (CITES) • Japan/Australia Migratory Birds Agreement 1974 (JAMBA) • China/Australia Migratory Birds Agreement 1974 (CAMBA) • Republic of Korea Migratory Birds Agreement 2006 (ROKAMBA) • USSR-Australia Migratory Bird Agreement • Convention on Wetlands of International Importance especially waterfowl habitat 1971 (RAMSAR) • International Convention on Whaling 1946 • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)	Department of Environment and Energy (DOEE) NOW assessed by NOPSEMA under streamlining arrangements

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Environment Protection (Sea Dumping) Act 1981	The Act protects the waters surrounding Australia's coastline from wastes and pollution and regulates waste loading and dumping activities, incineration at sea and artificial reef placement. Act prevents the deliberate **disposal of wastes** (loading, dumping, and incineration) at sea from vessels, aircraft, and platforms. ***Relevance:*** *Requirement observed within practices developed for this activity.*	Convention on the Prevention of Marine Pollution by dumping of waste & other materials 1972 (London Convention) MARPOL (*Regulates vessel routine/non-routine operations*)	DOEE
Hazardous Waste (Regulation of Exports and Imports) Act 1989	Relating to the controls over the importing and exporting of hazardous (intractable) materials. Permits are required to dispose of waste overseas or to import waste into Australia. ***Relevance:*** *Intractable waste will not be generated in this activity.*	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1992)	DOEE
Australian Maritime Safety Authority (AMSA) Act 1990	This Act specifies that AMSA's role includes protecting the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering Marine Orders in Commonwealth waters. Legislation also facilitates international cooperation and mutual assistance in **preparing and responding to a major oil spill incident** and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. ***Relevance:*** *Authority is included into necessary oil response documents for reporting purposes.*	International Convention on Oil Pollution (Preparedness, Response and Cooperation) 1990 (OPRC) (*Relates to non-routine operations (oil spills) and sets up a system of oil pollution contingency plans and cooperation in fighting oil spills*)	Australian Maritime Safety Authority (AMSA)
Historic Shipwrecks Act 1976 (& Historic Shipwreck Regulations 1978)	Protects the **heritage values of shipwrecks and relics** for shipwrecks over 75 years or more. It is an offence to interfere with a shipwreck covered by this act**.** ***Relevance:*** *Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified & assessed (as applicable) within this EP.*	• Australian-Netherlands Agreement concerning old Dutch Shipwrecks 1972 • Convention on Protection of Underwater Cultural Heritage 2001	DOEE

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Ozone Protection & Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of **ozone depleting substances (ODPs) and SGGs**. ***Relevance:*** *Applicable to the handling of any ODP or SGG Substances on vessels during survey.*	• MONTREAL Protocol on substances that deplete the ozone layer 1987 (Concerns the phase-out of ODPs) • UN Framework Convention on Climate Change 1992 (Stabilise greenhouse gas concentrations in the atmosphere at a level which would prevent dangerous interference with the climate system)	DOEE
National Environment Protection Council Act 1994	Council develops (in conjunction with other state authorities) through the Intergovernmental Agreement on the Environment (IGAE) sets consistent environmental standards to be adopted between states. These requirements take the form of a National Environmental Protection Measure (NEPM) and include the *National Pollutant Inventory.* ***Relevance:*** *Pollution discharge monitoring and measurement.*	Not applicable	National Environment Protection Council
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	Regulates ship-related operational activities in Commonwealth waters and invokes certain requirements (discharge conditions and constraints) of the **MARPOL convention (Annexes I, II, III, IV, V & VI) relating to discharge of oil, noxious liquid substances, sewage, garbage, air pollution etc.** ***Relevance:*** *Discharge practices (oil/water, sewage, air emissions, garbage) by survey vessel activities observe these constraints.*	International Convention for the Prevention of Pollution from Ships [MARPOL 73/78] provisions and unified interpretations of the articles, protocols and Annexes of MARPOL 73/78, including the incorporation of all amendments that have been adopted by the MEPC and have entered into force, up to and including the 2000 amendments (as adopted by resolution MEPC.89(45))	AMSA
Biosecurity Act 2015 (& Regulation 2016)	The Act empowers authorities to assess and manage biosecurity risks associated with good and conveyances (for example, aircraft and vessels). Authorities may quarantine goods, vessels and people to **prevent the introduction, establishment or spread of diseases or pests (e.g. invasive marine species)** affecting human beings, animals, or plants. For the petroleum industry, it regulates the condition of vessels and drill rigs entering Australian waters with regard to ballast water and hull fouling. **Relevance:** The survey and support vessels will adhere to guidelines regarding quarantine clearance to enter Australian ports and waters. *Requirement observed within practices developed for survey vessels during international transits.*	International Convention for the Control and Management of Ships Ballast Water & Sediments 2004 World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS agreement) World Organization for Animal Health (OIE) and the International Plant Protection Convention (IPPC).	Department of Agriculture and Water Resources (DAWR)

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Navigation Act 2012	Regulates ship-related activities and invokes certain requirements of the MARPOL convention relating to **equipment and construction of ships (vessel survey and certification); crewing; seafarers' qualifications and welfare; occupational health and safety; carriage and handling of cargoes; and marine pollution prevention.** Several Marine Orders (MO) are enacted under this Act relating to offshore petroleum activities, including: • MO Part 11: Living & Working Conditions on Vessels • MO Part 21: Safety and emergency arrangements • MO Part 27: Safety of navigation and radio equipment • MO Part 30: Prevention of collisions • MO Part 41: Carriage of Dangerous Goods • MO Part 42: Carriage, stowage and securing of cargo and containers • MO Part 50: Special purpose ships • MO Part 57: Helicopter operations • MO Part 59: Offshore industry vessel operations • MO Part 91: Marine Pollution Prevention - Oil • MO Part 93: Marine Pollution Prevention - Noxious liquid substances • MO Part 94: Marine Pollution Prevention - Packages harmful substances • MO Part 96: Marine Pollution Prevention - Sewage • MO Part 95: Marine Pollution Prevention - Garbage • MO Part 97: Marine Pollution Prevention - Air pollution • MO Part 98: Marine Pollution Prevention - Antifouling Systems ***Relevance:*** *Observed in the selection of vessels for survey activities.*	International Convention for the Prevention of Pollution from Ships [MARPOL 73/78] (*certain sections*) International Convention for Standards of Training and Watch-keeping for Seafarers (STCW) International Convention for the Safety of Life at Sea (SOLAS) Convention on the International Regulations for Preventing Collisions at Sea (COLREGS) United Nations Convention on the Law of the Sea (UNCLOS)	Department of Infrastructure & Regional Development (administration) /AMSA (operational activities)
Protection of the Sea (Harmful Anti-fouling Systems) Act 2006	Regulates the use of harmful **anti-fouling systems employed on boats** and their effects on the marine environment. ***Relevance:*** *Observed in the selection of vessels for survey activities.*	International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001	Department of Infrastructure & Transport & Regional Development (administration)/AMSA (operations)

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Protection of the Sea (Powers of Intervention Act) 1981	This Act gives AMSA appropriate powers to intervene in shipping operations to protect the Australian coastline. ***Relevance:*** *AMSA authority acknowledged in these seismic activities.*	Convention relating to the Intervention on the High Seas in Cases of Oil Pollution Casualties (Provides for state parties to intervene on ships on the high seas when their coastlines are threatened by an oil spill from that ship).	AMSA
Protection of the Sea (Oil Pollution Compensation Fund) Act 1993	This act implements the requirements of the International Convention for the Establishment of an International Fund for Compensation of Oil Pollution Damage.	International Convention for the Establishment of an International Fund for Compensation of Oil Pollution Damage 1992	AMSA
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage which sets up a compensation scheme for those who suffer damage caused by spills of oil that is carried as fuel in ships' bunkers. There is an obligation on ships over 1,000 gross tonnage to carry insurance certificates when leaving/entering Australian ports or leaving/entering an offshore facility within Australian coastal waters. ***Relevance:*** *Survey vessel to hold the necessary insurance certificates.*	International Convention on Civil Liability for Bunker Oil Pollution Damage 2000	AMSA
Protection of the Sea (Shipping Levy) Act 1981	Provides that where, at any time during a quarter when a ship with tonnage length of no less than 24 m was in an Australia port, there was on board the ship a quantity of oil in bulk weighing more than 10t, a levy is imposed in respect of the ship for the quarter. ***Relevance to this survey:*** *The survey and support vessels will adhere to the shipping levy.*	Not applicable	AMSA
National Greenhouse and Energy Reporting Act 2007	Introduces a single **national reporting framework** for the reporting and dissemination of information about **greenhouse gas emissions**, greenhouse gas projects and **energy use and production of corporations.** ***Relevance:*** *Requirement to report greenhouse gas emissions above certain thresholds.*	Not applicable	Clean Energy Regulator

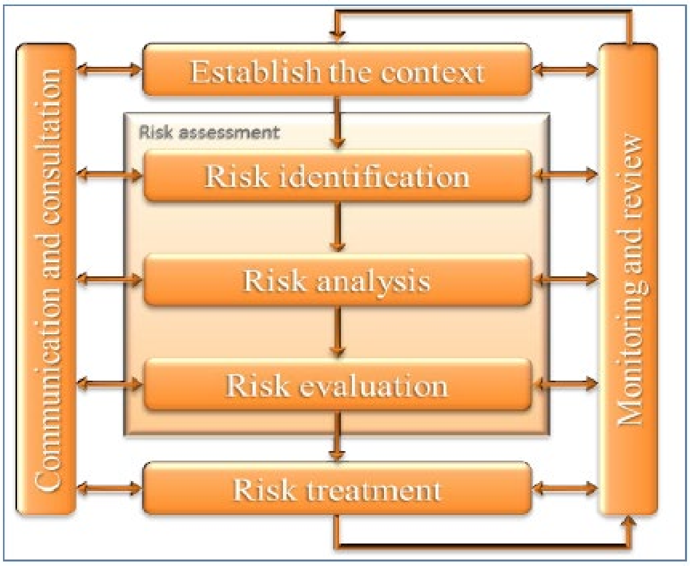
Table 4-2: Key South Australian Legislation

Legislation	Coverage
Environment Protection Act 1993	Act which seeks to protect, restore and enhance the quality of the environment and provides the framework for waste disposal aspects. Administered by the Environment Protection Authority (SA).
Protection of Marine Waters (Prevention of Pollution from Ships) Act 1987	This Act is the South Australian state legislation giving effect to the requirements of MARPOL 73/78 within state waters (i.e. pollution by oil and other substances). Administered by the SA Department of Planning, Transport and Infrastructure (DPTI).
Dangerous Substances Act 1979	This Act regulates keeping, handling, transport, conveyance, use and disposal of dangerous substances. Administered by Safework SA.

5 Environmental Impacts and Risk Assessment Methodology

This section provides details of the environmental impact assessment (EIA) and environmental risk assessment (ERA) methodology employed for the Duntroon multi-client survey. This methodology adopts PGS's risk assessment framework which is consistent with the approach outlined in ISO14001 (*Environmental Management Systems*), ISO31000:2009 (*Risk Management*) and HB203: 2012 (*Environmental Risk Management – Principles and Process*). Figure 5-1 provides the key steps in the process adopted for managing impacts and risks associated with the activity.

Figure 5-1: AS/NZS ISO 31000 - Risk Management Process



5.1 Environmental Hazard Assessment Methodology

For this activity, the environmental hazards, impacts and risks have been identified and assessed by undertaking the following steps:

- Defining the activity and associated environmental hazards (planned and unplanned);
- Identifying the environmental and social values at risk within, and adjacent to, the petroleum activity area;
- Establishing the credible environmental impacts of the hazard to receptors and determine the maximum impact for each hazard associated with the proposed activity[41]. Impacts are assessed across many dimensions (e.g., environment, safety, reputation, financial);
- For unplanned environmental hazards (incidents), identifying the likelihood of occurrence of the impact;
- Identify control measures to eliminate or reduce the level of impact and/or the likelihood of the impact occurring;
- Assign a level of residual impact or risk (after control measures are implemented) utilizing the PGS qualitative risk matrix. In accordance with PGS's acceptance criteria, the impacts and risks continue to be reassessed until it is demonstrated the impact and risk is reduced to a level which is as low as reasonably practicable (ALARP) and is acceptable to PGS's acceptance criteria.

For the Duntroon multi-client survey, environmental hazard identification and assessment has considered the following:

[41] This is the impact or risk of the hazard given no control measures (inherent impact or risk).

- Survey program details including acoustic array/streamer details/equipment type, proposed location and timing of survey and the support activities which are proposed (e.g. escort vessel, possible wastes generated from seismic acquisition (e.g. lithium batteries), possible fluid discharges from streamers, etc.);
- The general vessel activities/operations during the survey and the possible threats to marine species and habitats;
- Environmental sensitivity of the receiving environment with respect to species distribution, subsea habitat types and location of environmentally sensitive areas (i.e. breeding, resting, etc.,) undertaken as part of literature reviews; and
- Feedback from marine stakeholders to understand possible socio-economic activities which may conflict with seismic operations via communication and consultation activities.

Within this context a listing of credible activity-related environmental hazards and possible impacts and risk are identified for the activity.

5.2 Impacts and Risk Evaluation

5.2.1 Definitions

Regulation 14(5) & (6) of the OPGGSER requires that the EP detail and evaluate the environmental impacts and risks for an activity including control measures used to reduce the impacts and risks of the activity to ALARP and an acceptable level. This must include impacts and risks arising directly or indirectly from all activity operations (i.e. planned events) or potential emergency or incident conditions (i.e. incident events).

For this activity, PGS has determined that impacts and risks, and the planned and incident events are defined as follows:

- **Impacts** result from events where there *will* be consequences associated with the event occurring. Impacts are an inherent part of the activity. For example, there will be sound emissions with associated impacts due to vessel activity.
- **Risks** result from events where there *may* be consequences if the incident event actually occurs. Risk is a combination of the *consequences* of an event and the associated *likelihood* of its occurrence. For example, a hydrocarbon spill may occur if a vessel's fuel tank is punctured by a collision incident during the survey. The risk of this event is determined by assessing the consequence of the impact (using factors such as the type and volume of fuel and the nature of the receiving environment) and the likelihood of this event happening (which may be determined qualitatively or quantitatively).

5.2.2 Impact and Risk Evaluation Process

The purpose of impact and risk evaluation is to assist in making decisions, based on the outcomes of analysis, about the controls required to reduce an impact or risk to ALARP. For both planned and incident events, the following methodology has been followed.

1. **Calculate Inherent Impact & Risk for a Particular Hazard**
    a. Select the Consequence (impact) Level: Determine the worst-case credible outcome associated with the hazard assuming all existing preventative controls have failed. Where more than one impact applies (e.g. environmental and social/cultural) the consequence for each impact is recorded (refer Table 5-1).
    b. For an incident event: Select the likelihood level from the description that best fits the chance of the identified consequence occurring (Refer Table 5-2).
    c. For an incident event: Calculate the inherent risk ranking. This is determined by a comparison of the selected consequence and likelihood levels using the qualitative risk matrix in Table 5-3**.**

Table 5-1: Environmental Consequence Categories

Consequence Category	Biodiversity and Ecosystem Function			Environmental Quality			Social	
	Protected Species	Marine Primary Producer Habitat	Ecological Diversity	Water Quality	Sediment Quality	Air Quality	Protected Areas	Cultural
Catastrophic	Local population eradication and/or loss of critical habitats/activities	Permanent eradication at regional scale	Permanent effects at regional scale	Permanent reduction in water quality. Known biological effect on a regional scale	Permanent contamination with known biological on a regional scale	Continuous damage to the environment and/or human health	Significant permanent effects on one or more of protected areas values	Significant, permanent effects on aesthetic, economic or recreational values. Overall societal benefits do not outweigh impacts
Massive	Extensive population-level effects. Significant effect on critical habitats/activities	Large-scale, long term effects. Recovery >10 years, or effects permanent	Large-scale, long term effects. Recovery >10 years or effects permanent	Continuous or regular discharge. Known biological effect concentrations on large scale (1-100 km^2)	Long term contamination above background. Known biological effect concs. On large scale	Sustained, exceedance over national/ international air quality standards. Potential harm to environment or human health	Significant long term effects on one or more of protected areas values	Significant long term effects on aesthetic, economic or recreational values. Overall societal benefits do not outweigh impacts
Major	Minor disruption to significant portion of population. Minor effects on critical habitats/ activities. No threats to population viability	Localised but long term effects. Recovery >10 years, or effects permanent	Localised, long term effects. Community maintains ecological integrity with significant change in composition	Continuous or regular discharge. Known biological effect concentrations on medium scale (1-10 km^2)	Short to medium-term contamination above background. Known biological effect concs on large scale	Major and temporary exceedance over national/international air quality standards. Potential harm to env. or human health	Minor but long term or permanent effects on one or more of protected areas values	Major effects on aesthetic, economic or recreational values. Overall societal benefits do not outweigh impacts
Moderate	Minor disruption to small portion of population. Minor, temporary effects on critical habitats/ activities. No threat to population viability	Localised, medium-term effects. Recovery 5-10 years	Localised, medium-term effects. Ecological integrity maintained with insignificant change to species composition	Continuous or regular discharge. Known biological effect concentrations on small scale (<1 km^2)	Short to medium-term contamination above background. Known biological effect concentrations on medium scale	Moderate and temporary exceedance over national/ international air quality standards. No harm to the environment or human health expected	Minor and medium-term effects on one or more of protected areas values. Full recovery expected	Moderate effects on aesthetic, economic or recreational values but overall societal benefits outweigh impacts
Minor	Minor and temporary disruption to small portion of population. No effects on critical habitats/activities	Localised, short term effects. Recovery in the timescale of months to <5 years	Localised, short to medium-term effects. Full recovery expected	Temporary discharge with contamination above B/G levels. Known biological effect concentrations on medium scale (<10 km^2)	Temporary contamination above background. Known biological effect concentrations on medium scale	Minor and temporary exceedance over national/international air quality standards. No harm to the environment or human health expected	Minor and short term effects on one or more of protected areas values. Full recovery expected	Minor and temporary effects on aesthetic, economic or recreational values
Slight	Possible incidental effects to flora and fauna in a locally affected environmental setting	Localised, temporary effects. Recovery in the timescale of days to weeks	Localised, temporary effects. Slight impact on ecological integrity or species composition	Temporary discharge with contamination above background levels. Known biological effect concentrations on small scale (<1 km^2)	Temporary contamination above background. Known biological effect concentrations on small scale	Slight, temporary exceedance over national/international air quality standards. No harm to the environment or human health expected	Slight to negligible effects on any protected area values	Slight to negligible effects on aesthetic, economic or recreational values

Table 5-2: Operational likelihood categories

Category	Likelihood Description		
	Definition	Probability	Experience History of Occurrence in Company or Industry
Remote	Once every 10,000-100,000 years at location	1 in 100,000-1,000,000	Unheard of in the industry
Highly Unlikely	Once every 1,000-10,000 years at location	1 in 10,000-100,000	Has occurred once or twice in the industry
Unlikely	Once every 100-1,000 years at location	1 in 1,000-10,000	Has occurred many times in the industry, but not in the Company
Possible	Once every 10-100 years at location	1 in 100-1,000	Has occurred once or twice in the Company
Likely	Once every 1-10 years at location	1 in 10-100	Has occurred frequently in the Company
Highly Likely	More than once a year at location or continuously	>1 in 10	Has occurred frequently at the location

Table 5-3: PGS Semi-quantitative risk matrix

		LIKELIHOOD Level					
		Remote	Highly Unlikely	Unlikely	Possible	Likely	Highly Likely
CONSEQUENCE Level	Catastrophic	2	2	1	1	1	1
	Massive	3	2	2	1	1	1
	Major	3	3	2	2	1	1
	Moderate	4	3	3	2	2	1
	Minor	4	4	3	3	2	2
	Slight	4	4	4	3	3	2

2. Identifying Control Measures

For each identified impact and risk, control measures are required to reduce the impact or risk. Although commonly used for Occupational Health and Safety (OHS) hazard control, the hierarchy of controls is a useful framework to identify effective controls (refer Figure 5-2). Multiple controls from this hierarchy provide a depth (number) and breadth (control type) to prevent the impact or risk. Control types listed in the upper section of the hierarchy are recognised as more effective in terms of functionality, availability, reliability, survivability, independence and compatibility given their inherent design characteristics.

Figure 5-2: Hierarchy of Controls

Control Type	Effectiveness	Seismic Survey Examples
Eliminate		Get rid of the impact or risk. Excess chemicals are returned to shore rather than discharged overboard.
Substitute		Change the impact or risk for a lower one. Substitute a large airgun array for a smaller one.
Engineering		Engineer out the impact or risk. Use solid streamers rather than fluid-filled streamers
Isolation		Isolate people or the environment from the impact or risk. Avoid acquiring data near sensitive turtle nesting beaches during nesting season
Administrative		Provide instructions/training to people to lower impact/risk. The use of procedures (e.g. at sea refuelling) and pre-work job hazard analysis (JHAs) to assess and minimise the environmental impact/ risk.

3. Calculating the Residual Impact and Risk

With control measures implemented, all inherent impacts and risks are then reassessed for their residual consequence and risk according to the PGS qualitative risk matrix (refer Table 5-3). If the residual impact or risk does not meet the ALARP tolerability criteria provided in Table 5-4, iterations on the assessment process continue until the impact or risk is considered broadly acceptable; or additional controls have been identified and/or rejected or accepted via an ALARP demonstration.

Table 5-4: Risk and impact levels and associated management response actions

ALARP Criteria	Impact	Risk	Environmental Threshold	Environmental Decision Principles
Broadly Acceptable Zone	SLIGHT	LOW (4)	No substantial impact or risk (i.e. negligible risk) of harm to species or communities	If the environmental impact or risk of the hazard has been found to be 'Broadly Acceptable' and the control measures are consistent with applicable standards and good industry practice then no further action is required to reduce the risk further. However, if a control measure that would further reduce the impact or risk is readily available, and the cost of implementation is not disproportionate to the benefit gained, then it is considered 'reasonably practicable' and should be implemented.
ALARP Zone	MINOR MODERATE MAJOR	MEDIUM (2-3)	Likely to cause, or substantial risk of causing serious harm to non-listed species or communities	An iterative process to identify alternative / additional control mechanisms has been conducted to reduce the impact or risk to the 'Broadly Acceptable' zone. However, if the risk cannot be reasonably reduced to the 'Broadly Acceptable' zone without grossly disproportionate sacrifice; then the mitigated environmental risk is considered to be ALARP.
Intolerable Zone	MASSIVE CATASTROPHIC	SEVERE (1)	Likely to cause, or substantial risk of causing significant impact to protected species or communities	If the environmental impact or risk has been found to fall within this zone then the activity should not be carried out. Work to reduce the level of risk should be assessed against the Precautionary Principle with the burden of proof requiring demonstration that the risk has been reduced to the ALARP Zone before the activity can be commenced.

4. Demonstration of ALARP

The level of ALARP assessment is dependent upon the residual impact and risk level, and the degree of uncertainty associated with the assessed impact or risk.

a. **Residual Risk Level:** For higher level impact and risk residuals, ALARP assessments shall consider:

i. Alternative (replacement) controls which may be potentially effective (e.g. lie higher on the hierarchy of controls);

ii. Additional controls which add to the suite of control measures which reduce the environmental impact; and

iii. Improvements to already adopted controls which increase their effectiveness.

All controls considered are documented and the justification for accepting or not adopting the controls documented as part of the assessment. Methods used for justifying whether a control may or may not be accepted include:

- *Comparative Options Assessments*: Evaluation of a range of control measure options describing the relative merits and drawbacks, with the selection of options which are practicable and offer environmental benefit; and/or

- *Cost Benefit Analysis* (as required): Numerical assessment of costs relating to the control measure, the expected risk reduction expected and the cost of the measure to be implemented.

The final residual impact and risk is then determined by reassessing the residual consequence and risk according to the PGS qualitative risk matrix (refer Table 5-3).

As per Table 5-4, impacts and risks are reduced to ALARP where:

i. The residual impact is SLIGHT, or risk is LOW:

   1. Good industry practice or comparable standards have been applied to control the impact or risk, because any further effort towards impact and risk reduction is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.

ii. The residual impact or risk is MEDIUM:

   1. Good industry practice is applied for the impact/risk; and

   2. Alternative controls have been identified and the control measures selected reduce the impacts and risks to ALARP. This may require assessment of industry benchmarking, review of local and international codes and standards, consultation with stakeholders, etc.

b. **Impact/Risk Uncertainty:** Based upon the level of uncertainty associated with the impact or risk, the following framework, adapted from the Guidance on Risk Related Decision Making (Oil & Gas UK, 2014) (refer **Figure 5.3**) provides the decision-making framework to establish ALARP.

This framework provides appropriate tools, commensurate to the level of uncertainty or novelty associated with the impact or risk (referred to as the Decision Type A, B or C). The decision type is selected based on an informed decision around the uncertainty of the risk. Decision types and methodologies to establish ALARP are outlined in Table 5-5**.**

Figure 5-3: Impact and Risk-related Decision-Making Framework

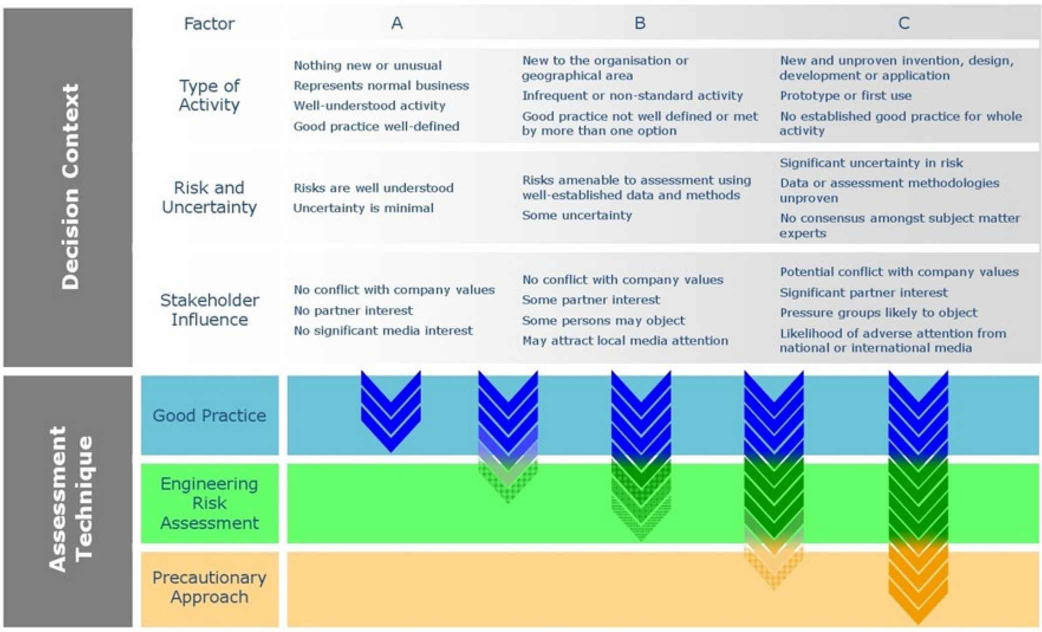


Table 5-5: ALARP Decision-making based upon Level of Uncertainty

Decision Type	Description	Decision Making Tools
A	Impacts and risks classified as a Decision Type A are well-understood and established practice.	**Legislation, codes and standards (LCS):** Identifies the requirements of legislation, codes and standards which are to be complied with for the activity **Good Industry Practice (GIP)**: Identifies further engineering control standards and guidelines which may be applied over and above that required to meet the legislation, codes and standards. **Professional Judgement (PJ)**: Uses relevant personnel with the knowledge and experience to identify alternative controls. When formulating control measures for each environmental impact or risk, the 'Hierarchy of Controls' philosophy, which is a system used in the industry to identify effective controls to minimise or eliminate exposure to impacts or risks, is applied.
B	Impacts and risks classified as a Decision Type B are typically in areas of increased environmental sensitivity with some stakeholder concerns. These risks may deviate from established practice or have some life-cycle implications and therefore require further analysis using the following tools in addition to those described for a Decision Type A	**Risk-based tools such as cost based analysis or modelling:** Assesses the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost benefit analysis to support the selection of control measures identified during the risk assessment process. **Company values:** Identifies values identified in PGS's HSEQ Policy.
C	Impacts and risks classified as a Decision Type C will typically have significant risks related to environmental performance. The risks may result in significant environmental impact; significant project risk/ exposure; or may elicit strong stakeholder awareness and negative perception. For these risks, in addition to Decision Type A and B tools, company and societal values need to be considered by undertaking broader internal and external stakeholder consultation as part of the risk assessment process	**Societal Values (SV):** Identifies the views, concerns and perceptions of relevant stakeholders and addresses relevant stakeholder concerns as gathered through consultation

5. Demonstration of Acceptability

PGS considers a range of factors when evaluating the acceptability of environmental impacts or risks associated with its activities. This evaluation works at several levels, as outlined in Table 5-6 and is based on NOPSEMA's Guidance Notes for EP Content Requirements (N04750-GN1344, Rev 3, April 2016).

Table 5-6: PGS Acceptability Criteria

Test	Question	Acceptability Demonstrated
Internal Context: Policy Compliance	Is the proposed management of the risk or impact aligned with PGS's HSE Policy?	The impact or risk must be compliant with the objectives of the company's policies.
Internal Context: Management System Compliance	Is the proposed management of the impact or risk aligned with the HSEQ Management System?	Where specific procedures/ work instructions are in place for management of the impact and risk in question, acceptability is demonstrated
External Context: Commonwealth and State legislative criteria, industry standards and best practice	Is the impact or risk or impact being managed in accordance with existing Australian or international laws or standards?	Compliance with specific laws or standards is demonstrated.
External Context: Marine reserve management plans, species recovery plans, conservation advice and threat abatement plans.	Is the impact or risk meeting the management objectives outlined in species recovery plans, CMR management plans and species conservation advice?	Assessment and compliance with documented
External Context: Stakeholder Engagement	Have stakeholders raised any objections or claims about adverse impacts associated with the activity, and if so, have merits of the objection been assessed? For those objections and claims with merit, have measures been put in place to manage those concerns?	Stakeholder concerns must have been adequately responded to and closed out
External Context: Environmental Context	Is the impact or risk being managed pursuant to the nature of the receiving environment (e.g. sensitive or unique environmental features generally require more management measures to protect them than environments widely represented in a region)?	The proposed impact or risk controls, EPO and EPS must be consistent with the nature of the receiving environment

Test	Question	Acceptability Demonstrated
Environmentally Sustainable Development (ESD) Principles (EPBC Act 1999 Section 3A):	Does the proposed risk/impact comply with the APPEA Principles of Conduct (APPEA, 2008), requiring integration of ESD principles into company decision-making; and Government policy frameworks which integrate ESD principles into implementation strategies. ESD Principles are: A) Decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations (NB: *This principle is inherently met through the EP assessment process. This principal is not considered separately for each acceptability evaluation*). B) If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. *If there is, the project shall assess whether there is significant uncertainty in the evaluation, and if so, whether the precautionary approach should be applied* C) The principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. (*NB. The EP assessment methodology ensures that potential impacts and risks are ALARP, where the potential impacts and risk are determined to be serious or irreversible the precautionary principle is implemented to ensure the environment is maintained for the benefit of future generations. Consequently, this principal is not considered separately for each acceptability evaluation*) D) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making (*Project to consider if there is the potential to affect biological diversity and ecological integrity*) E) Improved valuation, pricing and incentive mechanisms should be promoted (*Not relevant to this EP*)	The overall operations are consistent with the APPEA Principles of Conduct and Commonwealth environmental strategy documents.
Environmental impact & risk (ALARP)	Are there any further reasonable and practicable controls that can be implemented to further reduce the impact or risk?	There is a consensus that residual risk has been demonstrated to ALARP.

5.3 Monitor and Review

Monitoring and review activities are incorporated into the impact and risk management process for the purpose of ensuring that controls are effective and efficient in both design and operation. This is achieved for the proposed survey through the environmental performance outcomes, standards and measurement criteria that are described for each environmental hazard in **Section 6** of this EP. Additional aspects of monitoring and review are described in the Implementation Strategy in **Section 7** of the EP:

- Analysing and lessons learnt from events (including near-misses), changes, trends, successes and failures;
- Detecting changes in the external and internal context, including changes to risk criteria and the risk itself which can require revision of risk treatments and priorities; and
- Identifying emerging risks.

6 Environmental Impact and Risk Assessment

This section outlines the outcomes of the environmental impact and risk assessments completed for the Duntroon multi-client survey using the methodology described in **Section 5**. The impacts from planned activities are assessed in **Section 6.1** to **6.8** and risks from unplanned activities are assessed in **Section 6.9** to **6.19.**

This section also details the environmental performance outcomes, performance standards and measurement criteria for each of the identified environmental hazards. Where measurement criteria associated with *performance outcomes or performance standards* are not met, a recordable incident is recorded and will be reported to NOPSEMA (refer **Section 8.4**). The following legislative and guideline definitions are used within this section:

- **Environmental performance outcomes** (EPO) are defined as a measurable level of performance required for the management of the environmental aspects of the activity to ensure the environmental impacts and risks will be of an acceptable level;
- **Environmental performance standards** (EPS) are defined as a statement of performance required of a control measure; and
- **Measurement criteria** define the measure by which environmental performance will be measured and whether the outcome has been met during the activity.

A summary of the residual rankings for all impacts and risks identified and assessed in this section are summarized in Table 6-1**.**

Table 6-1: Duntroon multi-client survey environmental impact and risk rankings summary

#	Environmental Hazard	Section	Residual Impact or Risk Ranking
Impacts			Impact
1	Lighting impacts	6.1	SLIGHT
2	Acoustic sound disturbance (seismic source)	6.2	MINOR
3	Treated bilge water discharges (vessels)	6.3	SLIGHT
4	Sewage/grey water discharges (vessels)	6.4	SLIGHT
5	Food-scrap discharges (vessels)	6.5	SLIGHT
6	Air emissions	6.6	SLIGHT
Risks			Risk
1	Introduction of invasive marine species	6.7	LOW
2	Disruption to commercial shipping	6.8	LOW
3	Disruption to commercial fishing	6.9	LOW
4	Vessel Collision spill (diesel)	6.10	MEDIUM
5	Oil Spill Response	6.11	LOW
6	Deck spill (chemical/oil)	6.12	LOW
7	Waste overboard incident (solid/non-biodegradable)	6.13	LOW
8	Seismic streamer loss	6.14	MEDIUM
9	Cetacean collision by vessel	6.15	LOW

Routine, planned or known activities (e.g., routine discharges or emissions) with a known impact are assigned an environmental impact rating from 'slight' through to 'catastrophic'. Accordingly, the impact assessment tables presented in **Sections 6.2** to **6.7** provide impact consequence rankings (rather than a risk ranking).

Incidents *may* or *may not* occur. Accordingly, assessment is based upon a risk analysis which focuses on the impact if the event occurs and its likelihood of occurrence (for example, a diesel spill from a vessel). The assigning of a likelihood and consequence ranking is based on the knowledge and experience of those involved in the survey as well as, where possible, data on event probabilities (e.g., vessel collision frequencies, etc.).

6.1 Impact – Light emissions

6.1.1 Hazard

Light emissions will be emitted from all survey vessels on a 24 hour per day basis during survey activities from the following:

- For marine safety, vessel navigation lighting in accordance with the *Navigation Act 2012*, Marine Order Part 30 (Prevention of Collisions) will be maintained to provide clear identification to other marine users;
- Deck lighting will be provided to allow for the safe movement of personnel around the deck during hours of darkness; and
- For intermittent periods during night hours, spot lighting may be required for in-sea equipment inspection, deployment, and retrieval (this will mainly involve the use of spot-lights focusing aft of the vessel towards the source and deflectors). It should be noted that prevailing sea state conditions in the region may preclude in-water night-hour inspections on a personal safety basis.

6.1.2 Known and potential impacts

The known and potential impacts of artificial lighting sources in the marine environment are:

- Light on vessels may attract light-sensitive species such as seabirds, squid and zooplankton;
- Artificial lighting may affect species during breeding periods (e.g. shearwaters, turtle hatchlings).

6.1.3 Evaluation of environmental impacts

High levels of marine lighting can attract and disorient seabird species resulting in species behavioural changes (e.g. circling light sources leading to exhaustion or disrupted foraging), injury or mortality close to the light source. It is understood that bird strikes have been recorded on fishing vessels in the Southern Ocean where powerful ice lights are used in back-deck activities, however bird mortality arising from these events are generally low (Black, 2004). Seismic vessels do not utilise such lighting on back-deck activities with the lighting emitted diffuse and considered to be similar to passing commercial shipping. Given the temporary and constantly moving nature of the light source measurable impacts to marine bird species are not expected.

Artificial light can cause significant impacts on burrow-nesting petrels and shearwaters. Fledglings often become disoriented and grounded from artificial light adjacent to rookeries as they attempt to make their first flights to sea, a phenomenon known as ‘fallout’ (Birdlife International, 2012). Rodrigez at al. (2014) investigated the effects of artificial lighting from road lighting on short-tailed shearwater fledglings. The study established by removing this light source located close to nesting areas there was a decrease in grounded fledglings and a corresponding reduction in bird fatalities. Marine operations will operate at significant distance from coastal bird colonies (> 51 km) and measurable impacts on fledglings from vessel lighting are not expected.

Other marine life may also be attracted to the survey vessels as a result of an attraction by prey items (e.g., fish, squid and plankton) that can aggregate directly under downward facing lights. This is a technique used by squid jig fishermen, who utilise powerful downward facing lights on stationary vessels, to attract and capture squid species. Fur seals have been reported as being a minor irritation for squid vessels, as they chased prey species attracted to light sources (Gales et al. 2003). As most survey vessel lighting is directed onto deck surfaces rather than marine waters and given the constant movement of the vessels, any impacts arising from light emissions will be localised and temporary only and are considered to be slight.

Light pollution can be an issue along, or adjacent to, turtle nesting beaches where emerging hatchlings orient to, and head towards, the low light of the horizon unless distracted by other lights which disorient and affect their passage from the beach to the sea (EA, 2003). Given the lack of turtle nesting in southern Australia, light impacts to turtle hatchlings are not expected.

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of marine mammals. Cetaceans do not rely upon visual cues, instead relying upon sound (Simmonds et al. 2004). On this basis light is not considered to be a significant factor in cetacean behaviour or survival.

Given the limited duration of survey acquisition and constant movement of the vessel, alteration to marine species foraging patterns or behavioural impacts are considered to be localised, temporary and restricted to a small proportion of the population.

<u>Commonwealth Recovery Plans:</u>

A review of the management actions and objectives listed in threatened species conservation/recovery plans that may be present in the survey area and the possible threats posed by the survey activity have been assessed in **Section 3.6**.

While the Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017) has requirements for lighting minimisation adjacent to nesting beaches, this is not considered relevant to the Duntroon survey location. No management actions, as contained in other recovery/conservation management plans, are considered relevant to marine lighting impacts.

<u>Marine Reserves (Conservation Values and Management Principles)</u>:

PGS has undertaken an assessment of these localised lighting impacts against the requirements of the South-west Marine Parks Network Management Plan 2018 (DNP, 2018),the Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-2). Impacts to relevant CMP conservation values are slight, recoverable and consistent with the management principles for sustainable long-term use of the area. No prescriptions within the Management Plan prevent vessel lighting for safety purposes. ALARP and acceptability is demonstrated in Table 6-2.

6.1.4 Environmental Impact assessment

Table 6-2 provides the impact assessment for vessel light emissions.

Table 6-2: Light emissions EIA

Aspect	Artificial light emissions from survey vessels.
Impact Summary	Light spill attracting light-sensitive species (seabirds, fish, nesting turtles) which may affect predator-prey dynamics.
Extent of Impact	LOW - Localised immediately around constantly moving vessel.
Duration of Impact	Temporary (duration of survey) and recoverable
Level of Certainty of Impact	HIGH. Impacts from lighting in the marine environment have been studied and documented.
Species affected within survey environment:	**Marine seabirds** (protected, widely distributed, small portion of population potentially affected). **Fish** (not protected, widely distributed, small portion potentially affected)
Impact Decision Framework Context	**A** *(nothing new or unusual, represents business as usual, well understood activity, good practice is well defined)*. Impact assessment decision making based upon LCS, GIP and PJ.
Impact with controls failure (Inherent)	
MINOR	

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Reduce vessel external lighting to levels required for navigation, vessel safety and safety of deck operations.	Substitute	YES	Good Practice well defined and established in Marine Orders for vessel operating at sea.
Environmental induction for crew including MFOs, marine, deck and bridge crew	Administrative	YES	Good Practice – established and adopted by the offshore petroleum sector
Periodically inspect lighting on-board to confirm it complies with minimum lighting requirements.	Administrative	YES	Good Practice – established and adopted by the offshore petroleum sector
Alternative Control: Reduce lighting below levels required for navigation and back-deck activities	Substitute	NO	No additional cost but introduces unacceptable safety risk to personnel and vessel. Very little benefit given the low numbers of light sensitive fauna in surrounding survey waters.
Alternative Control: Use of lighting wavelengths that are less intrusive to marine fauna	Engineer	NO	Not regarded as practical given the range of marine fauna that may be present, and the different wavelengths that may affect behaviours of different species. Would result in little benefit given low level of impacts expected
Modified Control: Introduction of low spill lighting shields.	Engineer	NO	Not considered warranted. Back-deck activities are normally semi-enclosed which limits the level of light spill entering the environment.
Impact consequence with controls (residual)			
SLIGHT			
ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS			
EPO	EPS		MEASUREMENT CRITERIA
EPO1: Vessel lighting maintained at a minimum which still allows safe operation. **MC:** Inspection records verify lighting standards are implemented on vessel.	**EPS1:** Vessel deck and navigational lighting aligns with the following standard to prevent light spill to marine waters while ensuring the vessel is visible to other marine vessels: • Marine Order Part 30 (Prevention of Collisions.		Inspection records confirm that lighting is restricted to levels required for safe operations. <u>Responsible Person</u>: Party Chief
	EPS2: Environmental induction for survey crew including MFOs, marine, deck and bridge crew on lighting impacts.		Induction records verify attendance. <u>Responsible Person</u>: Vessel Master
	EPS3: External lighting of vessel is minimised to that required for safe navigation, vessel safety and safety of deck operations except in the case of an emergency.		Inspection records verify this standard is attained. <u>Responsible Person</u>: Vessel Master
Demonstration of ALARP			
Hazard Consequence Criteria	A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.		

Controls Assessment (Hierarchy of Controls)	Eliminate: • *None identified*. A 'do-nothing' approach (i.e. no vessel/ no survey) does not align with outcomes to obtain geological data. This risk is unavoidable and cannot be eliminated. Substitute: • Vessel lighting reduced to a level which meets safety (external and internal) requirements. Engineer: • *No practicable controls identified* Isolate: • Survey area is distant from shoreline species sensitive to artificial light. Administrative: • Inspection activities confirm compliance with required standards. • Vessel induction for relevant crew members on environmental sensitivities.

Compliance with International Conventions, Legislation, Codes and Standards	Compliance with –
	• International Convention:
	  ○ International Regulations for Prevention Collisions at Sea (COLREGS) 1972
	• Legislation (Commonwealth):
	  ○ Navigation Act 2012
	  ○ Marine Order 30 (Prevention of Collisions)
	  ○ Marine Order 11 (Living and Working Conditions on Vessels)
	  ○ EPBC Regulations 2000 (IUCN principles of Schedule 8)

Good Industry Practice	**APPEA CoEP:** Objectives met for offshore seismic surveys with respect to reducing the impacts other marine life to a level which is ALARP and acceptable including: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilisation of appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the seismic source will operate and assess potential impacts. **IAGC** Environment Manual (Worldwide Geophysical Operations): No guidance provided regarding vessel lighting. Compliant with these guidelines.
Professional Judgement	Alternate controls identified but none found to be practicable. Adopted controls cover multiple levels on the control hierarchy.
Engineering Risk Assessment	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
PGS Policy compliance	The risk management strategy for artificial lighting impacts reflects PGS's Environment Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates that PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised about artificial lighting.
External Context: Environment	The survey area is in deep offshore waters which will not affect aggregations of light sensitive species which maybe present along shorelines. Encounter with species will be infrequent given their dispersive characteristics. No turtle nesting is present in southern Australian waters.
External Context: Legislative criteria & standards	Legislation: Commonwealth *Navigation Act 2012* and the following subordinate legislation: • Marine Order Part 11 (Living & Working Conditions on Vessels); and • Marine Order Part 30 (Prevention of Collisions). • EPBC Regulations 2000 (IUCN principles of Schedule 8) Industry Standards: • APPEA CoEP • IAGC Environment Manual

External Context: Marine Reserves, management plans, species recovery plans and conservation advices	Western Eyre CMP: Lighting impacts associated with the survey are contained within the survey area and the Western Eyre CMP (where relevant). Lighting impacts do not conflict with relevant management plan prescriptions, and meet the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*lighting impacts do not compromise this*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Recovery/Conservation Plans: Review and assessment of threatened species recovery plans and conservation advice (refer **Section 3.6**) did not identify threats associated with vessel artificial lighting impacts. No action objectives from recovery plans are applicable to this impact.
Environmental impact demonstrated to be ALARP	The residual impact level meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**)
Environmental Monitoring	
Nil	
Record Keeping	
Safety Inspection Records. Environmental Induction records	

6.2 Impact: Acoustic sound disturbance (seismic source & vessel/helicopter sound)

6.2.1 Hazard

Sound from seismic operations:

Underwater high intensity, low frequency impulse sounds will be generated by the seismic array during survey activities. Sound will be produced at regular intervals with the energy directed primarily towards the seafloor however sound will also radiate at angles close to horizontal potentially propagating sound over long distances. Attenuation of sound with distance is governed by the bathymetry, seabed and oceanographic properties (Urick, 1983).

PGS will utilise a source array of volume size 3260 in^3 (max) for acquisition during the Duntroon MC2D/MC3D survey.

The sound source of 3260 in^3 is considered the smallest source size which ensures that sub-surface reservoir targets are correctly imaged and meaningful data can be acquired. Source volumes do not correspond linearly with source output levels but instead follow a cubic-root relationship. A reduction in source volume has only a minor influence on source level. For example, an 8,000 in^3 array produces about twice the loudness of a 1,000in^3 array when all other parameters held constant (i.e. number of elements and spatial dimensions of the array) (IAGC, 2014).

Based upon this source size assessment, acoustic modelling has been undertaken on a 3260 in^3 array, for the Duntroon MC3D/MC2D MSS by JASCO Applies Sciences (‘JASCO’). The study used four sound propagation models to predict the acoustic field around the airgun array for frequencies from 5 Hz to 25 kHz (modelling report is provided in **Appendix B**). This modelling accounts for the acoustic emission characteristics of a 3260 in^3 seismic source array towed at a depth of 7 m considering source directivity and range dependent environmental properties in the Duntroon survey area. The results are presented as sound pressure levels (SPLs), zero-to-peak pressure levels (PK), peak-to-peak pressure levels (PK-PK) and either per pulse or accumulated sound exposure levels (SEL) as appropriate to the ecological threshold comparison.

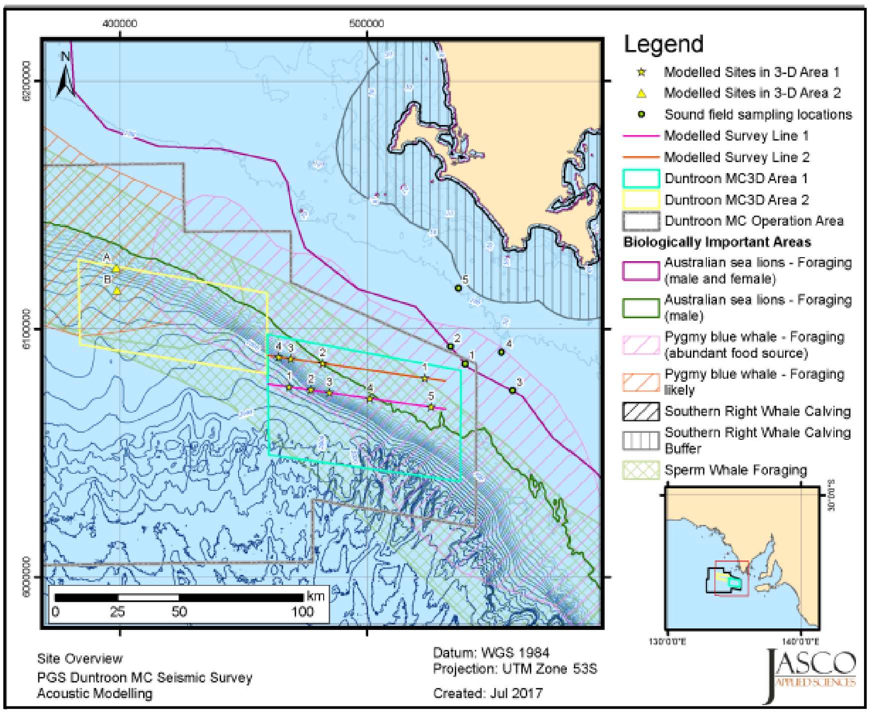
The underwater acoustic signature of the array predicted by JASCO’s Airgun Array Source Volume Model (AASM) accounting for array layout; volume, tow depth, firing pressure of each airgun and interactions between different airguns in the array is provided in Table 6-3. Results predict a broadside peak pressure of 249.5 dB re 1µPa (PK) and end fire peak of 246.2 dB re 1µPa (PK) with energy predominantly in the 10-600 Hz frequency range.

Table 6-3: Source Level Specifications in the horizontal plane for the 3260 in^3 array towed at 7 m water depth (Wladichuk et al. 2018)

Direction	Peak Pressure (PK) (dB re 1µPa @ 1m)	SEL (dB re 1µPa^2.s @1m)		
		10-2,000 Hz	2,000-25,000 Hz	10-25,000 Hz
Broadside	249.5	224.9	186.9	224.9
Endfire	246.2	223.5	186.9	223.5
Vertical (with ghost)[42]	255.6	231.1	197.5	231.1

For the Duntroon MSS, acoustic modelling was performed at multiple sites representative of the differing water depths and bathymetry within the OA (refer Figure 6-1). These sites varied from water depths of 127 m (Line 2, Site 1) to 1496 m (Line 1, Site 1) and covered the continental shelf, shelf break, continental slope and deep-water areas of the OA. Table 6-61 provides the relevant locational details of these modelled sites.

Figure 6-1: Modelled sites and relevant bathymetric features for the Duntroon OA (Wladichuk et al., 2018)



[42] This includes the signal which is reflected off the surface water interface.

Table 6-4: Location details for the modelled sites within the Duntroon OA (SPL and SEL) (Wladichuk et al., 2018)

Permit Area	Line	Site#	Latitude	Longitude	Water Depth	Tow Heading	Bathymetric Feature/ Location
EPP-41/42	1	1	-35.4538	134.6535	1496	098	Deep water
		2	-35.4655	134.7511	1001	098	Continental Slope
		3	-35.4753	134.8331	501	098	Continental Slope
		4	-35.4966	135.0135	164	098	Continental Shelf
		5	-35.5282	135.2866	135	098	Continental Shelf
	2	1	-35.4225	135.2578	127	278	Continental Shelf
		2	-35.3693	134.8035	141	278	Continental Shelf
		3	-35.3521	134.6603	348	278	Continental Slope
		4	-35.3456	134.6064	747	278	Continental Slope
		5	-35.4329	134.3488	128	278	Continental Shelf
EPP-46		A	-35.0171	133.8879	496	278	Continental Slope
		B	-35.0980	133.8903	950	278	Continental Slope

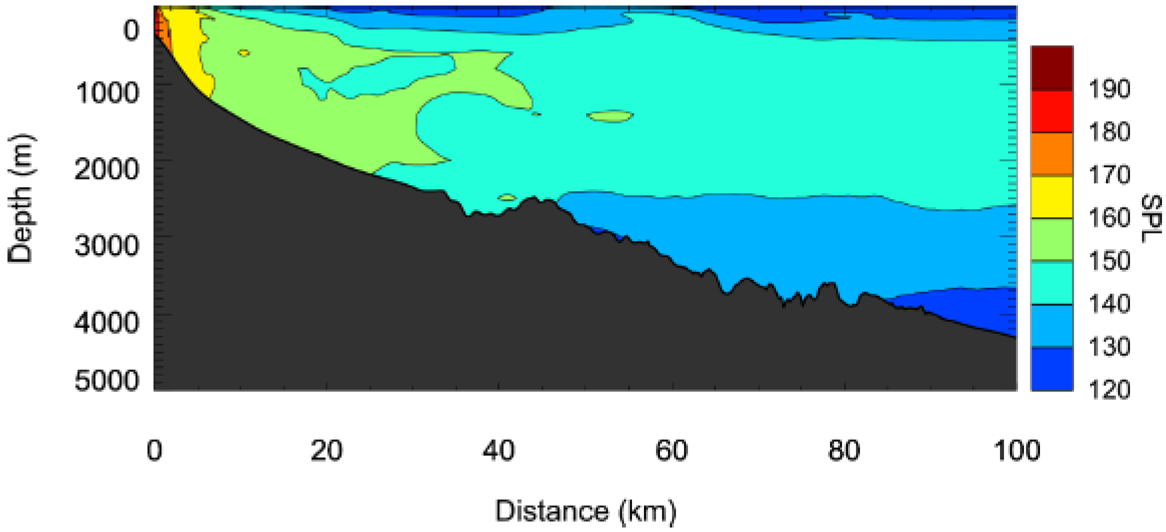
Per Pulse Modelling Results:

SPL and per-pulse SEL sound fields were modelled at ten sites within the EPP-41/42 MC3D survey area and two sites within the EPP-46 MC3D survey area. These locations were selected to establish modelled sound propagation across bathymetric variations within the Duntroon OA forming a library of representative footprints for the survey. Modelled sound results for the SPL and per-pulse SEL isopleths are presented as horizontal distances from the operating array as a 'maximum value' over all modelled depths (refer Table 6-6 and Table 6-7) or as a 'maximum over all depths ≤ 600m' (refer to Table 6-8 and Table 6-9). Note the latter has been established as it is considered more biologically relevant for assessing impacts to mysticetes, turtles and pinnipeds which occupy water depths less than 600 m and represents the "region of effect" rather than sound levels over the entire water column.

Modelling of PK water column levels within EPP-41/42 and EPP-46 assessed the horizontal distances from the array where injury (permanent thresholds shifts (PTS)) impacts to marine species might result. Modelled PK and PK-PK at the seafloor undertaken at locations identified in **Figure 6-3** have been used to determine injury impacts to benthic/ demersal species. These values allow for the assessment of species which live close to the seafloor (e.g. invertebrates, demersal fish).

Distances associated with the per-pulse values are expressed as R_{max} (the maximum range to the given sound level over all azimuths). The alignment of the acquisition lines with the continental shelf and the source directivity causes the broadside lobes to propagate strongly in the offshore direction as depth increases. The modelled sites close to the shelf slope are influenced heavily by the presence of the slope and shows long range propagation towards deeper waters (including the western end fire and southern broadside directions). For the deeper sites the deep water reduces the reflection rate close to the source and limits the range to individual sound thresholds close to the source. At greater distances, the sound footprint is predominantly controlled by bathymetry, with greater propagation towards deeper waters because less energy is lost to seabed interactions.

Figure 6-2: Site 3 Line 2: Predicted unweighted SPL in the offshore direction as a vertical slice. Levels are shown along a single transect from broadside offshore along an azimuth of 188°. The source depth is 7 m and the tow direction is 278° (Wladichuk et al., 2018)



Weighted Cumulative SEL:

Modelling also considered one scenario that assessed the accumulated frequency-weighted SEL of multiple airgun pulses over 24 hours of seismic operation to establish PTS criteria for cetaceans and pinnipeds, and Temporary Threshold Shifts (TTS) in pinnipeds according to the NMFS (2016) criteria. Modelling predicted the cumulative impacts of sound, considered the change in location and azimuth of the source at each pulse point with no mitigation (i.e. shutdowns).

Weighted cumulative SEL_{24h} were also sampled at five locations outside the Duntroon OA which represented the closest approach of the array to the female and male Australian sea lion foraging BIA and the 100 m isobath. The acquisition line characteristics - vessel speed, line spacing, shot interval and turning time used are consistent with those parameters expected on the Duntroon survey. These locations are identified in Figure 6-3 and their locations identified in Table 6-10.

Table 6-5: Location details for the 24hr sound field sampling locations for the Duntroon MSS (Wladichuk et al. 2018).

Permit Area	Label	Latitude	Longitude	Water Depth	Tow Heading	Bathymetric Feature/ Location
EPP-41/42	C	-35.3675	134.7265	200	098	Continental Shelf/Break
	D	-35.4565	134.7216	1099	098	Deep Water
EPP-46	E	-35.1267	134.2016	649	098	Continental Slope
	F	-35.0786	134.2650	160	098	Continental Shelf

Figure 6-3: Seafloor modelling locations for PK sound assessment (Wladichuk et al., 2018)

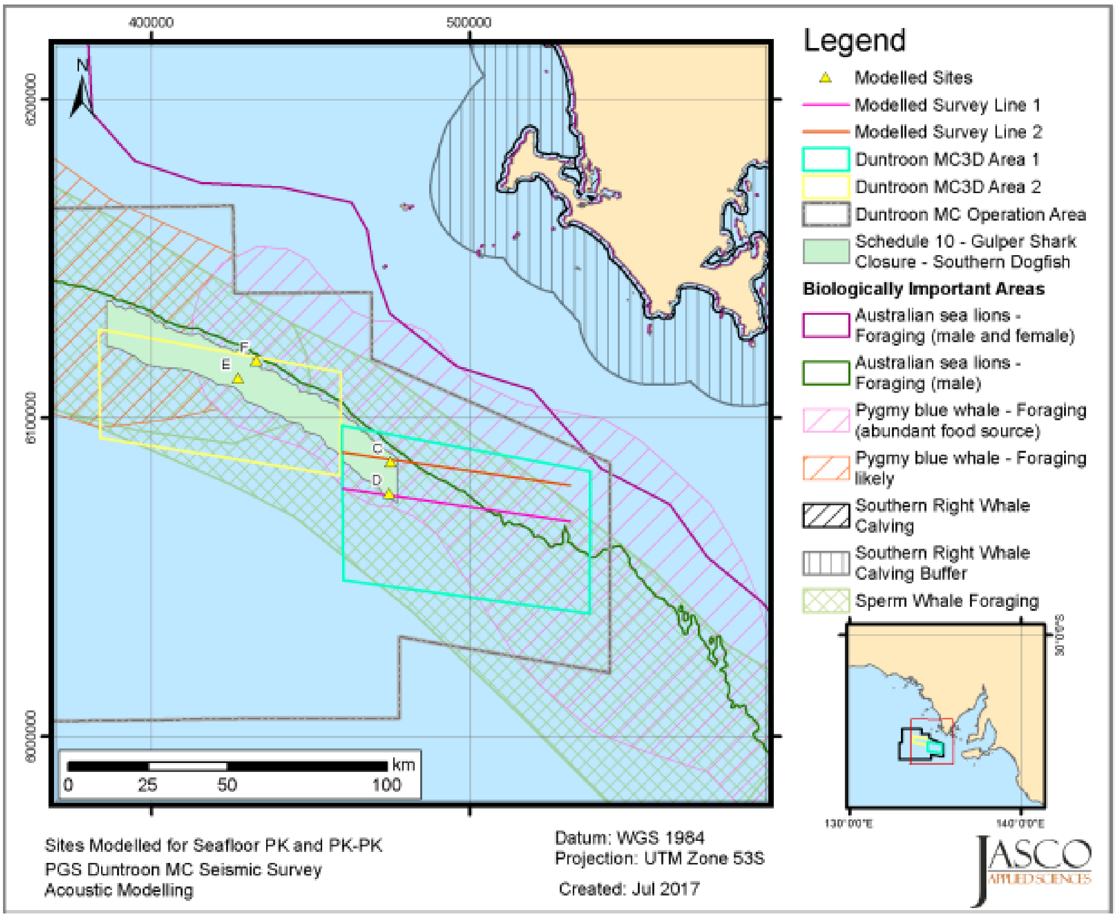


Table 6-6: Maximum (R_{max}) and $R_{95\%}$horizontal distances (in km) from the 3260 in^3 array to modelled maximum over depth per pulse SEL isopleths (Wladichuk et al., 2018)

Per Pulse SEL (dB re 1µPa².s)	Line 1 (EPP-41 & EPP-42)										Line 2 (EPP-41 & EPP-42)								EPP-46			
	Site 1		Site 2		Site 3		Site 4		Site 5		Site 1		Site 2		Site 3		Site 4		Site A		Site B	
	1496 m		1001 m		501m		164m		135m		127m		141m		348m		747m		496m		950m	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.65	0.06
180	0.16	0.13	0.16	0.13	0.16	0.13	0.17	0.15	0.18	0.16	0.18	0.17	0.18	0.16	0.16	0.14	0.16	0.13	0.16	0.13	0.16	0.13
170	0.51	0.42	0.52	0.42	0.53	0.47	0.83	0.68	1.03	0.70	1.02	0.88	0.82	0.68	0.94	0.83	0.52	0.42	0.56	0.48	0.51	0.42
160	**1.75**	**1.54**	**3.2**	**2.52**	**2.88**	**2.29**	**4.00**	**2.98**	**4.47**	**3.50**	**4.12**	**3.48**	**4.32**	**3.33**	**2.51**	**2.06**	**3.18**	**2.45**	**2.78**	**2.23**	**3.03**	**2.52**
150	9.12	7.26	20.17	11.86	13.94	10.75	10.06	8.16	11.60	9.55	11.39	9.31	10.76	8.53	15.97	11.33	17.38	15.54	13.86	12.36	11.83	9.43
140	43.51	31.95	74.48	47.52	88.48	69.88	60.16	47.22	24.62	18.43	24.25	19.58	47.58	32.48	101	64.30	70.47	47.84	69.07	49.64	48.59	37.85
130	108	91.81	137	109	141*	113*	141*	114*	91.24	64.35	72.12	39.52	122	104	141*	114*	137	113	128	106	106	90.22

Table 6-7: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum over depth per pulse SPL isopleths (Wladichuk et al, 2018)

Per Pulse SPL (dB re 1µPa)	Line 1 (EPP-41 & EPP-42)										Line 2 (EPP-41 & EPP-42)								EPP-46			
	Site 1		Site 2		Site 3		Site 4		Site 5		Site 1		Site 2		Site 3		Site 4		Site A		Site B	
	1496 m		1001 m		501m		164m		135m		127m		141m		348m		747m		496m		950m	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.14	0.12	0.14	0.12	0.14	0.12	0.15	0.12	0.15	0.14	0.16	0.14	0.15	0.14	0.14	0.12	0.14	0.12	0.14	0.12	0.14	0.12
180	0.45	0.36	0.45	0.37	0.46	0.38	0.76	0.63	0.72	0.60	0.73	0.61	0.72	0.60	0.84	0.44	0.45	0.37	0.46	0.40	0.45	0.37
170	1.42	1.24	2.68	2.2	2.59	2.07	3.24	2.46	3.63	2.8	3.61	2.86	3.59	2.82	2.28	1.8	2.75	2.11	2.55	1.99	2.66	2.28
166	4.45	3.57	4.43	3.46	3.58	2.82	4.89	3.81	5.38	4.32	5.13	4.30	5.3	4.17	3.69	2.96	4.16	3.33	4.00	3.31	3.84	3.17
160	**7.6**	**6.08**	**11.9**	**9.78**	**10.77**	**6.48**	**7.87**	**6.32**	**9.09**	**7.38**	**8.71**	**7.16**	**8.71**	**6.81**	**11.05**	**6.67**	**12.75**	**6.25**	**13.05**	**8.66**	**9.10**	**6.72**
150	7.84	28.3	48.94	42.2	60.53	45.6	38.25	32.07	19.24	14.62	20.36	16.32	33.92	20.63	59.16	42.25	54.60	43.47	65.65	41.90	43.29	32.91
140	107	89.9	133	100	141*	114*	128	103	65.85	38.56	43.02	34.41	106	94.12	141	114	132	108	117	97.73	105	90.18
130	141*	116*	141*	116*	141*	118*	141*	115*	141	109	114	92.61	141*	113*	141*	119*	141*	118*	141*	119*	141*	119*

*Radii extend beyond modelling boundary and are not able to be defined.

Not recommended for use given distortions of distance by modelling 'sound islands'

Table 6-8: Water Depth ≤ 600m - maximum (R_{max}) and $R_{95\%}$horizontal distances (km) for 3260 in^3 array to modelled maximum over depth per pulse SEL isopleths (Wladichuk et al., 2018)

Per Pulse SEL (dB re 1µPa^2.s)	Line 1 (EPP-41 & EPP-42)										Line 2 (EPP-41 & EPP-42)								EPP-46			
	Site 1		Site 2		Site 3		Site 4		Site 5		Site 1		Site 2		Site 3		Site 4		Site A		Site B	
	1496 m		1001 m		501m		164m		135m		127m		141m		348m		747m		496m		950m	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
180	0.16	0. 13	0. 16	0. 13	0. 16	0. 13	0. 17	0. 15	0. 18	0. 16	0.18	0. 17	0. 18	0. 16	0. 16	0.124	0.16	0.13	0.16	0.13	0.16	0.13
170	0.51	0.42	0.52	0.42	0.53	0.47	0.83	0.68	1.03	0.7	1.02	0.88	0.82	0.68	0.94	0.83	0.52	0.42	0.56	0.48	0.51	0.42
160	**1.71**	**1.39**	**1.78**	**1.44**	**2.25**	**1.81**	**4.00**	**2.98**	**4.47**	**3.50**	**4.12**	**3.48**	**4.32**	**3.33**	**2.41**	**2.00**	**2.31**	**1.95**	**2.34**	**1.87**	**1.76**	**1.44**
150	8.57	7.29	20.17	11.99	13.72	7.5	10.06	8.17	11.60	9,55	11.39	9.31	10.76	8.53	15.97	11.18	17.38	15.69	13.86	12.40	11.83	9.89
140	43.2	28.44	74.48	3923	64.29	30.39	55.91	39.71	24.62	18.43	24.25	19.58	47.58	20.10	62.49	51.93	70.01	47.17	53.86	39.50	45.78	38.2
130	108	88.91	137	108	140	113	141	97.92	73.06	56.95	72.12	35.34	108	98.88	141	110	134	111	123	98.98	106	87.5

Table 6-9: Water Depth ≤ 600m - maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (km) for 3260 in^3 array to modelled maximum over depth per pulse SPL isopleths (Wladichuk et al, 2018)

Per Pulse SPL (dB re 1µPa)	Line 1 (EPP-41 & EPP-42)										Line 2 (EPP-41 & EPP-42)								EPP-46			
	Site 1		Site 2		Site 3		Site 4		Site 5		Site 1		Site 2		Site 3		Site 4		Site A		Site B	
	1496 m		1001 m		501m		164m		135m		127m		141m		348m		747m		496m		950m	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.14	0.12	0.14	0.12	0.14	0.12	0.15	0.12	0.15	0.14	0.16	0.14	0.15	0.14	0.14	0.12	0.14	0.12	0.14	0.12	0.14	0.12
180	0.45	0.36	0.45	0.37	0.46	0.38	0.76	0.63	0.72	0.60	0.73	0.61	0.72	0.60	0.84	0.44	0.45	0.37	0.46	0.40	0.45	0.37
170	1.41	1.15	1.44	1.18	1.98	1.58	3.24	2.46	3.63	2.80	3.61	2.86	3.59	2.82	2.02	1.71	2.16	1.80	2.01	1.63	1.47	1.23
166	2.25	1.87	2.64	2.16	3.09	2.61	4.89	3.81	5.38	4.32	5.13	4.30	5.30	4.17	3.12	2.71	2.94	2.39	3.27	2.69	2.76	2.37
160	**6.68**	**5.58**	**1.89**	**9.98**	**6.58**	**5.20**	**7.87**	**6.32**	**9.09**	**7.38**	**8.71**	**7.16**	**8.71**	**6.81**	**11.05**	**6.34**	**12.75**	**6.20**	**13.05**	**8.70**	**9.10**	**6.63**
150	34.30	26.62	42.75	32.50	31.16	27.20	38.15	15.83	19.24	14.62	20.36	16.32	17.93	14.25	54.60	40.87	54.60	44.32	33.71	30.51	43.29	37.03
140	107	79.89	133	98.17	136	114	102	94.66	65.85	36.27	40.44	31.57	106	98.33	124	104	132	106	103	90.89	104	85.71
130	141	116	141	116	141	117	141	112	117	89.73	83.48	64.23	119	102	141	119	141	118	141	119	141	119

*Radii extend beyond modelling boundary

Not recommended for use given distortions of distance by modelling 'sound islands'

Table 6-10: Location details for the 24hr sound field sampling locations for the Duntroon MSS (Wladichuk et al. 2018).

Location		Latitude	Longitude
1	Closest point between the array the Sea Lion BIA	-35.3692	135.4365
2	Closest point between the broadside of the array and the Sea Lion BIA	-35.3075	135.3703
3	Closest point between the end-fire of the array and the Sea Lion BIA	-35.4668	135.6470
4	Closest point between the array and 100 m isobath	-35.3262	135.5985
5	Closest point between the broadside and the array and the 10 m isobath	-35.0958	135.4054

Vertical Sound Profile:

SPL and per-pulse modelling were conducted to assess the sound field at receiver depths spanning the entire water column from 127 m to 1496 m along radials separated by 2.5°. The predicted distances to specific levels have been computed from the maximum-over-depth sound fields with the reported distance being the maximum value across all radials and modelled depths at each location. The vertical slice plots in Figure 6-1 and Figure 6-2 show the sound profile within the water column. Close to the source (e.g. SEL > 170 dB re 1µPa^2.s) the maximum horizontal distance from the array to a specific sound level typically occurs in the water column. When modelling PK levels to assess for potential mortal injury to fish, eggs and larvae, the horizontal distances to the level at the seafloor for this survey is also less than the in-water distances (refer to Figure 6-6 for modelled PK levels).

Figure 6-4: Site 1 Line 1 (Deep water – 1496 m): Predicted unweighted per pulse SEL as a vertical slice. Levels are shown in the broadside (top) and end fire directions (bottom). The source depth is 7 m and the tow direction is 098° (Wladichuk et al, 2018)

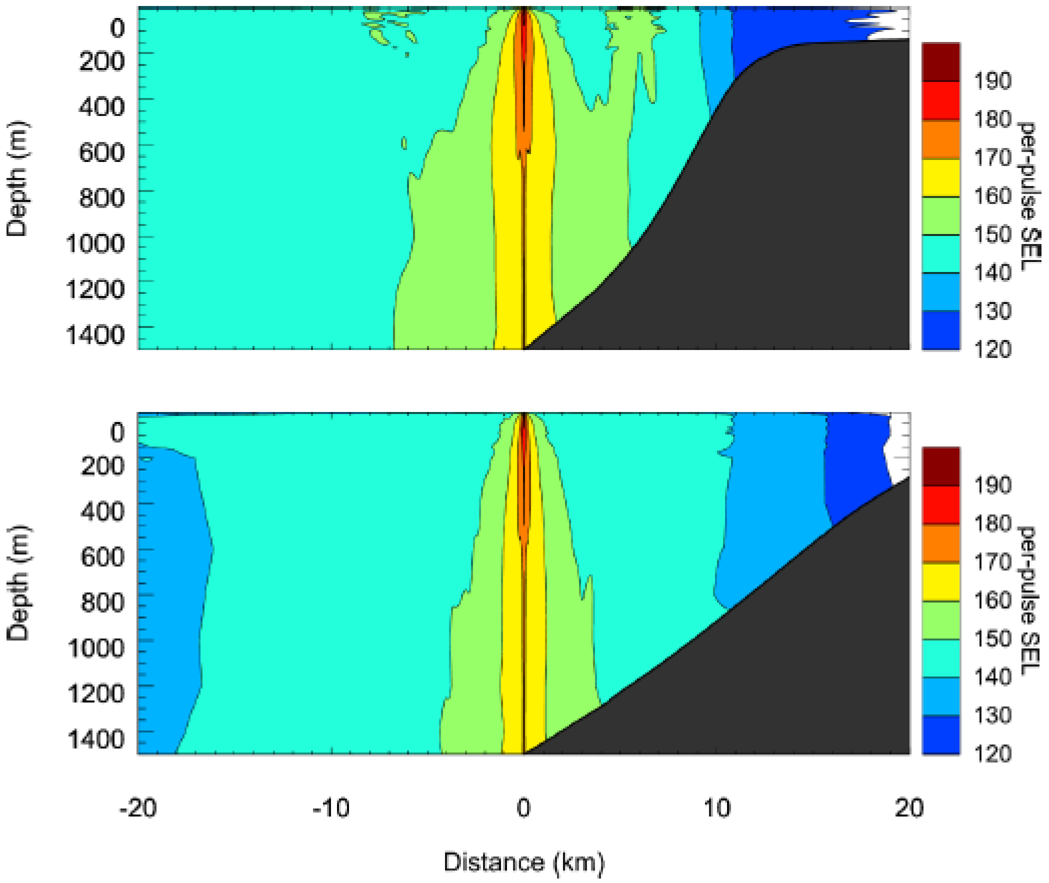


Figure 6-5: Site 1 Line 2 (127 m water depth): Predicted unweighted per pulse SEL as a vertical slice. Levels are shown in the broadside (top) and end fire directions (bottom). The source depth is 7 m and the tow direction is 098°

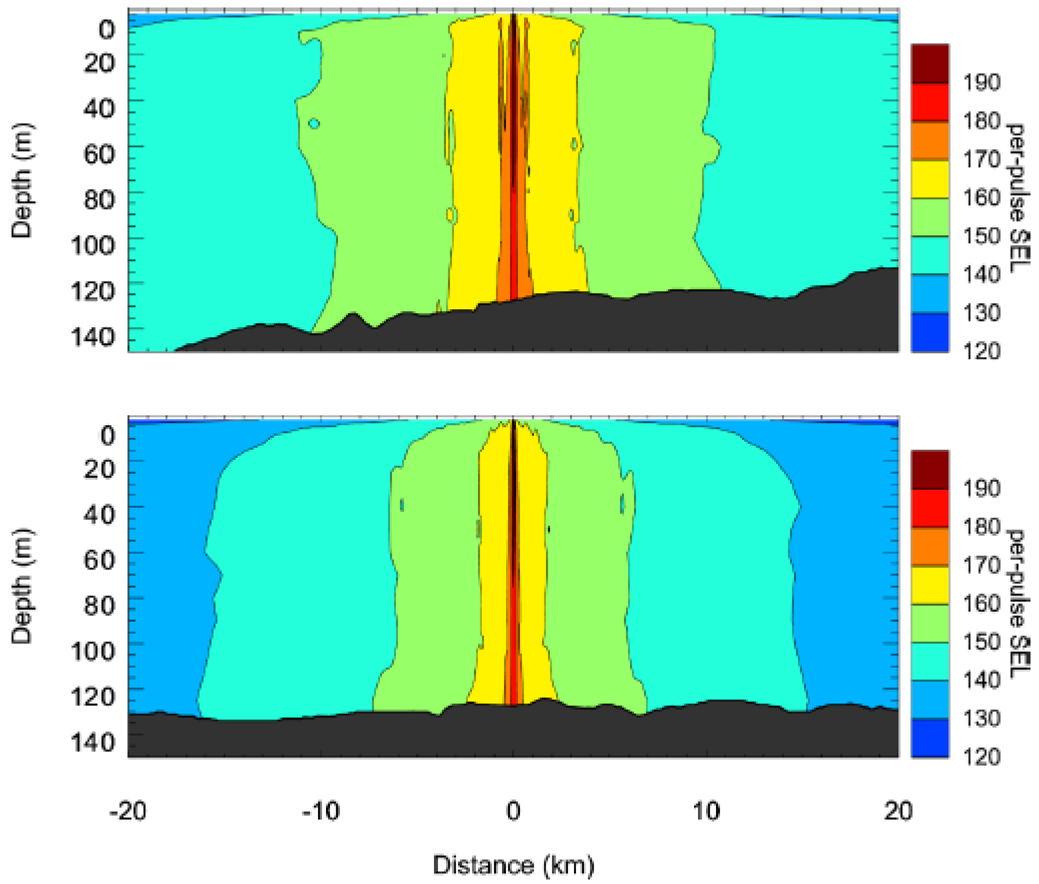
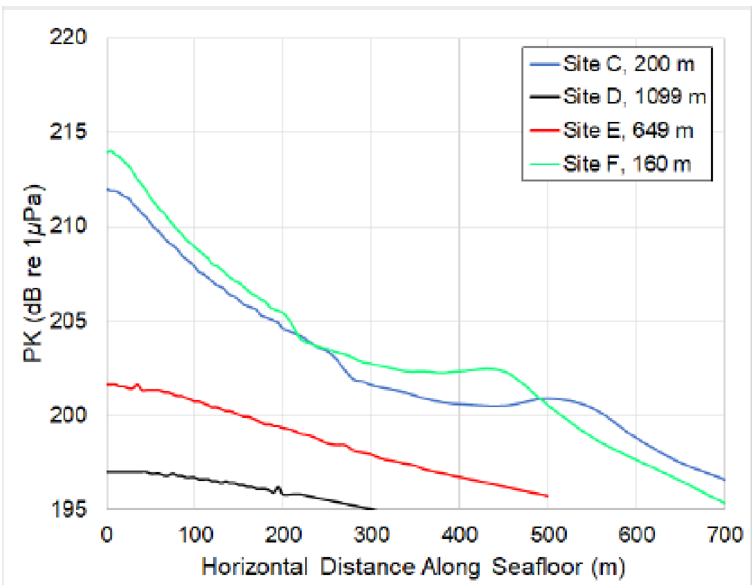


Figure 6-6: Predicted maximum PK along the seafloor at Sites C-F. Levels are the maximum transects assessing both broad fire and end fire directions. The source depth is 7 m.



Ambient Sound Levels:

Ambient sound levels have been described in Section 3.5.4. Based upon work undertaken by BP (McCauley et al, 2012; cited in BP, 2015) in the GAB to understand underwater sound characteristics of the area, sound loggers were deployed near the Head of Bight (HOB) in a water depth of 50 m and two along the shelf break at water depths of approximately 200 m for approximately six months. The measurements were assessed over the bandwidth of 3 to 3180 Hz. Ambient sound was higher at the shelf break sites compared with the HOB site with background sound levels increasing over summer into early winter. The results, in SPL, were:

- HOB: 73.5 to 131.9 dB re 1µPa (median of 97.1 dB re 1µPa); and
- Shelf break: 74.9 to 144.9 dB re 1µPa (median of 111.7 dB re 1µPa).

This background sound environment is considered similar to the Duntroon OA area given the similarly of geology and topography between areas.

Impact assessment thresholds:

For impact assessment purposes, PGS has assessed relevant scientific literature and utilised most recent guidelines where available for species present in the Duntroon OA. These thresholds are discussed in the individual receptor sections of this impact assessment.

Sound from Vessel/Helicopter Operations:

Sound emissions will occur at surface and in-water from the operation of helicopters and vessels.

Vessels: Operation of the survey vessels will generate underwater sound. There will be very limited periods of time when the acoustic array is not operational e.g. during maintenance and marine fauna shut-downs, during which time vessel sound will be the predominant source of sound. A commercial shipping lane bisects the survey area and based upon the vessels which traverse those lanes, it is unlikely that vessel sound levels will be greater than that of any other vessel normally operating in the area.

The sound levels and frequency characteristics of underwater noise produced by vessels are related to ship size and speed. Typically, marine vessels produce low frequency sound (i.e. below 1 kHz) from the operation of machinery on-board; from hydrodynamic flow noise around the hull; from engine transmitted through the hull and from propeller cavitation, which is typically the dominant source of sound (Ross, 1987; 1993 in Skjoldal et al. 2009). Most vessel sounds are broadband (i.e. contain a broad range of frequencies), though, tones are generally associated with the harmonics of the propeller blades (Ross, 1987; 1993 in Skjoldal et al. 2009).

Usually, the larger the vessel or faster a vessel moves results in more sound (Richardson et al. 1995). Depending on the vessel size and speed, source levels can range from (Gotz et al. 2009):

- 160-175 dB re 1 µPa (SPL) for small leisure craft and boats with length up to 50 m (e.g. recreational craft, jet skis, speedboats, operational work boats and hovercraft);
- 165-180 dB re 1 µPa (SPL) for medium vessels between 50 and 100 m in length (e.g. support and supply ships and many research ships [seismic]); and
- 180-190 dB re 1 µPa (SPL) for large ships of length greater than 100 m (e.g. container/cargo ships, super tankers and cruise liners).

The survey vessel will be generally operating at a low speed of 4-5 knots during the survey, although the support vessels may operate at faster speeds in order to effectively patrol the requested clearance area around the survey vessel.

McCauley (1998; McCauley and Duncan, 2001) examined the sound from a 64 m, 2,600 tonne rig tender vessel underway, which had a broadband source level of 177 dB re 1µPa @ 1m (units not specified) in approximately 110 m water depth. The use of thrusters or main propellers under load produced very high levels of cavitation noise. During these activities, the measured vessel noise was broadband in nature, with the highest level measured at 137 dB re 1µPa (units not specified) at 405 m astern; levels of 120 dB re 1µPa (units not specified) recorded at 3-4 km; and the noise audible at up to 20 km against a 'natural background level' of 90 dB re 1µPa (units not specified).

The seismic survey vessel is expected to have the largest acoustic footprint of all survey vessels with an estimated sound source level of approximately 180 dB re 1µPa (SPL). These emitted noise levels will have a limited and mobile footprint with any behavioural impacts to marine fauna expected to be temporary and short range (i.e. a nuisance factor) (McCauley, 1998).

Helicopters: Helicopters may be used during survey activities.

Helicopter operation produces strong underwater sounds for brief periods when the helicopter is directly overhead (Richardson et al. 1995). The received sound level underwater depends on the helicopter source altitude and lateral distance, the receiver depth and water depth. Sound emitted from helicopter operations is typically below 500 Hz and sound pressure is greatest at surface in the water directly below a helicopter, but this diminishes quickly with depth. Literature identifies a Bell 214 helicopter (stated to be one of the noisiest) is audible in air for 4 minutes before the helicopter passed over underwater hydrophones, and audible underwater for only 38 s at 3 m depth and 11 s at 8 m depth (BHP Billiton, 2006). Source sound pressure levels reported for a Bell 212 helicopter during fly-over is 149dB re 1µPa @ 1m (units not stated) with a received SPL of 109 dB re 1µPa (units not specified) at a distance of 152 m. Primary frequencies were between 1000 and 4000 Hz (Richardson et al. 1995). For a Sikorsky-61 the received SPL is 108dB re 1µPa at 305m (units not stated) (WDCS, 2003).

Acoustic sound from the operating array is expected to have the greater potential impacts, when compared with helicopter and vessel sound output, and is discussed below.

6.2.2 Known and potential impacts

Acoustic Array Operation:

The potential biological, ecological and economic impacts from sound impulses generated during seismic array operation are:

- Physical injury such as mortality or damage to auditory tissues or other air-filled organs resulting in hearing loss [temporary threshold shift (TTS) or permanent threshold shift (PTS)];
- Physiological, such as changes to metabolic rate or biochemical stress indicators;
- Behavioural effects through disturbance or displacement of local species with subsequent disruption of natural behaviours or processes, e.g. migration, resting, calving, feeding or spawning or impairing/masking ability to navigate, find food or communicate.

Receptors within the zone of ensonification include:

- Plankton (including commercially important fish larvae/eggs) (ubiquitous);
- Marine invertebrate assemblages (including lobsters, crabs, sponges);
- Fish (including commercial species, sharks, demersal/pelagic species);
- Cetaceans:
  - Foraging habitat for pygmy blue whales and sperm whales;
  - Nursing and/or migrating habitat for southern right whales (emerging non-calving aggregation is located at Sleaford Bay ~50 km north of the survey area);
  - Other migrating and transient whales known to occur in the region;
  - Dolphin species likely to occur in temperate near shore habitats (e.g. bottlenose dolphin, common dolphin).
- Pinnipeds - foraging habitat for the Australian sea lion, Australian and New Zealand fur seals;
- Turtles – transient through the region;

- Foraging habitat for sea birds;
- Tourism values of the region including diving (commercial and recreational), recreational fishing, recreational beach use, eco-tourism (whale watching operations, swimming with tuna (Port Lincoln), swimming with sea lions and fur seals (Hopkins Island) and charter boat operations (sightseeing, fishing, diving).

Note, the potential impact on individual animals from exposure to elevated sound levels above ambient in a given area depends on a number of factors, including the individual's proximity to the sound source, its ability to avoid the sound field generated by the source, its specific physiological tolerance and the overlap between its hearing range and the sound source frequency range (McCauley 1994).

Vessel and helicopter sound:

Receptors known to be sensitive to vessel and/or helicopter sound include fish, marine mammals and turtles. Based upon the level of sound generated from vessels and helicopters, potential impacts are expected to be limited to non-physiological effects such as behavioural change and localised avoidance. Refer to acoustic array operation section for context.

6.2.3 Evaluation of environmental impacts

6.2.3.1 Temporal Assessment of Activity

As the three proposed surveys in the Duntroon program cover different spatial areas with differing seasonal sensitivities, an assessment of the temporal sequencing of the surveys has been undertaken to prevent where possible an overlap in time of key sensitivities and survey activities to prevent impacts. This assessment forms the basis of the following impact evaluation section whereby:

- Temporal overlaps are prevented as far as possible;
- Where temporal overlaps cannot be avoided spatial exclusions are adopted to prevent impacts; and
- Finally, where spatial overlap exists, control measures are adopted to prevent impacts.

In undertaking this assessment, it is important to note the following:

- Switching between MC2D survey activities and MC3D survey activities is operationally inefficient. On this basis, the surveys discrete and separate. There will be no concurrent data acquisition activities undertaken by PGS survey vessels. All Duntroon surveys will be undertaken using a single acquisition vessel.
- MC3D surveys in EPP-41/42 and EPP-46 may be undertaken as:
    - A single MC3D survey by one acquisition vessel if survey areas abut each other; or
    - Two sequential areas by one acquisition vessel if survey areas do not abut each other.
- Timeframes required to complete all surveys are MC2D (45 days) and MC3D (60 days). Noting that the total MC3D and MC2D survey duration exceeds the 91-day allocated period, the total scope of either or both surveys will be reduced to the 91-day period (September 1 to November 30, 2019) available for any one season or vessel remobilisation during the following season (September 1 to November 30, 2020) is possible.
- The proportion of survey areas which lie on the continental shelf overlapping areas of high productivity are:

  - MC2D survey has 7% of survey lines located on the continental shelf (349 km of 5100 km sail lines); and
  - EPP-41/42 MC3D survey has 40% of survey polygon located on continental shelf; and
  - EPP-46 MC3D survey has not been confirmed, however MC3D spatial exclusions will apply around the 30nm gulper shark closure area.

- Elimination of survey activities within the Western Eyre CMP is not possible, given the primary targets sought in the EPP-41/42 area lies beneath the CMP area. Also, MC2D data is required across the complete area of EPP-46 to define leads for future 3D activity. The MC2D survey also cannot avoid the CMP area.

Recognising the different types of sensitivity within the Duntroon OA and utilising the key sensitivity summary for the Duntroon OA area contained within Figure 3-91, the temporal assessment has utilised the hierarchy of assessment criteria detailed in Table 6-11 to establish the preferred survey sequencing. This assessment is provided in Table 6-13.

Table 6-11: Hierarchy of Sensitivities for Assessment Purposes.

Priority	Descriptor
HIGH	Species which have a high sensitivity to low frequency sound in the marine environment.
MEDIUM	Species which have a medium sensitivity to low frequency sound in the marine environment.
LOW	Species which have a low sensitivity to low frequency sound in the marine environment.
Sensitivity	(P1) – Denotes that there is a BIA important to the species which has lifecycle impacts (i.e. foraging, breeding) within the OA (P2) – Denotes that there is a BIA important to the species which has lifecycle impacts (i.e. foraging, breeding) adjacent to the OA

Primary sensitivities within the Duntroon OA region during the September to November timeframe lie in November on the continental shelf or at the shelf break associated with the potential for upwellings (i.e. highly productivity) to occur .

As identified in Section 3.3.2, upwellings appear reliant on both deep currents flowing onto the shelf and upwelling favourable winds from the south-east which are temporally variable. Utilising the wind roses in Figure 3-10, a higher proportion of favourable south-easterly winds occur during the December to March period (Middleton and Bye, 2007). There is no preferred wind direction for September/October, with south-easterly winds possible in November. Many sensitivities are present during the prevailing upwelling season (December to March) including foraging baleen whales, fish stock increases, foraging pinnipeds, etc.). One of the key seasonal sensitivities in the area in the period September to November is the presence of the SRW along the South Australian coastline for calving together with its migration away from the coastline.

On this basis, PGS has assessed that any survey activity is best situated temporally and spatially outside of the primary upwelling period (December-March) and not within foraging BIAs associated with upwelling events during this period. Accordingly, PGS has adopted the timeframe between September 1 and November 30 to avoid upwellings and upwelling related activity/productivity. This temporal control protects primary productivity within upwelling areas and the upwelling-related foraging BIAs from disturbance during the seasonal upwelling period (December to March). In addition, MC3D survey activities will commence in the shallower water depths in September-October and move further offshore as the season progresses thereby limiting the potential for spatial overlap with areas affected by upwelling during November where slow-moving weather patterns increase the potential for upwelling favourable winds .

Table 6-12 provides a summary of the sensitive receptors (ecological and socio-economic) within the Duntroon OA, the defined acceptable level of impact for the Duntroon survey and the context of the acceptability parameter.

Controls assessment to limit temporal overlap:

Table 6-14 provides an assessment of temporal controls which have been considered to avoid coincident activity with sensitivities in the Duntroon OA.

Table 6-12: Duntroon survey – acceptable levels of impact

Receptor	Relevant Context	Acceptable Level of Impact
Ecological		
Western Eyre CMR	South-west Marine Parks Network Management Plan 2018: • Multiple Use Zone Objective (IUCN VI): *Provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species*. • Special Purpose Zone Objective (IUCN VI): *Provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species while applying special purpose management arrangements for specific activities.* Note: There is very little spatial overlap of Western Eyre CMP area with Duntroon OA on the continental shelf. Primary overlap is within deeper off-shelf waters. Species such as the white shark and sea lion generally occupy to 100 m water depth on the continental shelf.	*No serious or irreversible disruption to key ecological processes for key fauna values present in the CMP.* *No behavioural disturbance to:* • *Foraging whales (blue and sperm);* • *Foraging white shark (white shark BIA not within CMP);* • *Foraging Australian sea lions (no significant overlap of survey lines in CMP on continental shelf);* • *Foraging seabirds.* • *Calving southern right whales (no spatial overlap).* *No serious or irreversible ecosystem disturbance to:* • *Demersal fish within the Ancient Coastline KEF;* • *Primary productivity within the Kangaroo Island Pool, canyons and associated shelf break and Eyre Peninsula Upwelling meso-scale eddies KEF;* • *Small pelagic fish KEF;* • *Benthic invertebrate communities of the eastern GAB.*
Demersal Fish associated with the Ancient Coastline KEF (90-120 m water depth)	Spatially defined KEF with benthic diversity and demersal fish species which connect the slope to the shelf environments.	*No physical injury to demersal fish in water depths less than 120 m within the Ancient Coastline KEF.* *Cumulative sound exposure within the ancient coastline KEF boundary does not exceed temporary threshold shifts in hearing for fish.*
Plankton and small pelagic fish associated with the Kangaroo Island Pool, canyons and adjacent shelf-break & Eyre Peninsula Upwelling KEF; and meso-scale eddies.	Area of high seasonal upwelling (zooplankton biomass) supporting small pelagic fish of south-west region KEF and foraging-related BIAs of apex predators (Ruth, 2009; Pattiararchi, 2007). Stakeholder feedback (OGASA, Blue whale study, ASTBIA, TWS, KI Dolphin Watch): Concerns with impact to high productivity upwelling waters particularly before April 1.	*No serious or irreversible foraging disturbance to up-welling related foraging BIAs during upwelling events (i.e. no disruption to upwelling zooplankton biomass affecting ecosystem functioning).*
Pygmy blue, sei and fin whale (in foraging BIA)	• EPBC Act 1999 (EPBC Policy Statement 1.1/2.1) • Conservation Management Plan for the Blue Whale (DoE, 2015). • Conservation Advice for the fin whale (DoE, 2015) • Conservation advice for the sei whale (DoE, 2015) • SW Marine Park Network Management Plan 2018 (Australian IUCN Reserve Management Principles (IUCN VI))	*No injury to pygmy blue, fin and sei whales.* *No interference with foraging behaviours in the blue whale foraging BIA including no displacement from foraging areas.*
Southern right whale (migrating and in calving BIA)	• EPBC Act 1999 (EPBC Policy Statement 1.1/2.1) • Conservation Management Plan for the southern right whale (SEWPC, 2012) • EPBC Act 1999 • SW Marine Park Network Management Plan 2018 (Australian IUCN Reserve Management Principles (IUCN VI))	*No injury to southern right whales.* *No biologically significant behavioural disturbance to SRWs in calving/aggregation areas located in coastal South Australian waters.*
Humpback whale (during migration)	• Conservation Advice for the Humpback whale (2015) • EPBC Act 1999 (EPBC Policy Statement 1.1/2.1)	*No injury to humpback whales.*

Receptor	Relevant Context	Acceptable Level of Impact
Sperm Whale (in foraging BIA)	• EPBC Act 1999 (EPBC Policy Statement 1.1/2.1) • SW Marine Park Network Management Plan 2018 (Australian IUCN Reserve Management Principles (IUCN VI)).	*No injury to sperm whales.* *No interference with foraging behaviours in the sperm whale foraging BIAs.*
Other whales (migrating)	• EPBC Act 1999 (EPBC Policy Statement 1.1/2.1)	*No injury to whales.*
Australian sea lion (foraging BIA)	• EPBC Act 1999 (EPBC Policy Statement 1.1) • SW Marine Park Network Management Plan 2018 (Australian IUCN Reserve Management Principles (IUCN VI) (no significant overlap with CMR)); • Recovery Plan for the Australian sea lion (SEWPC, 2013) • Marine bioregional plan – Southwest Region (SEWPC, 2012) • Stakeholder Feedback (WML, TWS)	*No injury to Australian sea lions.* *Ambient noise levels with the female Australian sea lion foraging BIAs are maintained at a level which does not result in site avoidance or other physiological or behavioural responses.*
Marine turtles	• EPBC Act 1999 (EPBC Policy Statement 1.1) • Recovery Plan for Marine Turtles in Australia (2017-2027) (DoEE, 2017)	*No injury to marine turtles.*
Short-tailed shearwater, Pacific gull, Caspian tern, Australian Fairy tern in foraging BIAs	• EPBC Act 1999 (EPBC Policy Statement 1.1) • SW Marine Park Network Management Plan 2018 (Australian IUCN Reserve Management Principles (IUCN VI)); • Short-tailed shearwater, Pacific gull, Caspian tern, Australian Fairy tern (foraging) BIA (NCVA, 2018)	*No behavioural disturbance to seabird (aggregations) foraging in up-welling related BIAs during upwelling events.*
White Shark (foraging BIA)	• EPBC Act 1999 (EPBC Policy Statement 1.1) • Recovery Plan for the white shark (SEWPC, 2013)	*No injury to the white shark.*
Cephalopods	• EPBC Act 1999 (EPBC Policy Statement 1.1)	*No injury to cephalopods.*
Crustaceans	○ Seismic research on effects of seismic on crustaceans ○ SA Giant Crab Fishery Status Report 2014/15 ○ NZRL Fishery Status Report 2014/15 ○ **Stakeholder Record 44** (Andrew Fergusson feedback): Sustainability of the fishery is required.	*No injury to crustaceans within the OA which would affect the sustainability of crustacean resources.* *(i.e. Crustacean population affected by seismic acquisition does not cause commercial/recreational fishing TACCs or fishery management KPIs to review harvest arrangements)*
Fish (pelagic & demersal)	○ Seismic research on effects of seismic on fish ○ Commonwealth Fisheries Status Report 2016/17 ○ Assessment of the SA Marine Scalefish Fishery in 2016 ○ SA Charter Boat Fishery Data Summary 2017 ○ SA Sardine Fishery Stock Assessment Report 2012	*No injury to fish within the OA which would affect the sustainability of fish resources.* *(i.e. Fish population affected by seismic acquisition does not cause commercial/recreational fishing TACCs or fishery management KPIs to review harvest management arrangements)*
Benthic invertebrates (sponges, sea-squirts) within the benthic invertebrate community of the eastern GAB KEF	• EPBC Act 1999 (EPBC Policy Statement 1.1) • SW Marine Park Network Management Plan 2018 (Australian IUCN Reserve Management Principles (IUCN VI))	*No disturbance to filter-feeders in benthic environments within the Duntroon OA which would disrupt benthic invertebrate community ecosystems.*
Socio-Economic		
Sardine Spawning Grounds	• Stakeholder concern on seismic impacts to sardine spawning grounds (SASIA – Stakeholder Record 8) • Potential for displacement effects if located over spawning fish population during spawning periods (DFO, 2004)	*No acquisition within spatially-defined fish spawning or aggregation areas during the survey period.*
Sardine Egg Survey	Stakeholder Consultation (SASIA – Stakeholder Record 8: Impacts to egg survey from seismic influencing quotas for subsequent fishing seasons)	*No disruption to sardine egg fishing surveys.*
CSIRO Survey (SBT)	Stakeholder Consultation (CSIRO – **Stakeholder Record 13** and ASBTIA – **Stakeholder Record 6**): Impacts to stock assessments affects quotas)	*No behavioural disturbance to fish stock during CSIRO SBT survey which would affect TACs allocated to the fishery.*

Receptor	Relevant Context	Acceptable Level of Impact
Rock Lobster Fishermen (Displacement)	Stakeholder Consultation from NZRLF fishermen [**Stakeholder Record 4**]	*No displacement or economic loss to rock lobster fishermen with an established fishing history in the survey area due to acquisition activities.*
Abalone Fishermen	Stakeholder Consultation Record from AIASA [Stakeholder **Record 54**]	*No survey activity in proximity to coastal areas and shallow coastal reefs during the spawning season.*
SBT Fishery (Commercial)	Requirements detailed in: • Stakeholder Consultation (SBT) [**Stakeholder Record 6**] • Sound exposure guidelines for Fish and Sea Turtles (Popper et al, 2014)	*No behavioural disturbance to SBT in pontoons located on the continental shelf before April 1 from Duntroon survey activities.*
Commercial/ recreational fishery within the Duntroon OA during survey period (exclusion impacts)	• OPGGSA S280 (Interference with other's rights) • Commonwealth Fisheries Status Report 2016/17 • SA Giant Crab Fishery Status Report 2014/15 • NZRL Fishery Status Report 2014/15 • Assessment of the SA Marine Scalefish Fishery in 2016 • SA Charter Boat Fishery Data Summary 2017 • SA Sardine Fishery Stock Assessment Report 2012 • Stakeholder consultation (GABIA Stakeholder Record 3): GAB Trawl fishing activities are not impacted by the Duntroon survey	*Survey activities will not interfere with fishing to a greater extent than is necessary for the reasonable exercise of acquiring seismic.* *No spatial conflict preventing access to fishing areas between commercial/recreational fishing and Duntroon survey activities during the survey period.*
Commercial/ recreational fishery within the Duntroon OA during survey period (Catchability/abundance impacts)	• OPGGSA S280 (Interference with other's rights) • Commonwealth Fisheries Status Report 2016/17 • SA Giant Crab Fishery Status Report 2014/15 • NZRL Fishery Status Report 2014/15 • Assessment of the SA Marine Scalefish Fishery in 2016 • SA Charter Boat Fishery Data Summary 2017 • SA Sardine Fishery Stock Assessment Report 2012 • Stakeholder consultation (GABIA Stakeholder Record 3): Location and abundance of fish species are not affected by the Duntroon survey	*Survey activities will not interfere with fishing to a greater extent than is necessary for the reasonable exercise of acquiring seismic.* *Catchability/abundance impacts from survey operations are localised, temporary and recoverable in the short-term within the Duntroon OA.*

Table 6-13: Temporal Assessment of Duntroon Surveys

Receptor Type	Receptor	Location	Context	January	February	March	April	May	June	July	August	September	October	November	December
			Survey Period												
Physical	Kangaroo Island Upwelling	Shelf	High Productivity, Intermittant (2-4 episodes per season)												
Whales	Pygmy Blue Whale (foraging BIA (Sensitivity P1)	Shelfbreak	BIA (High abundance foraging area) Intensity Figures - Survey (Year:sightings)	Gill (2004:0, 2005:0, 2015:0) PGS (2011:0) TGS (2014:0)	Gill (2002:0, 2006:0, 2012:0) PGS (2011:0) TGS (2014:0)	Gill (2003:0, 2005:0, 2006:0, 2012:0, 2015:0) PGS (2011:0) TGS (2014:0)	Gill (2002:0, 2004:0, 2007:0) PGS (2011:0) IFAW (2013:0) TGS (2014:0)	TGS Survey (2014:1) Gill (2002:0) PGS (2011:0) IFAW (2013:0)	Bilgmann (2014:0) TGS (2014:0)	Bilgmann (2014:0)	No Survey	No Survey	No surveys	PGS Survey (2011:12) Gill (2004:2, 2011:1)	Gill (2002:0, 2003:135, 2004:0, 2005:33, 2011:3, 2015:0) Anecdotal (25) PGS (2011:0)
	Humpback Whale	Shelf (from observation)	No BIAs within OA, migratory only. Intensity Figures – whales/1000 km observations	0	0	0	0	0.11	0.99	1.0			0	0.05	0.07
	Southern Right Whale (P2)	Coastal	BIA (Coastal Areas – Breeding/Breeding Buffer) else migratory. Intensity Figures – whales/1000 km obs.	0	0	0	0	0	0.8	3.1	6.8	8.8	0	0	0
	Fin Whale	Shelf (from observation)	No BIAs within OA, possible foraging. Intensity Figures – whales/1000 km observations	0.07	0.08	0	0	0	0	0	0	0	0	0.1	0.14
	Sei whale	Shelf (from observation)	No BIAs within OA, possible foraging. Intensity Figures – whales/1000 km observations	0.04	0.08	0.19	0	0.21	0	0	0	0	0	0.25	0.07
	Sperm Whale (P1)	KI Canyon Area	BIA (Foraging likely – abundant food sources). Intensity Figures – whales/1000 km observations	0.53	0.08	0.13	0.75	0.85	0	0	0	0	1.7	1.2	0.23
Pinnipeds	Australian Sea Lion (P1)	Shelf Areas	BIA (male and female – all year). Breeding asynchronous across region. Presence all year.												
	Australian fur seal	Shelf Area	No BIA. Presence all year											Breeding	Breeding
	New Zealand fur seal	Shelf/deep water	No BIA. Presence all year	Breeding										Breeding	Breeding
Turtles	Leatherback	Shelf/Slope	No BIA. Could be present at any time.												
Sharks	White Shark (P1 and P2)	Shelf	BIA (foraging adjacent to pinniped colonies – coastal). Present at any time												
	Shortfin Mako	Mainly Shelf	No BIA – migratory. Present at any time												
	Porbeagle	Shelf/Slope	No BIA – migratory. Present at any time												
	Southern Dogfish	Slope	No BIA. Fishing closure (breeding). Breeding all year												
	School Shark	Shelf/slope	No BIA. Present at any time												
Fish Spawning	Sardines/Anchovies	Shelf	No BIA. Cinincides with Upwellings												
	King George Whiting	Inner Shelf	Investigator Strait, north coast of KI & Spencer Gulf												
	Giant Crab	Shelf													
	Rock Lobster	Shelf													
Birds	Little Penguin (Sensitivity P2)	Shelf	BIA (Foraging/Provisioning for young) adjacent to OA				Moulting	Moulting	Moulting				Breeding		
	Caspian Tern (Sensitivity P2)	Shelf	BIA (Foraging/Provisioning for young) adjacent to OA												
	Black-faced Cormorant (P2)	Shelf	BIA (Foraging) adjacent to OA												
	Fairy Tern (P2)	Shelf	BIA (Foraging) adjacent to OA												
	Pacific Gull (P2)	Shelf	BIA (Foraging) adjacent to OA												
	Short-tailed Shearwater(P1)	Shelf	Migratory. BIA foraging.												
Fishing	Southern Bluefin Tuna	Shelf													
	Rock Lobster	Shelf	Shelf areas outside OA. Highest catch first 4 months. Potlifts from (Linnane et al. 2014)	75,000 pots	65,000 pots	50,000 pots	30,000 pots	10,000 pots						65,000 pots	65,000 pots
	Giant Crab	Shelf	Potlifts based upon 2007/8 year (Currie & Ward, 2009)	6,000 pots	3,000 pots	5,000 pots	4,500 pots	2,000 pots						4,000 pots	3,000 pots
	Sardine Fishery	Shelf	Netset data obtained from the 2012 Sardine Fishery Stock Assessment Report (PIRSA)	70 netsets	70 netsets	100 netsets	175 netsets	230 netsets	175 netsets	75 netsets			20 netsets	50 netsets	70 netsets
Fishing Surveys	CSIRO (Tuna)	Shelf/Slope	Not confirmed for 2019												
	Sardine (Egg Count)	Shelf	Early to Mid March												

Table 6-14: Assessment of Potential Control Measures to reduce temporal and spatial overlap

Control Measure	Practicable	Will it be Implemented?	Justification
Spilt survey over two seasons	Yes	Possibly	If all surveys cannot be completed then surveys over two seasons is possible, however to esnure that one survey can be completed (i.e. MC3D), the minimum survey window, allowing for weather downtime is 3 months.
Reduce survey period to avoid upwelling periods (i.e. September-October only)	No	No	PGS cannot guarantee that all surveys can be completed in this period and there is the potential that the MC3D survey could not be completed in the period available particularly if there is weather downtime. November is required to ensure that at least the MC3D survey can be completed. August cannot be considered for survey activities due to the swell-related ocean conditions which preclude the use of support vessels. Operation without such vessels carries a large HSE risk.
Eliminate all survey activities in the December to March timeframe to avoid primary upwelling period.	Yes	Yes	PGS has reduced the timeframe of the Duntroon survey to avoid temporal overlap with periods of high upwelling potential (December to March) as far as possible.

6.2.3.2 *Plankton (including fish eggs and larvae)*

Receptor Sensitivity:

Plankton, as described in Section 3.7.2, include fish eggs and larvae, is widely dispersed throughout the marine environment and transported by prevailing currents. Plankton cannot take evasive action to avoid seismic sources and although they can swim, they cannot progress against currents. Most zooplankton are microscopic with approximately 75% of the zooplankton population being copepods, small crustaceans that are the most abundant multicellular animals on earth. Zooplankton can be categorised as those species which spend most of their life as plankton (the *holoplankton)* and those that only spend part of their lifecycle in the planktonic phase such as eggs and larvae of fish, crabs, lobsters (the meroplankton) (Richardson et al, 2017).

As zooplankton do not have hearing structures, less research has been conducted into impacts of acoustic sound on these species. Table 6-15 provides a summary of the scientific literature available for acoustic impacts to zooplankton (including eggs, larvae and fry). This literature suggests that the impact of seismic activity on zooplankton is limited to a range ~10 m from an operating acoustic array (Richardson et al, 2017). McCauley (1994) using this 10m impact range calculated that total plankton mortality from a seismic survey would be <1% of plankton in the surveyed area assuming total plankton mortality within this range.

Popper et al. (2014) has reviewed scientific literature to establish sound exposure guidelines for turtles, fish and fish larvae and eggs. For the larval fish studies available, species appeared to have hearing frequency ranges similar to those of adults and similar acoustic thresholds. Swim bladders may develop during the larval phase which renders the larvae susceptible to pressure-related injuries (e.g. barotrauma). The literature review identified anthropogenic sound impacts to eggs and larvae range from no impact to mortality/tissue damage close to an operating array in most studies. For commercial invertebrate species such as crab and lobster, scientific studies outlined in Table 6-15 identify:

- Lobster eggs are not affected when exposed to a received sound level of 209-212 dB re 1µPa PK-PK. Specifically "*seismic exposure did not result in a decrease in fecundity, either through a reduction in the average number of hatched larvae or as a result of high larval mortality; compromised larvae or morphological abnormalities*" (Day et al. 2016). Test subjects were within 6-8 m of an operating array;
- Dungeness crab (egg and larvae) had no mortality or developmental impacts at exposure levels of 222-231 dB re 1µPa PK-PK (Pearson et al. 1994). This study was statistically robust and Pearson et al., (1994) suggested that "*early life stage crustaceans may be more resilient to seismic air gun exposure than other marine organisms*". A separate study exposing snow crab eggs to high levels of sound at close range (~2m) identified higher mortality and egg development delays at exposures of 221-227 dB re 1µPa PK. The authors noted that the study was based upon conditions which did not translate to the field and the limited sample size (2000 eggs – equivalent to 2% of a gravid female's eggs) could only provide preliminary findings (Christian et al. 2003). DFO (2004) building on the work of Christian et al.

(2003) undertook further work on the reproductive biology of snow crabs with results showing that there was no difference in larvae hatched from gravid females between control and exposed groups.

Other studies assessing seismic sound impacts to eggs, larvae and fry identified damage was possible up to 10 m from an operating array (Kostyuchencko, 1973; Matishov, 1992; Booman et al, 1996; and Cox et al, 2011) while other studies did not identify any sign of damage (Dale & Knudsen, 1987; Pearson et al, 1994; DFO, 2004, Payne et al, 2009; Bolle et al, 2012 and Day et al, 2016) (refer **Table 6-15**). Gausland (2000) noted several studies which confirmed that sound levels exceeding 230-240 dB re 1µPa (PK-PK) are necessary to harm zooplankton and physical damage only occurs within a few meters of the airgun. Consequently, seismic-created mortality is so low it can be considered to have an inconsequential impact on recruitment to fish/invertebrate populations.

McCauley et al. (2017) released field study research from the temperate waters of southeast Tasmania, which quantified zooplankton impacts(abundance and dead-to-total zooplankton counts) before and after exposure to a single 150 in^3 airgun at an operating pressure of 2000 psi. Deployed acoustic loggers measured sound fromthe air gun signals. Zooplankton samples were taken at three distances from the airgun - 0, 250m and 800 m which due to water movement through the study area were effectively at 200m, 500m and 1200 m from the airgun. Bioacoustic techniques employed to identify changes in zooplankton distribution and net samples were used to estimate the change in zooplankton abundance and the proportion dead of zooplankton after airgun exposure. In this study, copepods dominated the mesozooplankton (0.2-20 mm) and impacts were not assessed on microzooplankton (0.02-0.2 mm) or macrozooplankton (> 20 mm) (Richardson et al., 2017). The movement and lack of detail on water body mixing, advection and current set above tidal flows through the study area made interpretation of results difficult (Richardson et al, 2017) and did not allow conclusions on the difference in zooplankton abundance between Day 1 and Day 2 (McCauley et al., 2017) to be made.

McCauley et al. (2017) reported three findings from the field study, to show that zooplankton were affected by the airgun:

- The proportion of the mesoplankton community that was dead increased two–to-threefold;
- The abundance of zooplankton estimated by net samples declined by 64%; and
- The opening of a 'hole' in the zooplankton backscatter observed via acoustics.

McCauley et al. (2017) concluded "*although no adult krill were present, all larval krill were killed after airgun passage*". Review of the study's raw plankton abundance data identified 'larval krill' targets abundance counts for *Nyctiphanes australis* (krill) *Nauplius* larvae and does not refer to other krill larval phases (i.e. *calyptopis I, II & III)* present during field studies.

The results of this study found that zooplankton exposure to airguns increased mortality rates from a natural level of 19% per day to 45% per day on the day of exposure (i.e. a mortality rate of 32%) (Richardson et al., 2017). The impacts to plankton were limited to 1.2 km from the operating array as determined by raw plankton abundance counts. This distance is more than two orders of magniture greater than the 10 m previously measured (McCauley et al, 2017).

The study attributes the impact to external sensory hairs that zooplankton possess, may be extremely sensitive and in response to seismic sound, may shake to the point where damage may accrue to sesntory hairs or tissue. Importantly, the study notes that for anthropogenic sources to have significant impacts to plankton at an ecological scale, the spatial or temporal scale of the impact (i.e. the seismic survey) must be large in comparison with the ecosystem concerned.

CSIRO's Ocean and Atmosphere Business Unit were engaged by APPEA to undertake a desktop study to:

- Critically reviewed the methodologies and findings of McCauley et al. (2017) study; and
- Simulated the large-scale impact of a seismic survey on zooplankton in the Northwest Shelf (NWS) region based upon the mortality rate associated with airgun noise exposure reported by McCauley et al (2017).

CSIRO's review of the McCauley et al (2017) study found that there were three primary questions raised by the results of the study, all of which warrant further investigation (Richardson et al., 2017):

i. *There no attenuation of the impact with distance*

   The study did not observe a consistent decline in the proportion of dead zooplankton as distance or received sound level decreased.

ii. *There was an immediate decline in abundance*

   The immediate decline in zooplankton abundance as measured in the towed nets/acoustic data is unclear. If zooplankton were killed, they would not immediately sink from surface layers or be rapidly eaten. A time delay to reduced abundance would be expected. A lower abundance might be attributed to active avoidance of the area by zooplankton leaving a higher proportion of dead zooplankton. Richardson et al. (2017) concluded the immediate decline in abundance is difficult to explain.

Table 6-15: Observed sound effects on plankton, fish and invertebrate eggs and larvae

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Anchovy, Red Mullet, blue runner and crucian Carp (fish eggs)	Single airgun	250 (estimated)	0.5, 5 and 10	210-236 (Estimated)	Survival (combined species) one day post exposure: 75.4% at 0.5m; 87.7% at 5m; 90.2% at 10m compared with 92.3% in control group. The study found that at distances of 0.5m, 7.8% of anchovy eggs were damaged however detected no damage with the red mullet eggs at this distance. At 5 m from the source, 3.6% of anchovy eggs were damaged but at 10 m, four species of egg did not show any damage. Pathological effects (embryo curling, membrane perturbation and yolk displacement) were observed in small percentage in anchovy and blue runner eggs at 5 m and crucian carp at 0.5m. No effects in mullet eggs. **No effects beyond 10 m from the airgun**.	Kostyuchenko (1973)
Atlantic Cod (eggs, larvae and fry)	Single Airgun (640 cm^3) (eggs, larvae & fry) Single Airgun (8610 cm^3) (fry only - 110 age)	222 (640 cm^3) 231 (8610 cm^3)	1-10 150-300	200-210 (Estimated)	Smaller airgun: No significant difference of survival between test group and control group was observed for any distance (1-10 m from the source) for the egg stages (2, 3 and 10 day post fertilisation); the larval and post-larval stages (1, 5, 37, 38, 40 and 41 days after hatching); and hatching for fry (56, 69 and 110 days). The feeding success of the exposed larvae and fry was not significant compared with the control group indicating no sub-lethal effects from the small airgun. Fry (age of 110 days) experienced balance problems after exposure but recovered in a few minutes. Larger airgun: None of the specimens were killed however balance problems were observed after exposure. Fry recovered within a few minutes. **Captive eggs, larvae and post-larvae showed no signs of damage when placed 1 m from the source.**	Dalen & Knutsen (1987) Field Study
Cod (larvae 5 days)	Single airgun	250 PK-PK	1	250 PK-PK	Matishov (1992) observed delamination of the retina in cod larvae within 1 m of a seismic source. **Injuries to larvae reported for the closest (1m) exposure range.**	Matishov (1992)
Dungeness Crab (egg and larvae)	Seismic Array (842 in^3)	244	1, 3 & 10 m	222- 231 PK-PK	In blind, controlled field experiments, early Stage II zoaea of Dungeness crab (Cancer magister DANA) were exposed to sounds from single discharges of seven air guns. Their survival and development were followed during subsequent laboratory culture. The study was designed so that exposures were at the high end realistically expected during a typical survey operation. No statistically significant differences were found in immediate survival rates, long-term survival rates or time to moult between the exposed and control larvae, even within 1 m of the source. Post-hoc power calculations to confirm the adequacy of the study sample and 'effect' size identified here was adequate replication to detect Type II errors or 'false negative' effects. '*Failure to detect effects in the experiment indicates that any effects on survival and time to moult were small (e.g. < 10% for survival, < 1 day for time to moult to Stage II)*'. **Survival and growth of Dungeness crab larvae not impacted by airguns discharging within 10m.**	Pearson et al., (1994) Field/Laboratory Study
Cod, Pollock, Herring, Turbot, Plaice, (eggs, larvae & fry)	Airgun array consisting of 3 x Bolt 1500 C (585 in^3), 1 x Bolt 1500 C (290 in^3) and 1 x Bolt 1500 C (155 in^3)	NS	0.75 6.0	242 220	Field experiment using a stationary source array suspended 6 m below the surface with bags of specimens placed at distances from 1 to 5 m from the source. Two different set-ups were used. Highest mortality rates and most frequent injuries were observed out to 1.4 m distance, while low and no mortality rate and more infrequent injuries were observed out to 5 m distance. **Increased mortality and injury within 5 m of the array.**	Booman et al., (1996) Field Study

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Plankton (including bivalve larvae and fish eggs)	Airgun array (3542 in^3)	232 255 PK-PK	~200	NS	Undertaken in Bass Strait, this study used vertical plankton tows (0-20m water depth) along transects running parallel and adjacent to seismic survey lines to establish the significance in abundance and dead/alive plankton (including bivalve larvae and fish eggs). Methodology included sampling behind a seismic survey vessel, before the vessel or 2 km distant from the vessel. Sampling consisted of five control transects (5 net tows ~ 500 m apart on each transect) and one impact transect (10 net tows). No statistically significant changes associated with seismic testing were detected for planktonic taxa. However, high levels of variability in plankton communities meant that only large changes would have been detected by this sampling regime. Power analysis revealed for most taxa the number of transects sampled (5 control and 1 impact), in combination with the patchiness of the distribution of the taxa themselves, meant that for most taxa changes would only be detected if they cause an 80-90% decrease in the mean abundance of the taxa. Copepods were the least patchy taxa and a decrease of 20-40% was likely to have been detected. **No significant difference in abundance of zooplankton before/after a seismic vessel or 2 km distant from the vessel.**	Parry et al. (2002) Field Study
Snow Crab (fertilised eggs)	Single airgun (40in^3)	224-227	2	221-227 PK	Study into impacts on reproductive biology of female snow crabs including observation of developmental differences in fertilized eggs between control and test groups. One batch of eggs (about 4,000) showing a similar level of development were divided into two groups for exposure to a seismic airgun and as a control group. Twelve weeks after this exposure, the fertilized eggs showed a 1.6% higher mortality compared with the control group, and 25.7% fewer eggs had developed to the next developmental stage in the exposed group. However, the limited sample size (2000 eggs) in this instance (equivalent to 2% of a gravid female *C. opilio* brood) meant that findings were preliminary and further testing warranted. The authors note that females carry eggs at depth where received sound levels are much lower than the 2m test distance (i.e. not realistically translated to field conditions). **High sound levels may retard the development of eggs exposed to sound in excess of 221 PK at 2 m, although the eggs were taken from one individual.**	Christian et al., 2003 Field/Laboratory Study
Snow Crab (fertilised eggs)	Single airgun (1310 in^3)	Unknown	Unknown	Unknown	Survival of embryos being carried by female crabs and locomotion of the resulting larvae after hatch were unaffected by the seismic survey. **No increase in egg mortality or larvae survival.**	DFO, 2004
Monkfish (larvae) Capelin (fertilised eggs)	Single airgun (20in^3)	NS	~1.5m ~2.5m	205 PK-PK 199 PK-PK	Monkfish: Seven separate trials (6 trials with 10 airgun discharges and 1 trial with 30) No significant differences were observed between control and exposed larvae examined 48–72 hours post exposure. Capelin: No significant differences in mortality were observed between control exposed eggs to seismic energy and examined 3 days post exposure to 20 airgun discharges. **No difference in mortality in eggs and larvae exposed to acoustic sound.**	Payne et al., 2009 Laboratory Study

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Salmon (eggs and embryo)	Single airgun (40 in^3)	NS	0.1 m 2.7 m	207-232 PK	Study established airgun impacts to two salmon species (lake trout, rainbow trout and kokanee) both pest species. Embryos were exposure to acoustic sound at distances of 0.1 m and 2.7 m at two depth ranges (5 m and 15 m) to establish mortality impacts over ~ 20 days (i.e., eye-up to hatch). Mortality in lake trout embryos treated at 0.1 m from the air gun appeared higher than control groups at 74 (~5 days) and 156 daily temperature units in degrees Celsius (TU°C) at both depths. Exposure to the air gun at 0.1 m resulted in acute mortality up to 60% greater than controls among the four lake trout developmental stages. Mortality was at least 20% greater than corresponding controls, with the exception of the 5 m depth treatments at 207 and 267 TU°C. Treatments at 0.1 m from the air gun at 15 m depth had large effect sizes in the latter developmental stages (207 and 267 TU°C) relative to shallow treatments. The effect of the air gun discharge at 2.7 m was negligible across developmental stages and depths. **No significant difference in development at distances of 2.7 m from the operating array. Mortality evident in embyros at 0.1 m from the operating array.**	Cox et al., (2011) Field Study
Sole Larvae (Solea solea)	Projector playing pile driving sounds	210 dB re 1µPa^2.s (SEL)	100	≤ 206 dB SEL_{cum}	No clear differences between exposure groups and the control group were observed for any of the larval stages. **No increased mortality or injuries compared to control group.**	Bolle et al., 2012 Laboratory Study
Southern Rock Lobster (egg, larvae)	Single airgun (45in^3)	223-227 PK-PK 200-205 SEL	5.2	209-212 PK-PK 186-190 SEL	Study observed acoustic impacts on the larval stages of lobster development where egg-bearing female spiny lobsters (*Jasus edwardsii*) were exposed to a 45in^3 airgun operating at 2,000 psi (SEL ~200 dB re 1µPa^2.s). The study concluded the following: • There was no difference in fecundity between control and exposed lobsters; • A small but significant difference in the length of the larvae was observed in the exposed lobsters. No difference was found in width or dry mass of the larvae and no hatches were found to suffer from high mortality rates or deformities; • No energy difference was identified between larvae from control and exposed lobsters; and • Larval activity/survival between control and exposed lobster groups was not significant. Overall there were no differences in the quantity or quality of hatched larvae, indicating that the condition and development of spiny lobster embryos were not adversely affected by air gun exposure. **No impact of airgun on quality or quantity of hatched larvae at any distance.**	Day et al., 2016 Field Study

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Zooplankton	Single airgun ($150m^3$)	Not Stated	0, 250 & 800 m	183 PK-PK (or SEL 156) 178 PK-PK (or SEL 153)	Study measured the impact of a seismic array to zooplankton abundance and mortality (before/after airgun operation). Study was undertaken over a two-day period with the following findings: • The abundance of zooplankton was observed to open a "hole" within the zooplankton as measured by sonar. Abundances established through net tows had a median decrease of 64% within 1 hour. • The air gun exposure caused a two-threefold increase in dead adult and larval zooplankton observed out to the maximum 1.2 km range sampled. This was observed on both Day 1 and Day 2 however the zooplankton dead/total ratios were significantly reduced compared with controls at the maximum sampling range of ~1.2km. Exposure abundances of no-impact and 50% of control abundance for copepods/cladocerans (86% of the taxonomic composition <u>after exclusion of tows with zero values</u>) occurred at ranges of 509-658m and 973-1119m respectively. Movement of water was present between days and McCauley identified "without detailed information on mixing, advection and current set above tidal flow (not known), it is not possible to draw any conclusions on the different zooplankton abundance… between Day 1 and Day 2". McCauley (pers. Com) advised that due to the increase in abundance counts on Day 2 at the 800m sample location, this has been used as the determinant for stating that the impact range was 1.2 km. • The paper observes that all krill larvae within the exposed samples were dead at all range groups. Raw plankton abundance counts for *Nyctiphanes australis* (krill) identifies that no krill larvae (*Nauplius*) were present in the control/exposed tows for Day 1 (800 m) or Day 2 (250m & 800 m). It is also noted that the abundance counts for tows which did measure *Nauplius* kill were very low: Day 1 (0m) – 8 animals/m^3; Day 1 (250 m) – 10 animals/m^3 and Day 2 (0m) – 1 animal/m^3. It is also noted that for the krill *calyptopis* phases larvae were measured within all range groups on both days and there was an increase in abundance on Day 2 (800 m) for almost all plankton groups. McCauley (pers.com).	McCauley et al (2017) Field Study

i. *Was there sufficient replication to be confident in the study findings*

Conclusions drawn by McCauley are based upon a relatively small number of zooplankton samples. A total of 24 samples were collected: 2 tows each sampling time x 3 distances from the airgun (0m, 200m and 800m) x 2 levels (exposed, control) x 2 replicate experiments (Day 1, Day 2). This equates to a total of 24 samples – 12 samples collected under conditions associated with the airgun, six on each day of the two field tests. The main potential confounding explanation in the study would be that a different water mass entered the area on each day of the experiment and had lower abundance and higher proportions of dead zooplankton. Richardson et al. (2017) conclude that "*although this is relatively unlikely it cannot be discounted because of the relatively few samples collected and only two replicate experiments conducted".*

Independently, the International Association of Geophysical Contractors (IAGC) initiated an independent expert review of the McCauley et al (2017) paper by leading plankton ecologists in well-respected scientific institutions given the results were so inconsistent with previous studies. In short, the reviewers expressed the opinion that although the result of the study should be considered further, the data was not sufficient to support the conclusions of McCauley et al (2017). Independent reviewers identified the following issues with the study:

- *The sample size was inadequate.*
- *Water column movement data was insufficient to support the contention that there was a hole in the plankton field*.
- *Towed net and acoustic survey data disagree regarding zooplankton class size.*
- *The acoustic "hole' indicating dead zooplankton may result from zooplankton which had swum to the bottom (10 m away based upon an observed dense acoustic scattering layer).*
- *Bottom sampling should have been conducted to address the issue of whether large zooplankton was present (i.e. killed or actively swum to the bottom).*
- *The wrong size nets were used and not towed correctly*.
- *There is statistical error in the tow data*.

The independent reviews have been shared with the authors of the McCauley et al. (2017) paper, and those authors have concurred with many of the shortcomings in study design and evaluation identified by the independent reviewers (IAGC, 2017).

The IAGC (2017) concluded that the results of McCauley et al. (2017) showing patterns and trends do not actually exist in the data. Further, the results presented by McCauley et al. (2017) are of questionable scientific merit and, accordingly, must be subjected to more rigorous scientific study before being accepted as the "best available science" regarding the potential effects of seismic sound on zooplankton. Existing published studies demonstrating that any seismic effects on zooplankton occur only to tens of meters remain the best available science until the preliminary study by McCauley et al. (2017) can be properly replicated.

As identified in **Table 6-15**, Parry et al. (2002) studied the effects of seismic array operation on plakton. Vertical plankton tows (0-20 m water depth) were taken along transects running parallel and adjacent to seismic lines. Within this study, Parry et al (2002) established no statistical differences in plankton between control and impact samples (refer Table 6-15), however the statistical power of the study was low given the patchiness and variance in plankton samples obtained. For most plankton taxa abundance change would only have been detected if an 80-90% decrease in the mean abundance occurred. Copepods, the least patchy taxa, would have required an abundance decrease of 20-40% for changes to be detected. Post-impact samples were estimated to be sampled within ~ 200m of the centre of the water most impacted by the airgun array.

CSIRO also undertook a plankton simulation study to estimate the spatial and temporal impact of a seismic activity on zooplankton on the NWS from a large scale sesimic survey, considering the mortality estimates of McCauley et al. (2017) and estimated plankton growth rates and ocean circulation in the region. The hypothetical 3D MSS modelled was 2,900 km^2 in size with 60 survey lines, water depths 300-800 m deep, an airgun source of volume 3000-3200 in^3 operating at 2000 psi at the shelf edge of the outer Carnarvon Basin during summer. To simulate the movement of zooplankton by currents, a hydrodynamic model seeded with ~0.5 million particles utilised currents generated by CSIRO's Ocean Forecast Australia Model (OFAM) and particle trajectories were tracked every two hours to quantify the impacts to the zooplankton population (i.e. those impacted and not impacted). Zooplankton particles could be hit multiple times by airgun pulses if they were carried by currents into the future survey path. The greatest limitation of the model was accurate knowledge of the natural growth and mortality rates of zooplankton. To address this, the CSIRO researchers tested the sensitivity of the model to different recovery (growth-mortality) rates and also the sensitivity of the results to ocean circulation by undertaking simulations with and without water motion (Richardson et al, 2017).

The results of the simulations which included ocean circulation showed that the impact of the seismic survey on zooplankton biomass was greatest in the *Survey Region* (i.e. *survey region* with an impact buffer of 2.5 km) where a maximum removal of 22% of zooplankton biomass occurred at Day 22. Zooplankton within the *Survey Region + 15 km*[45] had a 14% reduction in zooplankton biomass; and the *Survey Region + 150km*[46] experienced a 2% biomass reduction.

The CSIRO study found there was a substantial impact associated with zooplankton population at a local scale, within or close to the survey area, however on a regional scale the impacts were minimal and not discernible over the entire NWS bioregion. In addition, the study found that the time for zooplankton biomass to recover to pre-seismic levels inside and within 15 km of the survey area was three days after the completion of the survey. The relatively quick recovery was due to the fast growth rates of zooplankton and the dispersal and mixing of zooplankton from both inside and outside the impacted region (Richardson et al, 2017).

Adopted Sound Impact Criteria (Plankton):

Sound exposure guidelines for eggs/larvae have been established by the Working Group on the Effects of Sound on Fish and Turtles (Popper et al. 2014) approved by the Accredited Standards Committee S3/SC 1 Animal Bioacoustics and accredited with the American National Standards Institute (ANSI). Mortality data for eggs and larvae are based on a recent study by Bolle et al. (2012) who found no damage to larval fish at received levels of 210 dB re 1µPa^2.s SEL_{24hr}. On this basis, this threshold considered conservative. Based upon available studies reviewed in Table 6-15, the Popper et al. (2014) thresholds nominated in Table 6-16 are considered relevant and adopted in this EP to assess plankton impacts for the Duntroon MSS.

Popper also identifies a moderate risk of impairment (i.e. recoverable injury or TTS) or behavioural impact (e.g. water column displacement) to eggs and larvae at locations near the source array (i.e. tens of metres), with a low risk of impairment at intermediate distances (hundreds of metres). Given these effects are close to the array, impacts are not expected to be significant at a population level.

Table 6-16: Sound exposure guidelines for mortality, impairment and behavioural change in fish eggs and larvae (Popper et al. 2014)

Type of Animal	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Eggs and larvae	> 210 dB SEL_{cum} or > 207 dB PK[47]	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Definitions:					
Mortal and mortal injury	Immediate or delayed death.				
Recoverable injury	Injuries including hair cell damage, minor internal or external haematoma, etc. None of these injuries are likely to result in mortality.				

[45] Defined as near-field
[46] Defined as far-field
[47] When assessing for possible egg/larvae mortality impacts, applying the PK thresholds generally results in a larger distance from the source and is therefore more conservative when compared to the SEL_{cum} value (McPherson et al. 2017).

Temporary Threshold Shifts	Short or long-term change in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6 dB or greater that persists and has been selected as the working group considers that anything less than 6 dB will not have a significant effect from a hearing standpoint.
Masking	Impairment of hearing sensitivity by greater than 6 dB in the presence of noise.
Behavioural effects	Substantial change in behaviour for the animals exposed to sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction or alteration in migration patterns. This criterion does not include effects on single animals or where animals have become habituated to the stimulus or small changes in behaviour such as a startle response or small movements.
Note: Peak and rms pressure levels are dB re 1µPa; SEL dB re 1µPa^2.s. All criteria are presented as sound pressure since no data on particle motion exists. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) (tens of metres), intermediate (I) (hundreds of metres) and far (F) (thousands of metres) (Popper et al. 2014).	

Acoustic modelling undertaken for the Duntroon survey assessed four locations across differing topographical features for the 207 PK thresholds (refer Table 6-17). The maximum predicted horizontal range for mortality impacts was within 150 m from an operating airgun array. The mortality and potential mortal injury using the SEL_{24hr} metric was not reached horizontally from the array and the PK metric is applied to assess impacts to plankton (refer **Appendix B** for the full report).

Table 6-17: Maximum (R_{max}) horizontal distances (in m) from the 3260 in^3 array to the modelled maximum over depth peak pressure level thresholds for eggs and larvae (Popper et al. 2014) criteria for mortality and potential mortal injury (Wladichuk et al., 2018)

PK Threshold (dB re 1µPa)	Distance R_{max} (m)			
	Site C (200m)	Site D (1099m)	Site E (649 m)	Site F (160m)
207	123	-	-	150

Using the received level at which McCauley et al (2017) measured an impact, as this is the latest research to show an impact to plankton, 178 PK-PK is reached at a maximum distance of 19.79 km from the operational array. It is noted that this distance relates to the horizontal distance within the deep-water environments within the Duntron survey area. For shelf environments, the 178 PK-PK isopleth is reached at a horizontal distance of 8.05 km from the operating array.

<u>Extent and Duration of Exposure and Identified Potential Impacts</u>:

Species/Habitats Present:

Plankton: The Duntroon OA is coincident with a portion of the continental shelf (~ 24% of survey area) and offshore waters of the eastern GAB which experience periodic upwellings between November and April (refer Section 3.3.2). Section 3.7.2 provides details of the measured plankton type and abundance for the area. The Duntroon OA (& Duntroon OA with 19.79 km buffer) does not intersect inshore areas along the Eyre Peninsula where there are high measured plankton abundance levels during periods of upwelling (refer Figure 3-25). The Duntroon OA is coincident with a recognised BIA (foraging) for the pygmy blue whale, a species directly affected by zooplankton (krill) availability. The species has been observed feeding within 15 km of the shelf-break area inshore of the canyon systems (refer Section 3.7.5.2).

Fish & Invertebrate Egg/Larvae: A review of commercial fish and invertebrate species present in the OA (refer Section 3.8.3) identifies the following fish/invertebrate spawning categories:

- Species that do not spawn in the eastern GAB (e.g. southern Bluefin tuna, redbait, blue grenadier, pink ling, Australian salmon) (*no expected airgun activity impacts to egg/larvae*);
- Species which spawn in inshore waters distant from Duntroon survey activities (e.g. garfish, King George whiting, snapper, calamari, herring, abalone) (*no expected spatial overlap to cause impacts to eggs/larvae due to airgun activity*);
- Species which spawn within the Duntroon OA, but outside the temporal period of the survey, and may have a larval phase present in the survey area during the survey period; or

- Species which spawn throughout their entire range (e.g. jack mackerel, Gould's squid, lobsters, giant crabs) with eggs/larvae ubiquitous in the OA during the Duntroon survey period.

Table 6-18 summarises key fish species, spawning timeframes, locations and reproduction characteristics for fish and shark species present in the Duntroon OA. The timing of the Duntroon survey avoids most fish spawning periods within the survey area except for the blue mackerel (serial spawner in late spring) and deepwater flathead (multiple spawner October to May but peaking December to March).

Table 6-18: Commercial/Recreational (incl. Charter Boat Fishery) fish stock present in Duntroon OA

Species	Habitat	Bathymetry Habitat	Spawning characteristics	Timeframe	Location
Fish Species					
Sardine [4]	Pelagic	Shelf	Multiple spawning. Approx. 30,000 eggs per week	January to March	Mid Shelf waters
Blue Mackerel [3]	Pelagic	Shelf	Serial Spawner	Late Spring to early autumn	GAB
Blue Grenadier[2]	Demersal	Shelf/Slope	Spawning Aggregations off the west coast of Tasmania	Summer	West Coast of Tasmania
Jack Mackerel [1] [2], [7]	Pelagic	Shelf	Serial spawners throughout range. Females produce about 34,000 eggs per event.	Regionally variable. Spawning in GAB in summer; Oct-Jan (NSW); Nov-Feb (east coast Tasmania)	Spawning thought to occur in vicinity of the shelf break in Tasmania GAB – Shelf break
Redbait [2]	Pelagic	Shelf	Serial spawners. Eggs released every 3 days. About 27,000 eggs per spawning event.	2-3 months during spring	Tasmanian waters
Western Garfish [2]	Demersal	Shelf/slope	Spawning aggregations	Summer	Western GAB
Bight Redfish [2]	Demersal	Shelf/slope (reefs and mud)	Serial spawners	Summer and early autumn	Above 'lumps' on seabed
Deepwater Flathead [2] [8]	Demersal	Shelf/slope	Multiple spawner. Aggregate for spawning. Females produce 0.5-3.5 million eggs/spawning season	Season: Oct-May Peak: December to March	No specified location
Ocean Jacket [2]	Demersal	Shelf/slope	Aggregate for spawning. Broadcast spawners with females producing 2 million eggs per season	Autumn for 3 months, peaking in April	Offshore waters (85-200m deep)
King George Whiting [3]	Demersal	Shallow Inner Shelf	Serial batch spawners. Larvae move to shore	Late Feb to early June	Offshore Waters (6-50 m deep) [6]
Snapper [3]	Demersal	Shelf/Inshore	Serial spawners	Late Oct-Early March	In waters <50m
Australian Salmon [3]	Pelagic	Shelf/Inshore	Serial Batch spawners	February to June	Albany to Busselton
Southern Calamary [3]	Pelagic	Shelf/Inshore	Lays eggs in capsules and attached to rocky substrates, algae or seagrasses	Throughout the year (peaks summer and winter)	Shallow waters <15m
Samsonfish [5]	Pelagic	Shelf	Form spawning aggregations	November to February	Spawning Grounds – lower west WA
Silver Trevally [3]	Pelagic	Shelf/inshore	Serial spawners releasing egg batches over weeks	Summer	Estuaries/shelf waters
Orange Roughy [2]	Demersal	Deep water	Spawning aggregations	Winter	Submerged hills and pinnacles.
SBT [3]	Pelagic	Shelf	Not Relevant	All year except July	Indian Ocean
Sharks					
Gummy Shark	Demersal	Shelf (80 – 350 m)	Viviparous	December (up to 14 pups)	Shallow coastal waters

Species	Habitat	Bathymetry Habitat	Spawning characteristics	Timeframe	Location
Elephant Fish	Demersal	Shelf (to 200m)	Eggs	Spring	Shallow coastal waters <40m
Sawshark	Demersal	Shelf/Slope (40-100 but as deep as 630 m)	Viviparous	October - January	Shallow coastal waters
School shark	Demersal	Shelf to 800 m	Viviparous	December/January	Inshore Victoria, Tasmania and SA

References:
1. Bulman et al (2015)
2. AFMA (2018)
3. Kailola et al, 1996
4. Ward et al (2012)
5. WA DoF (2011)
6. Hyndes et al (1998)
7. Bruce et al (2002)
8. Brown and Sivakumaran (2007)

Two species of interest in the area are:

- The conservation-dependent gulper shark, a viviparous species, inhabiting depths between 275-1000 m on the continental slope. A fishery closure area (breeding) exists within the Duntroon OA where increased presence of females has been observed to allow for the species to recover due to over-fishing. This species breeds year–round, however gives birth to live young and is not egg producing.

- The conservation-dependent school shark where pupping areas lie in shallow coastal areas which will not be affected by Duntroon survey activities.

Plankton: Studies within Table 6-15 identify damage to plankton is likely to be restricted to a range < 10 m from an operational airgun based upon the weight of scientific evidence. Calculations indicate that less than 0.01%[48] of the plankton in the Duntroon OA per day would be affected by acoustic sound.

Using the Popper et al. (2014) criteria in Table 6-17 for plankton mortality (207 dB re 1µPa PK @ 150 m)[49] less than 0.2% of the plankton present within Duntroon OA area would be impacted per day, which is less than the identified daily natural mortality rates for fish eggs and larvae.

Again, this impact is not significant at a population level and low compared with natural mortality rates of plankton which can be very high, exceeding 50% per day in some species and commonly exceeding 10% per day. A review of mortality estimates (Houde and Zastrow, 1993; cited in Fuiman & Werner, 2002) identified a mean mortality rate for fish larvae of 21.3% per day. For marine species, only 180 individuals are expected to survive the larval stage (> 99.9% mortality) from an initial cohort of one million larvae under average mortality rates and larval stage duration (36 days). Causal factors leading to high levels of mortality include predation, inadequate food resources, physical exposure or poor water quality and diseases/parasites (Fuiman & Werner, 2002). Seismic impact compared with natural mortality impacts is therefore not considered significant at a population level.

Using the received levels at which McCauley et al (2017), as this is the latest research to show plankton impacts, 178 dB re 1µPa PK-PK is reached at a maximum distance of 19.79 km. For comparative purposes, the equivalent "survey region" based upon the CSIRO study is the "*survey region* with an impact buffer of 19.78 km".

[48] Calculation is based on an area of 10m impact radius around airgun at 16.7 m shot-point intervals for the planned MSS. It assumes two 80 km x 54-line MC3D survey incorporating 5 km run-in/ run-out lines operating at full power (210 km seismic line traversed in 24 hours), uniform distribution of plankton and a 100% mortality rate within the 10m of the operational array.

[49] The basis of the calculation and area of mortality within a 150 m radius of all seismic lines based upon the length and spacing identified in Table 2.2 for a vessel travelling 4.8 nm per hour, 24 hr operation (210 km seismic line traversed in 24 hours). This assumes a uniform distribution of plankton and 100% mortality within 150 m of the operating array.

Though the CSIRO study was based on a hypothetical 3D survey in the Northwest shelf IMCRA meso-scale bioregion, which covers tropical waters of the continental shelf and slope north-west Australia and has differing oceanic conditions to the temperate Duntroon marine environment, the model is seen to have some applicability to the Duntroon survey area to establish relative levels of impact. Richardson et al (2017) identifies that '*the applicability of the study to specific regions should be done with some reservations, considering the local and regional oceanography. Further, zooplankton growth rates are slower in colder regions and so the recovery of zooplankton populations following exposure to seismic activity is likely to be slower*'. To enable a broad comparison between theoretical plankton impacts observed in the NWS study for conditions in the Duntroon survey area, a comparison of the survey and metocean conditions within the Duntroon MC3D MSS and NWS 3D MSS simulation are provided in Table 6-19.

Given the density of shot points within the Duntroon MC2D survey area is significantly less than the MC3D surveys, the NWS study is not seen as an applicable theoretical model as it would over-estimate the impacts. The greater density of shot-points in MC3D surveys leads to a greater number of 'plankton hits' within the survey area, affecting the relative biomass impacted in the model. MC2D survey lines and their line length are not expected to result in multiple 'plankton hits'.

Table 6-19: Comparison of NWS **3D MSS** simulation conditions with MC3D Duntroon survey conditions

Parameter	NWS 3D MSS	Duntroon MSS
Survey acquisition area (km^2)	2900	EPP-41/42: 3690 EPP-46: 2010
Survey sail line distance (km)	4831	EPP-41/42: 4320 EPP-46: 2460
Survey Dimensions (km)	80 km x 36 km	EPP-41/42: 80 km x 50 km EPP-46: 80 km x 26 km
Number of survey lines	60	EPP-41/42: 54 EPP-46: 30
Range of water depth (m)	300-800	100-3500
Survey duration (days)	35	60 (MC3D Combined)
Airgun capacity (in^3)	3000-3200	3260
Operating Pressure (psi)	2000	2000
Planned distance between seismic lines (m)	600	500-720
Planned distance between consecutive lines (m)	7,000	10,000
Shot point interval (m)	18.75	16.67-25
Proportion of bioregion affected (*acquisition area*)	0.0182	0.011 (Spencer Gulf Shelf Bioregion) 0.005 (Southern Province Bioregion)
Proportion of bioregion affected (*acquisition area + zone of impact*)	0.0268	0.032 (SGS Bioregion) 0.019 (Southern Province Bioregion)
Water Temperature (during survey period)	24-29°C (January)[50]	13-14°C[51]
Survey orientation	Parallel with current	45° cross current

[50] Temperature is selected for January/February given the simulation period (January 1 to March 1, 2003). Temperature obtained from IMOS Sea Surface Temperature Maps (http://oceancurrent.imos.org.au/sst.php)
[51] The Duntroon survey will be undertaken in spring. Water temperature has been assumed from regional data provided in Section 3.5.2.

Parameter	NWS 3D MSS	Duntroon MSS
Current speed/direction (refer **Appendix K**)	0.59 km/hr SW (avge)[52]	0.75 km/hr SE (avge)

On an individual survey basis, the MC3D surveys within the Duntroon area are similar in area, duration and acoustic source size. Consecutive line spacing is larger within the Duntroon MC3D surveys compared with the NWS study. Collectively both MC3D Duntroon surveys are larger in area, total duration and possibly longer line length, however only represent a small proportion of the bioregions they overlap. Differences between locations include ocean mixing rates, water temperatures and the zone of potential impact to plankton (2.5 km vs 19.79 km). An assessment of the differences of relative zooplankton impact levels and recovery rates between locations follows:

- **Ocean Mixing Rates** (i.e. total currents 0.59 km/hr (NWS *average and parallel to survey line direction*) and 0.75 km/hr (Duntroon *average and cross-current to survey direction (45°) to survey direction*): The increased ocean mixing in the Duntroon MSS area will increase plankton transport away from areas affected by survey operations minimising the potential for "multiple impacts" on plankton which directly effects the relative level of plankton depletion. Not all plankton within an area where a seismic source is active will be affected and once the source array has passed will commence recovery (Richardson et al, 2017).

  Richardson et al (2017) showed that zooplankton communities begin to recover during the survey period given oceanic circulation leading to the removal of affected plankton from the survey area. The NWS model predicted the relative zooplankton biomass in the survey area reduced to a minimum after 23 days of survey operations and then increased gradually until the end of the survey on Day 36. A continuous decline in total population throughout the survey period to a minima at Day 36 was not observed reflecting the movement of the water through the survey area and the recovery of zooplankton as they moved into non-impacted areas (Richardson et al, 2017).

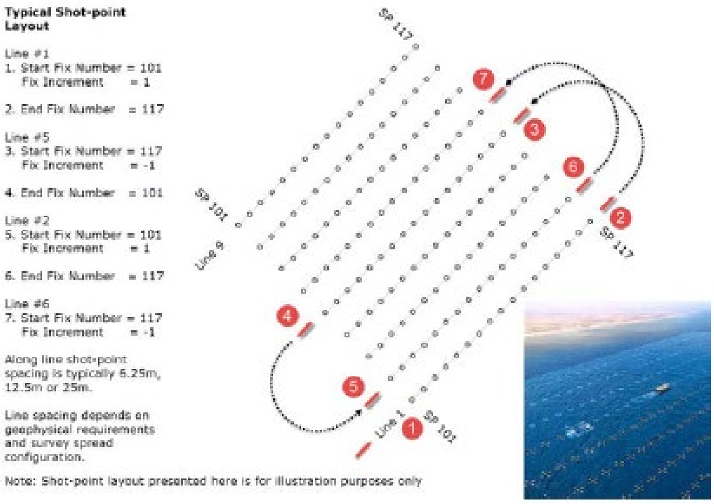
  Richardson et al (2017) identified that at any one time, most particles in the survey region are not impacted by noise (i.e. relative biomass is close to 1). However, the frequency distribution of those impacted vs non-impacted is skewed with a small number of plankton particles (<2%) affected multiple times with a relative biomass down to 0.4. Within the simulation this occurs if currents carry plankton populations into the future path of the survey and multiple exposures occur before the plankton has recovered. For the NWS study most plankton particles were not impacted and the maximum number of heavily impacted particles from Days 20 to 40.

  For the Duntroon MC3D survey area, based upon noise modelling, the maximum horizontal distance to the McCauley et al (2017) plankton impact threshold of 178 PK-PK threshold is 19.79 km[53]. Once the acoustic source is greater than 19.79 km from an area affected by sound, zooplankton is not affected by seismic operations. The Duntroon MC3D survey, as per the NWS 3D simulation, will be undertaken using a racetrack methodology which allows enough area for the seismic vessel with streamers to turn. Accordingly, the sound source moves further away from its original line position on each subsequent line (refer Figure 6-7). However, on the return of the survey vessel to an adjacent line (to the original line) as a result of the spacing between lines (~500 m apart) and the horizontal distance of impact (which is greater than adjacent line spacing) there is potential for sound multiple impacts to an individual plankton particle. The number of 'possible' impacts to an individual plankton particle is therefore a function of:

  - The speed at which the plankton particle traverses the survey area;
  - The horizontal distance from the survey line affected by sound at levels which impact plankton (i.e. 178 PK-PK); and
  - The distance between sequential lines in the survey area.

[52] Currents have been assessed using the average current data for the period 1 January to 31 May (2014, 2015, 2016, 2017). Current data for the period 1 January to 1 March 2003 could not be obtained.
[53] Note that this distance is the maximum over all topographies. For on-shelf activities (higher productivity areas) the 178 dB re 1µPa (PK-PK) is 8.05 km. Hence this analysis over-estimates theoretical impacts.

Figure 6-7: Typical Seismic Racetrack layout and Acqusition Methodology



The NWS study was positioned with acquisition lines parallel to the coast and used an oceanic model with the dominant current direction in the region was south-west. The direction of the MC3D lines were parallel to the current direction (i.e. not cross-current). The assumed seismic line length was 80 km and period of acquisition for one seismic line ~ 14 hrs allowing for a 2-hr line turn.

Based upon average NWS current conditions (refer Table 6-19), one plankton particle might be expected to move through the 80 km acquisition zone within 136 hrs. As the theoretical simulation assumes a 2.5 km impact zone around each seismic line and given the line spacing of 7 km, an individual plankton particle drifting on the current through the survey area and affected by seismic noise (‘A’ lines) from the original seismic line should not be affected by noise from the next sequential line (‘B’ lines). However, on return to the adjacent (‘A’) line, the plankton particle may be again impacted. Given the average current speed though the NWS survey area, a plankton particle might be impacted by acoustic sound a maximum of 5 times during its transit through the survey area (refer **Appendix K** for diagram and assessment).

Ocean currents within the Duntroon survey intersect at 45^{o} to the MC3D survey line orientation. While the ocean currents present within the Duntroon area are typically higher than currents in the NWS simulation, the current “vector component” removing plankton from the survey area (i.e. the component of the current perpendicular to the sound affected area from the survey) is similar in magnitude to the NWS.

Based upon the McCauley et al (2017) threshold of 178 dB re 1µPa PK-PK (i.e. horizontal ‘impact’ distance of 19.79 km around the operational array) and a sequential line spacing of 10 km, a potential impact zone of approximately 20 km lies on each side of the survey line. Within the Duntroon survey area one plankton particle is expected to move through this zone within 92 hrs (equivalent to 6.5 seismic lines). It is possible a plankton particle within the Duntroon MC3D survey area may also be affected on sequential lines except at the extremities of the zone. Calculations provided in **Appendix K** identify that a plankton particle may be theoretically impacted by sound a maximum of 5 times during transit through the survey area. On this basis, it is possible that a plankton particle within the Duntroon MC3D area may be exposed to “multiple exposures” equivalent to that calculated for the NWS simulation - a factor leading to the level of relative biomass depletion in that study.

- **Water Temperatures** (i.e. 24-29^{o}C (NWS) versus 13-14^{o}C (Duntroon)): Given the cooler water temperature within the Duntroon MC3D MSS area, plankton population recovery on a relative zooplankton basis will be slower than the NWS. Review of generation rates for plankton in different marine environments identified generation timeframes for plankton in 15^{o}C water temperatures were approximately double the timeframe to 25°C water temperatures (Huntley & Lopez, 1992)[54]. The NWS study utilised a typical copepod lifecycle of 13 days at 25°C with a recovery rate of 10% per day (r=0.10) (Richardson et al, 2017) to calculate relative zooplankton biomass recovery.

Water temperatures in the Duntroon survey area are lower than those used in the NWS study, however the study is considered applicable as it looked at a range of recovery rates (0.05, 0.1 and 0.15). Given the lower marine temperatures within the Duntroon region, biomass generation rates are expected to be approximately half of that utilised in the NWS simulation. The lower biomass recovery rate (r=0.05) has been used to inform expected relative biomass recovery times in the Duntroon MC3D survey area.

From Richardson et al (2017) for a recovery rate of 5% per day (r=0.05), zooplankton biomass declined until survey Day 22 with relative biomass recovery (i.e. return to 95% relative zooplankton population) predicted in both the *survey area* and the *survey area +15km* at Day 42, six days after the completion of the survey.

Richardson et al (2017) explored a number of variables (oceanic movement and plankton population recovery rates) utilising conditions in the NWS to establish theoretically, the potential impact to relative zooplankton biomass utilising McCauley et al (2017) sound thresholds. This theoretical model has been used to inform the potential relative zooplankton biomass impacts from individual MC3D surveys within the Duntroon OA. As per the above analysis and details provided in **Appendix K**, possible zooplankton impact (i.e. 'hits') as a result of survey duration and line length are not expected to be significantly different to that used in the simulated NWS study. However, as the water temperatures within the Duntroon OA are cooler and lower plankton recovery rates are expected, relative zooplankton biomass reduction will be at the lower end of the parameters studied in the NWS simulation (i.e. 0.75). On a conservative basis, a theoretical maximum relative biomass decline of 25% biomass might be observed within the *MC3D survey area*.

Note that conservative assumptions have been adopted for the Duntroon MC3D survey area to assess zooplankton impacts:

- The MC3D survey line adopts the smallest length possible (i.e. 80 km seismic line length in EPP-41/42). Possible extension of the line into the EPP-46 permit area will increase times between adjacent lines and reduce the potential for multiple zooplankton 'impacts' reducing the relative biomass decrease observed in the NWS simulation;
- Worst case impact zones have been assumed. Based on scientific literature adopted by Popper et al (2014), a mortality or mortal injury impact zone of 140 m around the operational array results in ~0.2% of the plankton present within Duntroon MC3D acquisition area impacted per day, which is inconsequential when compared with natural mortality rates for plankton (Houde & Zastrow, 1993; Saetre and Ona, 1996; Richardson et al, 2017).

Based upon this analysis, the application of the CSIRO study and the utilisation of the 'most conservative' McCauley et al (2017) plankton mortality threshold of 178 dB re 1µPa PK-PK, a relative plankton population biomass reduction of 25% may occur within 19.79 km of the Duntroon MC3D survey boundaries. While the Duntroon MC3D surveys are longer in timeframe compared with the NWS simulation, the level of relative zooplankton biomass affected within the *acquisition area + 19.79km* is expected to follow a similar depletion profile, given dependency on plankton encounter rates with the acoustic source. Using the lower plankton recovery rate from Richardson et al (2017) due to colder waters and slower population recoveries, relative plankton biomass would be expected to return to 95% population levels (r=0.05) within 6 days of survey completion.

The *MC3D acquisition area +19.79 km* (worst case assumed) spatially overlaps the:

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[54] Recovery rate in 13-14°C water temperatures is expected to take double the time as it does in 25°C water. This is based upon the works of Huntley & Lopez (1992) who measured the production of marine copepods as a function of temperature. A common copepod (*A. tonsa*) was used to provide the comparison between these temperatures (i.e. generation time of 7 days at 25.5°C and 14 days @ 15.5°C.

- Kangaroo Island Pool, canyons and adjacent shelf-break and Eyre Peninsula upwelling KEF (24.6% spatial overlap with *MC3D area + 19.79 km*) and the non-spatially defined small pelagic fish of the south-west region KEF which have productivity-associated values. Both KEFs contribute significantly to the local ecosystem during upwelling events. Given the timeframe of the Duntroon survey is positioned predominantly within the winter/spring (i.e. outside key upwelling period); the MC3D survey area which spatially overlap this KEF will be acquired first in the program to reduce the potential for temporal overlap in November; and with adopted controls to detect and protect against blue whale foraging displacement (refer Section 6.2.3.8) in November, impacts to zooplankton during upwellings within this KEF from survey activities is expected to be incidental. As demonstrated conservatively through the Richardson et al (2017) plankton simulation survey impacts are expected to be localised, short-term and recoverable.
- Western Eyre CMP (38% spatial overlap of MUZ[55] with *MC3D + 19.79 km*) which has convervation values associated with ecosystem productivity including foraging-related habitats for the Australian sea lion, white shark, blue whale, sperm whale and seabirds. As per the KEF assessment (above) through the selected Duntroon survey timeframe, survey sequence and adopted controls to prevent impacts to upwelling-related foraging, conservation values within the CMP are not compromised.

In summary, impacts to zooplankton and the broader environment are not expected to be significant given the following:

- Zooplankton, including fish eggs and larvae, present in the water column are abundant in the environment, not spatially restricted and broadly (but not evenly) distributed in the environment. Zooplankton is likely to exhibit spatial patchiness with movement with currents (Richardson et al, 2017);
- Survey is temporally positioned during winter/spring corresponding to lower absolute plankton loadings (Van Ruth, 2009). Zooplankton loadings in the Duntroon survey area during that period are representative of the broader Spencer Gulf Shelf (SGS) and Southern Province bioregions during the September to November period;
- Predicted zooplankton impacts (~0.2% of the plankton within Duntroon MC3D survey area impacted per day) is inconsequential when compared with natural mortality rates for plankton (Houde & Zastrow, 1993; Saetre and Ona, 1996; Richardson et al, 2017);
- Zooplankton has rapid recovery rates (~days) (Huntley and Lopez, 1992; Richardson et al, 2017);
- The Duntroon MC3D surveys will be undertaken over 60 days, with the majority of the MC3D survey area located in deep water away from continental shelf (i.e. ~ 1600 km^2 of 5700 km^2 (28%) (includes both EPP-41/42 and EPP-46 areas) and most of the MC2D survey also in water depths > 200m (i.e. 7% of survey lines). Acquisition in off-shelf environments have lower absolute impact on zooplankton biomass (Richardson et al, 2017);
- The Duntroon MC3D survey area does not contain any shoals or reefs which may attract and aggregate fish species (for spawning events) nor is the area located in key spawning areas for fish species. The Duntroon survey timeframe avoids most fish spawning periods except for the blue mackerel and deepwater flathead. The blue mackeral is distributed across southern Australia from southern Queensland to Western Australia; and deepwater flathead from north-western Tasmania to Western Australia (Latitude 27ºS) (Kailolia et al, 1996). The Duntroon survey falls outside their peak spawning period, and as these species are widely distributed in the environment and multiple spawners, impacts to fish eggs/larvae are very unlikely to have population level impacts. Both species biological stock assessments identify that biomass is not overfished (i.e. within biological reference limits) (Williams et al, 2018);

[55] Multiuse Zone is 15,878 km^2. There is no spatial ovelap of impact area with SUZ or other zones within the CMP.

- On a bioregional perspective, the impacted area (assessed on most conservative areal basis)[56] is localised within or close to the survey area and represents a small proportion of the SGS Bioregion (3.7%)[57] and Southern Province Bioregion (1.6%)[58].

Summary (Zooplankton):

Consequence Level (Zooplankton including fish eggs/larvae): If the activity results in mortality or mortal injury impacts to plankton, fish eggs and larvae, no long-term ecosystem population level effects are expected with population recovery expected to occur within days of ceasing acquisition. There is potential for localised, temporary impacts with population recovery on the timescale of days (SLIGHT Consequence).

Possible Impacts to higher trophic groups:

Figure 6-8 provides a simplified food web for the eastern GAB developed by McClatchie et al (2006). Within the local context of the Duntroon OA, impacts to zooplankton may have indirect impacts to higher trophic levels. For example, any impacts to small pelagic fish abundance has significant implications for the function of pelagic ecosystems (Barker and Vestjens 1990; Bax 1991; Blaber *et al*. 1995; Ward *et al*. 1998; Goldsworthy *et al*. 2003; cited in McClatchie et al, 2006). This species group represents a critical energy pathway between primary (phytoplankton) producers, secondary (zooplankton) producers and larger predatory fishes, sharks, seabirds, seals and cetaceans.

Table 6-20 provides a qualitative assessment of possible impacts to higher trophic levels during the period September to November in the Duntroon MC3D *survey area +19.78km*. Note leatherjacket, garfish, and hardyheads references in Figure 6-8 relate to inshore fish species which do not forage within the Duntroon MC3D Survey 'impact' area.

Table 6-20: Higher Trophic Level Impact associated with reduced zooplankton levels

Trophic Level	Species	Presence	Indirect Impacts
2	Zooplankton	Sep-Oct: Winter/spring conditions (low productivity in shelf environment) Nov: Possible upwelling conditions	Plankton species present within the Duntroon survey area have been described in **Section 3.7.2**. During survey a possible depletion of relative zooplankton availability by 25% within the Duntroon MC3D survey 'impact' area for a period of 60 days is possible. Relative zooplankton biomass within the survey area may be affected for 6 days after survey completion.

[56] Basis of calculation that total area impacted from MC3D survey activity is 17,241 km^2 (i.e. MC3D survey areas (allowing for a 5 km lead-in/out with 19.79 km buffer around perimeter) [EPP41/41 area is 11,481 km^2; EPP-46 area is 5,760 km^2]. Apportioning to bioregions is associated with proportion of MC3D survey on continental shelf (i.e. 40% EP41/42 is on continental shelf; 6% EPP-46 is on continental shelf (4592 km^2 (EPP-41/42) & 346 km^2 (EPP-46)). The remainder of the impact area is attributed to deep water or the Southern Province bioregion

[57] SGS bioregion area is 133,160 km^2

[58] Southern Province bioregion is 770,270 km^2

Trophic Level	Species	Presence	Indirect Impacts
2.5	Pilchards, anchovy & sardines (small pelagic fish)	Present all year	These small pelagic fish prey on both zooplankton and phytoplankton with the relative proportion consumed in the diet of small pelagic fish appearing to be reflective of the relative availability of these groups (McCaltchie et al, 2006). Given this diversity in prey species, phytoplankton consumption is expected to compensate for the relative population decreases in zooplankton. It should be noted that the survey area only has minor overlap with the habitat of these fish (inner shelf areas) (0.14% catch spatial[59]). As the MC3D survey will commence in shelf areas during the winter/spring period (September-October) the survey is not expected to affect primary productivity during upwelling periods and there is seasonal increase in these species in response to increased prey. Impacts to small pelagic fish due to a relative zooplankton biomass decrease to 75% is expected to be incidental to the population given the survey timeframe, spatial overlap and the diversity of prey species available (SLIGHT consequence).
3	Redbait/Mackerel (mid-sized pelagic fish)	Present all year	Jack mackerel are pelagic crustacean feeders and omnivores feeding on krill and pelagic fish (Bruce et al, 2002). Zooplankton (krill) is known to be an important prey for mackerel in the SE marine region (Young et al. 1993; cited in McClatchie et al, 2006) and the abundance of krill appears to affect recruitment success of the jack mackerel, however this link is not known in the SW marine region (Webb, 1996; Young et al, 1993; cited in Johannes & Young, 1999). Jack mackeral range from Wide Bay (Qld) to Shark Bay (WA) including Tasmania (Bruce et al, 2002). A relative reduction of zooplankton biomass of 25% within the Duntroon MC3D survey area would be expected to reduce foraging within only a very small area of the species range and within periods where absolute zooplankton levels are low. Reduced krill foraging (as a result of upwelling conditions) would be temporary and recoverable within November only, with the survey not affecting primary upwelling periods when krill becomes more abundant (i.e. December to March). Based upon this limited timeframe and limited area affected, reduced foraging impacts are temporary and recoverable and not significant o the species (SLIGHT Consequence).

[59] Refer to Table 3-60 (based on tonnage caught not spatial overlap)

Trophic Level	Species	Presence	Indirect Impacts
3.5	Blue whale (& other baleen whales)	Sep-Oct: Downwelling (low productivity – no presence) Nov: Possible upwelling, increased productivity and presence	Blue whales are seasonally present in the Duntroon OA, however have not been observed in the area during September and October (refer **Section 3.7.5.2**). The species has been observed during November if there is early onset of upwelling conditions. An "abundant food source" BIA for blue whales overlaps the Duntroon OA. The area of overlap between the Duntroon MC3D impact zone (*MC3D survey + 19.79 km*) and the blue whale foraging (abundant food source) BIA is ~6620km^2 or 27% of the BIA (abundant food source – Kangaroo Island canyons). It is possible the reduction in relative 'live' zooplankton biomass to 75% within this area may limit foraging capacity. However, zooplankton damaged from sound do not disappear from the area and would be expected to either sink to the seabed or be removed by predation (Richardson et al, 2017). Therefore, impacts to relative zooplankton biomass resulting in foraging impacts is not expected to be as large as zooplankton biomass reduction. In addition, the sequencing of the EPP-41/42 MC3D survey (i.e. racetrack closest to shoreline acquired first) limits the spatial overlap of the MC3D survey in blue whale foraging BIAs during November (should an upwelling occur). During November, PGS will actively monitor for upwelling conditions and for environmental conditions favourable to blue whale foraging within the BIAs coincident with the Duntroon survey areas. On the triggering of these conditions, PGS will initiate aerial surveillance to detect blue whale migration into the area, and if detected PGS will halt the survey for the season. Any impacts to 'live' zooplankton populations would be expected to short-term once acquisition ceases with recovery of live zooplankton biomass within ~5-6 days. Any impact to blue whale foraging due to plankton damage during November is expected to be restricted to the deep-water race-track in the Duntroon MC3D survey area (low absolute levels of zooplankton) with rapid recovery of zooplankton possible from the adjacent Kangaroo Island Pool upwelling KEF. Zooplankton recovery is predicted within a period of 5-6 days. As this impact may have minor temporary effects on critical habitat to a protected species the impact has been assigned as a MODERATE consequence.
3.2	Terns	Present year-round	Terns foraging within and in proximity to the Duntroon OA target primarily small pelagic fish however will also forage on small crustaceans, insects and squid as alternate prey. Given the incidental impacts which have been assessed for small pelagic fish, impacts to terns due to any zooplankton reduction within the Duntroon MC3D survey 'impact' zone is also incidental and temporary (SLIGHT consequence).

Trophic Level	Species	Presence	Indirect Impacts
3.5	Petrels/shearwaters	Short-tailed shearwater present from Sept-May.	Petrels are oceanic with a wide distribution throughout the southern hemisphere foraging on small fish, crustaceans and cephalopods. Given the limited area of zooplankton impact from the Duntroon survey against the species range, and the timeframe of the survey which does not overlap the primary upwelling period (December to March) when prey species are abundant, any reduced foraging as a resultof the survey would be temporary and recoverable. (i.e. SLIGHT consequence). Zooplankton (krill) is the main prey for the short-tailed shearwater (Johannes & Young, 1999). The Duntroon MC3D survey 'impact' area covers approximately 3.4% of the foraging BIA for this species where prey availability may be reduced. The survey does not overlap the primary upwelling period where krill becomes more abundant (December to March). In the event of an upwelling in November, reduced krill foraging is possible, however with control measures adopted to prevent foraging impacts to blue whales, any impacts would be temporary and recoverable. Any impacts associated with prey reduction to the species is expected to be localised, incidental and short-term (i.e. SLIGHT consequence). Zooplankton (krill) is also the main food for the fairy prion (Johannes & Young, 1999). The fairy prion is distributed throughout oceans and coastal areas on the Southern Hemisphere. In Australia, the species has been sighted from the Tropic of Capricorn around the eastern Australian coastline (including Tasmania) to Western Australia with the majority of sightings in the eastern states (No BIAs are present for this species in the Duntroon OA). The Duntroon MC3D survey 'impact' area represents only a small area of this species distribution where zooplankton availability may be reduced. Given this limited area affected relative to the species range, and the selected period of acquisition which does not overlap the primary upwelling period, any impacts associated with prey reduction to the species is expected to be incidental (i.e. SLIGHT consequence).
4	Cephalopods	Present year-round.	Cephalopods are a key component of the Duntroon OA marine ecosystem as primary consumers of pelagic crustaceans and fish (Boyle and Rodhurst, 2005) and is a food source for numerous predators of commercial and conservational significance. Known cephalopod predators include seabirds, teleosts and sharks, whales, dolphins and seals (Coleman 1984; Gales et al. 1993; cited in McClatchie et al, 2006). Reduced zooplankton availability (pelagic crustaceans) by 25% within the Duntroon MC3D survey 'impact' area during the survey period (Sept-Nov) may reduce prey availability, however cephalopods prey on other species present within the Duntroon survey area which are not limited in survey conditions. Cephalopods are widespread within the SW/SE marine region. The small area affected by the Duntroon survey in that range is not significant to cephalopod the survival. Impacts are incidental to the species foraging (SLIGHT consequence).
4	Little Penguin	Sep-Nov (Breeding)	The little penguin's diet is variable in the eastern GAB with prey consisting of fish (sardine, anchovy, sprat), squid, cephalopods and zooplankton (Page et al. 2005; cited in McClatchie et al, 2006)). The Duntroon survey timeframe coincides with little penguin breeding periods whereby the species normally stays within 15 km of their colony. The nearest colony to the Duntroon MC3D survey is Greenly Island located ~70 km from the MC3D acquisition boundary and ~ 45km from the nearest MC2D survey line. On this basis, foraging impacts due to reduced zooplankton population is not expected (i.e. SLIGHT consequence).

Trophic Level	Species	Presence	Indirect Impacts
4.5	Large Pelagic Fish (including tunas)	Present all year round	Small pelagic fish are prey to a wide range of epipelagic predators ranging from tuna to Australian salmon, pike and barracouta. Mid-size pelagics such as mackerel (as above) generally feed on epipelagic nekton and recruitment into the survey area would be related to fluctuations in krill abundance (McClatchie et al, 2006). Mid-size pelagic fish occupy a key position between lower trophic levels (small pelagics) and the apex predators, whereas larger tunas and billfishes at the top of the food webs affect local populations of fish and squid by opportunistically targeting locally abundant species. Large, migratory predators like tunas are pelagic piscivores with southern bluefin tuna known to consume lower trophic levels such as sardines, blue mackerel, anchovy, arrow squid and several other fish (Ward et al. 2006). Tunas and mackerels are also known to form a relationship with seabirds such as shearwaters, by driving schools of baitfish to the surface, which assists the birds in finding food. Given the incidental impacts to all small and mid-sized pelagic fish prey species (sardines, mackerel, anchovy, squid and other fish – as above) impacts to large pelagic fish species due to zooplankton reduction within the Duntroon MC3D survey 'impact' zone is also incidental and temporary (SLIGHT consequence).
4.5	Dolphins	Present all year	Dolphin species present in the Duntroon OA forage primarily on squid and fish (small and epipelagic) (refer **Section 3.7.5**). Given the incidental impacts to all prey species identified (squid, birds and fish – as above) impacts to dolphins due to zooplankton reduction within the Duntroon MC3D survey 'impact' zone is also incidental and temporary (SLIGHT consequence).
4.5	Pinnipeds	Present all year round	Higher order predators in the OA such as the New Zealand fur seal take a surprisingly high number of cephalopods and birds as prey. Cephalopods (mainly arrow squid) may constitute 28–34% of the fur seals' diet, with birds (little penguin, shearwaters) constituting 18–34% and fish (ocean jacket, Swallowtail, and redbait) the remainder. The diet of Australian sea lion includes fish, cephalopods (squid, cuttlefish and octopus), sharks, rays, rock lobster, and penguins. Given the incidental impacts to all prey species identified (squid, birds and fish – as above) impacts to pinnipeds due to zooplankton reduction within the Duntroon MC3D survey 'impact' zone is also incidental and temporary (SLIGHT consequence).

Stakeholder Feedback:

Stakeholders were made aware of the McCauley et al. (2017) paper and inquires were received by KI Dolphin Watch **(Stakeholder Record 32)** as to the potential impact of the Duntroon activity. PGS has provided their assessment of the study to all stakeholder requests and to stakeholders thought to have a general interest in the findings. The following stakeholders raised issues or concerns associated with plankton impacts.

The Wilderness Society (**Stakeholder Record 42**) and ASBTIA (**Stakeholder Record 6**)[60] both identified concerns with the Duntroon survey coinciding with the upwelling period within the Kangaroo Island Pool as a threat to the ecosystem which supports many other species. Information provided within the consultation material, particularly the CSIRO study was considered not applicable to the GAB environment, and the potential for significant detrimental impacts to plankton was raised by both stakeholders. Both stakeholders requested that an equivalent study is performed for an upwelling-driven ecosystem. *PGS did not see merit*

[60] Note both these stakeholders receive a copy of the submitted Environmental Plan.

in undertaking a similar study for the GAB but does see merit in confirming the plankton findings of McCauley et al (2017) expected to be undertaken by the Australian Institute of Marine Science (AIMS). CSIRO identified shortcomings with the McCauley et al, (2017) survey design and results and repeatability of the results must be completed as a priority.

PGS has altered the timeframe of the Duntroon survey to September 1 – November 30, 2019 with controls implemented to prevent displacement from foraging BIAs during November when there is the possibility of upwelling. This altered timeframe has been selected to prevent impacts to upwelling related productivity in the eastern GAB and falls outside of the primary upwelling period (December to March). The reason for this altered timeframe and adopted control measures has been articulated to these stakeholders eliminating the need for a similar 'CSIRO-type' study for an upwelling-driven ecosystem for the Duntroon survey.

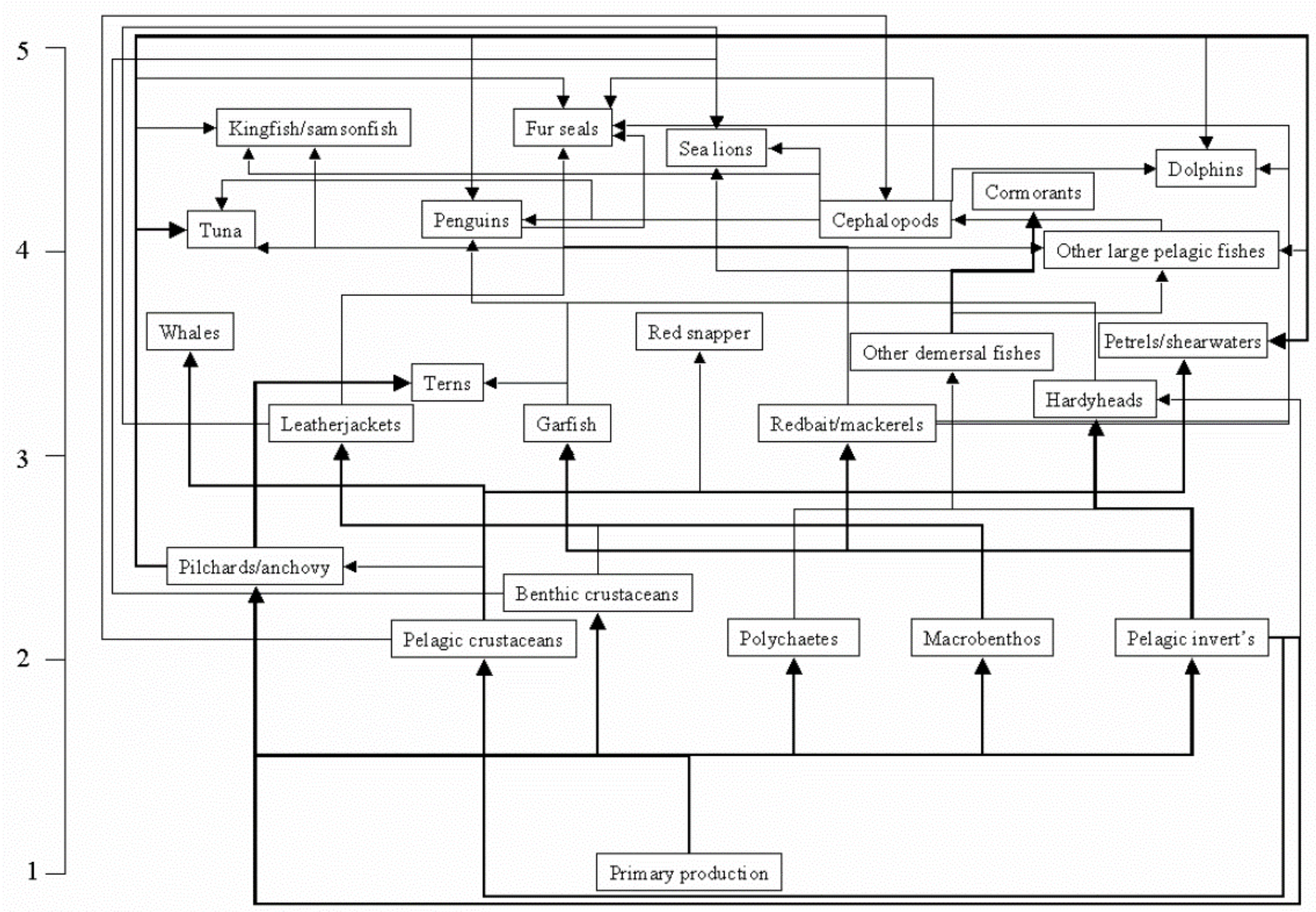
ASBTIA [**Stakeholder Record 6**] has the expectation that PGS should monitor plankton populations prior to survey commencement, set threshold levels based upon ambient conditions and using those measurements implement control measures and cease seismic operations if the pre-agreed thresholds are measured. This survey/control is proposed by ASBTIA for the Duntroon survey in a period which overlaps winter/spring conditions already shown to have very low zooplankton levels (refer Section 3.7.2). Accordingly, any zooplankton impacts affecting species such as SBT (not present in the eastern GAB during survey activities), as per the assessment undertaken in this section are expected to be localised, temporary and recoverable and will not affect the interests of ASBTIA. On this basis, PGS questions the 'value' and environmental benefit of such a monitoring program, however PGS is agreeable to participating in plankton monitoring studies during the survey providing it is financially supported by stakeholders ASBTIA has been advised of PGS's position on the plankton monitoring. PGS has adopted internationally-recognised received sound level thresholds to assess impacts. These thresholds are based upon biologically relevant received sound levels to determine impacts not incremental sound above ambient levels or levels of impact to plankton sampled. Measurable sound impact thresholds have not been developed on this variance basis, and suggested measure is not practicable given the variance of ambient sound in the environment. PGS has not received a reply from PGS correspondence to ASBTIA dated 3rd October 2018 which conveyed this information.

SASIA **[Stakeholder Record 8]** identified a concern with the possible acoustic impacts to spawning sardines, a small pelagic fish which underpins many higher trophic levels in the region including tuna. **Figure 3-25** provides details of the OA relative to areas of sardine egg abundance during the spawning period (January to March). The Duntroon survey has been positioned in the September to November period which prevents temporal overlap with sardine spawning events. SASIA also expressed concern with potential interference of the Duntroon MC3D survey in EPP-41/EPP-42 if started prior to April 1, 2018 due to interference with sardine stock surveys in line with ASBTIA's concerns. SASIA identified that sardine stock surveys occur annually in February-March. The Duntroon OA marginally overlaps sardine survey transects in the north-eastern section of the Duntroon OA on the continental shelf. PGS in response to this concern has positioned the Duntroon survey in the September 1 to November 30, 2019/20 period to prevent interference with sardine egg count survey. This altered timeframe information has been provided to SASIA and no feedback to the altered timeframe has been received.

OGASA (**Stakeholder Record 68**) expressed concerns associated with seismic acquisition impacts to high productivity upwelling areas prior to April 15 in any year. PGS in response to this concern has positioned the Duntroon survey in the September to November 2019/20 period to prevent interference with the peak upwelling period. This alterered timeframe information has been provided to OGASA and no feedback to the altered timeframe has been received.

AIASA [**Stakeholder Record 54]** oppose any seismic activity being undertaken close to the coast and outer reef systems and during sensitive abalone spawning months. AIASA will not support the activity until there is an income protection/indemnity policy in place for the industry by PGS. PGS has responded to AIASA providing information on the survey location against coastal reef areas suitable for abalone and does not consider there is spatial overlap with outer reef habitats. PGS has provided impact assessment details of noise on abalone and abalone eggs/vegliers which may be present during the Duntroon survey timeframe in commercial fishery areas. The impact assessment, given the localised distribution of abalone eggs/vegliers in coastal waters and distance of the Duntroon survey from these coastal commercial fishing areas, is not expected to have impacts on spawning and recruitment to the fishery. PGS has not received any feedback from AIASA on this information to date.

Figure 6-8: Simplified food web that summarises the main trophic interactions among species groups in the eastern GAB (McClatchie et al, 2006).



Note: Species trophic levels are indicated on the left. To improve clarity, dietary contributions [50% are indicated by bold lines, contributions <50% are indicated by fine lines and contributions <10% have been omitted.

Controls assessment to limit impacts to plankton abundance:

Richardson et al (2017) identifies survey design parameters to be considered in limiting impacts of seismic sound to zooplankton. These are assessed in Table 6-21.

Table 6-21: Assessment of Potential Control Measures to reduce impacts to zooplankton

Control Measure	Practicable	Will it be Implemented?	Justification
Temporal Buffer: Position the Duntroon MC3D surveys temporally to avoid seasons with higher zooplankton biomass (i.e upwellings).	YES	YES	PGS has sequenced the Duntroon survey outside of the peak upwelling period (December to March). The survey will be undertaken during periods where downwelling conditions are present (September-October) and periods where there is a lower likelihood of weather and current conditions leading to upwellings (November). PGS will monitor environmental parameters which are precusors to upwelling events (i.e. sea bottoms temperature, surface winds) and conditions favorable to foraging blue whales (i.e. sea surface temperature). In the event that any of these parameters identify upwelling/favorable blue whale foraging conditions are present, aerial surveillance will be initiated and if blue whales are identified within one day of travel of the survey area, the survey will be halted. If blue whales are not observed, surveillance will continue until whales are detected or November 30 when the survey will be halted for the season.EPP41/42 MC3D Inshore racetrack will be completed prior to offshore racetrack to avoid temporal overlap with productive shelf areas in November Zooplankton patches lag the development of phytoplankton concentrations and generally occur downstream (McClatchie et al, 2006).
Temporal Buffer: Conduct survey in seasons where upwelling will not occur (May to October)	Partial	Partial	Sea states across this period prior to September are not conducive to seismic acquisition on both a safety basis and acquisition basis (i.e. there is greater downtime increasing survey duration and swell size limits support vessel attendence). From a safety perspective and possible risk to human safety, this option is not acceptable. .
Seismic Line Directions: Orient survey so lines are across or into prevailing currents to prevent /minimise multiple impacts to zooplankton.	Partial	Partial	The current MC3D survey runs at 45º to the survey acquisition alignment and is partially across prevailing currents. The MC3D polygons and survey line alignment have been designed to maximise acquisition efficiency and reduce the time taken to acquire data. Alternate line alignment would lead to more infill lines and a greater survey duration with plankton impacts lasting for a longer period in total. AMSA requested that the sesimic transects are run parallel with shipping routes to avoid interference with commercial shipping. The selcted alignment, while not totally parallel with shipping lanes minimises the potential for spatial conflict with this marine user group. Seismic line design which acquires at 90º to the prevailing current would have significantly more commercial shipping spatial conflict issues.
Location of the Survey: Conduct survey in areas off the continental shelf to have less absolute impact.	Yes (as far as possible)	Yes	The majority of the MC3D survey area is located in deep water away from continental shelf regions (i.e. ~ 1600 km^2 of 5700 km^2 (28%) (includes both EPP-41/42 and EPP-46 areas) lies on the continental shelf) with most of the MC2D survey also in water depths > 200m (i.e. 7% of survey lines). Measurement of zooplankton concentration in offshore location also supports lower absolute concentrations (refer **Section 3.7.2**). Given the spatial overlap with deeper water areas, and survey timeframe, absolute impact will be low. Survey areas located on the continental shelf have been minimised to the extent practicable while still obtaining sufficient information on underlying drilling targets. The EPP-41/EPP-42 and MC2D survey lines are required to provide definition of targets.

Control Measure	Practicable	Will it be Implemented?	Justification
Hours of Operation: Conducting surveys during the day rather than night to minimise impacts on zooplankton (due to diurnal movement).	NO	NO	The seismic signal does not sufficiently attenuate in the vertical direction (design parameter not considered relevant to the Duntroon survey).

Acceptability of Impact:

Impacts to zooplankton are considered acceptable, with controls implemented, based upon the following criteria:

- There is no serious or irreversible impacts to zooplankton during non-upwelling or upwelling seasonsor to the ecological processes for key fauna values and ecosystem within the Western Eyre CMR (Southwest Marine Parks Network Management Plan 2018 - IUCN Reserve Management Principles (IUCN VI));
- No serious or irreversible disturbance from acquisition activities in up-welling related foraging BIAs during upwelling events ensuring no disruption to plankton biomass or integrity of ecosystem functioning (Ruth, 2009);
- No acoustic interference to pygmy blue whale foraging within, or displacement from the blue whale foraging BIA (Conservation Management Plan for the blue whale (DOE, 2015));
- No significant disturbance to seabird aggregations foraging in up-welling related BIAs during the seasonal upwelling period (Southwest Marine Parks Network Management Plan 2018 -Australian IUCN Reserve Management Principles (IUCN VI));
- No acquisition within any spatially-defined fish spawning, aggregation or breeding grounds during the survey period (DFO, 2004; SASIA – Stakeholder 8);
- Plankton mortality rates from acoustic exposure are expected to be low compared with natural mortality rates in plankton (Kostyuchencko, 1973; Matishov, 1992; Booman et al, 1996; Cox et al, 2011; Dale & Knudsen, 1987; Pearson et al, 1994; DFO, 2004, Payne et al, 2009; Bolle et al, 2012;,Day et al, 2016 and Houde and Zastrow, 1993; cited in Fuiman & Werner, 2002;);
- Survey period does not temporally overlap key periods for upwelling (December to April) (ASTBIA – Stakeholder 6; Wilderness Society – Stakeholder 42; OGASA – Stakeholder 68); and
- No possible impacts sardine egg surveys during March (SASIA – Stakeholder 8) or to abalone spawn (AIASA – Stakeholder Record 54).

Acceptability Statement: The Duntroon survey does not temporally or spatially have serious or irreversible impacts on areas of high productivity (plankton) during the Duntroon survey. Impacts to local plankton populations are localised, temporary and recoverable in the short-term.

6.2.3.3 Marine invertebrates

General:

Marine invertebrates lack a gas-filled bladder and are thus unable to detect the pressure changes associated with sound waves. All cephalopods as well as some bivalves, echinoderms and crustaceans have sac-like structures called statocyst which includes a mineralised mass (statolith) and associated sensory hairs. Statocysts develop during the larval stage and may allow an organism to detect the particle motion associated with sound waves in water to orient it-self (Carroll et al. 2017). In addition to statocysts, cephalopods have epidermal hair cells which help them to detect particle motion in their immediate vicinity similar to the lateral line in fish (Kaifu et al., 2008). Similarly, decapods have sensory setae on their body (Popper et al., 2001) including antennae which may be used to detect low-frequency vibrations (Montgomery et al., 2006).

For invertebrates, auditory invoked potentials have revealed responses in cephalopods at 400 Hz with sensitivity dropping below 10 Hz (Carroll et al., 2017). Similarly, behavioural studies on squid revealed an optimal hearing range of 200-400 Hz with capacity down to 80 Hz (Money et al., 2016: cited in Carroll et al., 2017). Prawns have shown a response at 500 Hz irrespective of body size, while lobsters have shown variation according to life stage with juvenile lobsters detecting sounds between 20-1000 Hz and adults showing acoustic sensitivity at two peaks 20-300 Hz and 1000-5000 Hz (Pye and Watson, 2004: cited in Carroll et al., 2017). No data is available on the frequency-specific hearing/particle motion detection capability of lobsters although some preliminary experiments have shown responses to water vibrations in the frequency range 20–180 Hz (Goodall et al., 1990). For hermit crabs, responses were detected at a frequency of 5 – 400 Hz and particle velocities of 0.03-0.44 ms^{-2}; and for *Panopeus* crabs between 90 and 200 Hz where vibrations of <0.01 ms^{-2} could be sensed (Edmonds et al. 2016).

Edmonds et al. (2016) cites evidence that crustaceans have a noise resistant physiology as the snapping shrimp (family *Alpheidae*) may represent the greatest single contribution to biological sound in shallow temperate and tropical waters. Snapping shrimp produce clicks at source levels of ~ 175-220 dB re 1µPa (PK-PK) and span a broad frequency spectrum from 2 Hz to more than 200 kHz.

Some research postulates that shellfish, crustaceans and most other invertebrates only ‘hear’ seismic sounds at very close range of a sound source (i.e. The “near-field”) (McCauley, 1994; Parry & Gason, 2006; UNEP, 2012). Aquatic invertebrates with ciliated “hair” cells may be sensitive to water movements caused by currents or “particle motion” which occur close to the sound source. These hair cells may allow for the sensing of near-by prey or predators or help with local navigation. Particle motion falls off rapidly with distance from an acoustic source (Tasker et al., 2010) so only aquatic invertebrates in close proximity may be affected or detect nearby sound sources.

Marine benthic invertebrates also generally have far lower mobility than pelagic species and are often localised to particular microhabitats. As such, they have generally have less ability to avoid seismic sound by moving away from an area. Some sound sensitive species, such as cephalopods, have greater mobility and are expected to move away from areas where sound levels might have the capacity to cause physiological damage.

Table 6-22 provides a summary of available scientific literature for the invertebrate species which may be present in the Duntroon OA area – benthic porifera, ascidians, and bryozoans; crustaceans; giant crab and lobster; and molluscs[65].

Filter feeding communities (Benthic porifera (sponges), ascidians (sea squirts), bryozoans)

Species Sensitivity:

Filter feeding communities are generally associated with hard substrates and may include ascidians, porifera and bryozoans. Sponges provide homes for a variety of animals, including shrimp, crabs, barnacles, worms, brittle stars, sea cucumbers, and other sponges (Turner, 2002).

Marine invertebrate species such as porifera, bryozoans and ascidians do not contain air cavities which might function like a fish bladder in responding to pressure (i.e. trauma due to rapid pressure changes) or statocysts present in some species (e.g. cephalopods) which assist in maintaining equilibrium and in some cases linear or angular acceleration (Normandeau Associates, Inc. 2012). On this basis, impacts to benthic fauna in the survey area are not expected from the sound “pressure” (far-field) component of the sound wave. Also, as above, given the depth of water within the survey area, near-field “particle motion” impacts are not expected to impact on these invertebrate species.

Little research has been undertaken as to sound impacts on ascidians, bryozoans or porifera. One study, looking at possible acoustic impacts from seismic sources to (glass) sponge (i.e. porifera) feeding characteristics, identified no increased feeding rates within the species when exposed to a received SEL of 151 dB re 1µPa^2.s at 160 m (Tunnicliffe et al. 2008). It is noted that sponges have a narrow range of behavioural responses – they cannot swim away, change shape, move appendages or alter blood flow however response effects can be measured by flow through the animal. This flow through the walls and out a central “mouth” is necessary for respiration and for feeding and cessation for sustained periods is likely to affect the animal’s health. Cessation of pumping has been observed in sponges in response to high

[65] Molluscs include scallops, abalone, oysters, clams, limpets, squid, octopus and cuttlefish.

sediment loads. This study, undertaken in Fraser Ridge (Strait of Georgia, Vancouver), is subject to high currents, high suspended matter, strong tidal modulation and ambient noise from shipping (Tunnicliffe et al. 2008). The study concluded that based on this experiment there was little or no evidence that acoustic pressure from the airgun influenced the physiological functions of the sponge.

Surveys of coral reef areas offshore Brunei and post seismic acquisition did not detect any impacts on hard corals, soft corals, sponges or other sessile benthic organisms as a result of pressure pulses from airgun emissions (IEC, 2003: in Woodside 2012d).

Soft coral, another sessile filter feeder, was studied in the Maxima 3D survey at Scott Reef. Because of their flexibility which allows them to minimise stress by reconfiguring in response to fluid forces, soft corals are not expected to be injured by sound pulses produced by airguns as close as 1 m away (Woodside, 2012). Corals in and around the lagoon were exposed to seismic signals (both experimental seismic lines and full seismic survey) using a 2055 in^3 source over a 59-day period. The experimental lines passed directly over the coral communities (source @ 7m water depth, corals at ~ 60 m water depth) whereas the full seismic survey passed within tens to hundreds of metres (horizontal offset). The maximum estimated received sound levels at coral impacts sites were 226-232 dB re 1µPa (PK-PK); 214 -220 dB re 1µPa (SPL), 197-203 dB re 1µPa^2.s (per-pulse SEL) and a maximum cumulative SEL of 197-203 dB re 1µPa^2.s (Salgado-Kent et al, 2016). The corals were monitored for dead and bare coral cover and % red algae. No detectable effects were found from one or multiple passes of the seismic airgun array. Further there was no evidence of coral breakage, no signs of physiological impairment of the corals and no long-term change in coral community structure related to the experimental or full seismic survey activities (Woodside, 2012).

Extent/duration of exposure and identified potential impacts (biomass):

Habitats Present:

There are no BIAs present in the Duntroon OA for filter feeders, however the benthic invertebrate community of the eastern GAB KEF is identified as possibly present in the Duntroon OA.

Sessile invertebrates such as porifera, bryozoans and ascidians are known to be present on the continental shelf area of the Duntroon OA (refer Section 3.7.3) however decrease in abundance as water depths increase (refer Section 3.7.1). The OA was found to support the lowest average biomass of sessile invertebrates in the eastern GAB in studies undertaken by Ward et al., (2006). It is known that these sessile species are particularly sensitive to activities which physically impact the seabed and create sedimentation (Boertmann and Mosbech, 2011).

Potential Impacts:

Based on the research findings to date and similar soft coral studies undertaken at Scott Reef, it is highly unlikely that the sessile invertebrates present in the Duntroon OA will be exposed to sound levels of sufficient magnitude to cause any physical or physiological impacts. Predictive modelling identifies that per pulse SELs of 190 dB re 1µPa^2.s, a lower threshold than the 'no damage' per-pulse threshold in the Maxima survey, lie within 60m of the operational array. The maximum PK-PK value predicted in modelling was 219 dB re 1µPa (PK-PK) in shallow water depths of 160 m. On this basis, no areas are predicted to be exposed to levels of 226-232 dB re 1µPa (PK-PK).

Summary:

Consequence: As predicted noise levels in the Duntroon OA are below the 'no-damage' per-pulse thresholds any impacts to filter-feeding communities would be incidental localised, temporary and recoverable (SLIGHT consequence).

Acceptability of Impact:

Impacts to filter feeding communities are acceptable, with controls implemented based upon the following criteria:

- There is no disturbance to filter-feeders in benthic environments in the Western Eyre CMR which would damage ecosystem functioning of the benthic invertebrate communities of the eastern GAB (Australian IUCN Reserve Management Principles (IUCN VI)).

Acceptability Statement: The Duntroon survey does not disturb filter-feeders. Impacts are localised, temporary and recoverable.

Abalone (Mollusc)

Species Sensitivity:

Many molluscs, including gastropods and bivalves, possess statocysts which assist the animal in maintaining balance and orientation in its immediate environment (Carroll et al, 2017).

Statocysts are fluid-filled, capsule-like sensory organs, usually including ciliated hair cells and containing a single dense body (statolith) or multiple smaller ones (statoconia). The statocyst and/or statoconia interact with the cilia lining in the capsule, probably (as has been shown in gastropods and cephalopods) conveying information about orientation to the organism. This may also enable the animal to detect low-frequency pressure waves in sediment – either in porewater or as vibrational signals associated with the movement of sediment particles (Wethey and Woodin, 2005). It has been postulated that the statocyst organs may be receptive to the particle acceleration component of a sound wave, possibly in the far-field (Hawkins and Myrberg; cited in McCauley, 1994). Franzen showed that tellinid bivalves (*malcoma balthica*) are sensitive to frequencies in the range 50-200 Hz, which corresponds to shear-wave vibration that propagates along the sediment surface. A study on the ox-heart clam (*Glossus humanus*) has demonstrated sensitivity to vibrations and hypothesised that the sensitivity was related to sensing breaking waves on the incoming tide (Frings, 1964; cited in McCauley and Kent, 2008). *Donax variabilis*, a coquina clam, responded to pressure signals in the range 20 Pa, or a sound pressure of 140 dB re 1µPa (SPL) (Ellers, 1995).

In another bivalve mollusc, response to sound has been evident by changes in aggregations. Low frequency sound (30 to 130 Hz) has been demonstrated as an effective control measure for zebra mussel fouling (Donskoy and Ludyanskiy, 1996).

Beyond the distances of impact outlined in McCauley (1994), no information is available concerning the distances over which bivalve molluscs may be able to detect either the pressure or particle motion components of a sound wave. Wethey and Woodin (2005) concluded that a conquina clam could probably detect defecation signals generated by a polychaete worm at 60 cm in sediment.

Mortality/Potential mortal injury and impairment:

The most recent critical review of potential marine seismic surveys on fish and invertebrates (Carroll et al, 2017) identified only one study that indicated a mortality response in bivalve molluscs at realistic exposure levels (Day et al, 2016b). This study in Bass Strait found that exposure to a seismic source (single airgun of either 45in^3 or 150 in^3 and maximum exposure levels of 191-213 dB re 1µPa PK-PK) did not cause any incidence of immediate mass mortality, however repeated exposure increased mortality and mortality risk with time as the majority of mortalities were recorded at the 120-day sample point (Day et al, 2016b). This dose-dependent increase in mortality translates into an annual increase in mortality of between 9.4% and 20%. This falls towards the low end of what might be expected when compared with natural mortality rates in wild scallop populations, which range from 11-51% with a six-year mean of 38% (Day et al, 2016b).

It is noted that limitations exist within the Day et al (2016b) study which means the finding of increased mortality must be treated with caution. As detailed in Przeslawski et al (2016a), the Day et al (2016b) study:

- Used a manipulative approach in which scallops were transplanted to the study area, exposed to an operating airgun and then held captive during subsequent monitoring;

- The scallop populations were obtained from commercial sources or transplanted from other regions to coastal waters, rathern than using in-situ populations in Bass Strait. Stress associated with handling during translocation may have contributed to impacts. Transplanted populations had increased mortality, inability to maintain homeostasis, reflex changes, depressed immune response after they had been exposed to an air-gun in shallow water;

- A single airgun was used in water depths of 10-12 m (i.e. very close-range impact) rather than a commercial airgun array in deeper waters;
- Identified long-term impacts after rearing scallops in suspended lantern nets such that the scallops were not in their natural environment (i.e. buried beneath sediment), thereby adding potential, though undetected stress.

Therefore, it seems likely that the observation of increased mortality, albeit minimal when compared to natural mortality rates, is probably related to other factors such as stress caused by transportation and the rearing of animals in the water column rather than in seabed sediments.

Przeslawski et al (2016a; 2016b) studied the effect of a 2530in^3 commercial airgun array at water depths between 36-61 m to examine an in-situ scallop population in seabed sediments. The study recorded no impact of seismic exposure on adult scallop mortality rates or a range of physical attributes two months after exposure although this study had several issues with the presented acoustic sound levels, both measured and modelled. While this study should not be used to interpret the effects of sound on in-situ scallops in seabed sediments, the results of this study, identified no mass mortality of molluscs correlating with the results of Day et al (2016b).

All other studies reviewed by Carroll et al (2017) found no response with respect to mortality effects in bivalve molluscs including two studies using the scallop *Pectin fumatus* (Parry et al, 2002; Harrington et al, 2010). Parry et al (2002) found that mortality rate and adductor muscle strength of scallops suspended in the water column and exposed to the operating airgun array (at a minimum distance of 11.7 m) was not significantly different from controls. However, it should be noted that the scallops were suspended in nets during exposure, and as such, were not subject to the relevant ground borne vibrations. Harrington et al (2010) conducted a scallop (*Pectin fumatus*) dredge before and two months after exposure to a 2000 psi airgun array. No evidence of short-term or long-term impacts on the survival or health of adult specimens was detected.

Studies have also looked at two oyster species and the effect of detonation of high explosives underwater and found the species to be resilient to the shock-waves created by underwater detonation. LeProvost et al (1986) studied the effects of underwater explosions on the pearl oyster and found no mortality occurred in the exposed animals over a 13-week period and at a minimum range of 1 m from the blast centre.

Seismic sources cause less impact to invertebrates than explosives, therefore it is likely that molluscs would need to be within a very close range of a seismic source to receive sound levels associated with immediate mortality – with available evidence suggesting 1-2 m. It is more difficult to determine the distances at which sub-lethal impacts (morphological, biochemical and physiological changes as stress indicators) could occur. Note there are limited studies done specifically on gastropods and so conclusions must be drawn from studies done on similar species.

Behavioural responses:

Most studies undertaken on behavioural impacts from seismic to molluscs have utilised commercial scallop species. As for other invertebrate studies results are mixed between impacts and no impacts (Carroll et al, 2017). Typically impacts are seen in laboratory studies or in field studies where there have been repeated exposures.

La Bella et al (1996) examined biochemical indicators of stress in bivalves exposed to seismic noise and found that hydrocortisone, glucose and lactate levels between test and control animals were significantly different ($P>0.05$) in the venerid clam *Paphia aurea* showing evidence of stress caused by acoustic noise. This was at a minimum exposure range of 7.5 m. La Bella et al (1996) also reported catch rates of gastropods via gillnet methods were significantly reduced the day after the seismic survey ceased and concluded the motility of the species was affected. No differences were observed in gastropod catch rates via hydraulic dredge methodology. These observations were associated with an operational array emitting a source level of 210 dB re 1µPa in water depths of 15m. Received sound levels are not stated (Moriyasu et al, 2004).

Extent/duration of exposure and identified potential impacts:

Based upon research to date, mortality and injury impacts to molluscs have been reported in studies relating to seismic surveys at close range to the operating source. Available literature suggests particle motion, rather than sound pressure, is a more important factor for molluscs. Water depth and seismic source size are related to the particle motion levels at the seafloor, with larger arrays and shallower water being related to higher particle motion levels, more likely relevant to effects. The Duntroon survey will occur in deeper waters, and therefore high particle motion levels and inducement of ground roll at the seafloor are unlikely.

Any possible impacts would only occur in the shallowest sections of the acoustic acquisition area and would not have a widespread impact beyond that footprint. From available literature on site-attached molluscs, if mortality impacts did occur, impacts would lie within natural mortality rates and are unlikely to have long-term or population impacts. As there is no overlap of the abalone fishery with the Duntroon OA and the Duntroon OA does not contain suitable habitat for abalone, no mortality or mortal injury effects are expected).

Physiological impacts identified in molluscs may affect individual animals on a localised basis, however this is unlikely to have long-term or population level impacts to abalone based on the localised area of impact and the distance to commercial abalone harvesting areas from acquisition activities.

Habitats Present: The closest abalone area to the Duntroon OA is Four Hummocks Island located 36 km from the nearest Duntroon OA boundary. Other abalone fishery areas are in South Australian coastal waters (~ 50 km from the nearest OA boundary).

Summary: If the activity resulted in mortality or physiological impacts to molluscs, no ecosystem or population level effects are identified given the spatial separation between the survey and the fishery. Impacts are expected to be incidental in the environmental setting (SLIGHT consequence).

Acceptability of Impact: Based upon research to date, mortality and mortal injury effects in molluscs resulting from seismic surveys occur in close proximity to the source.

Potential impacts to abalone are acceptable based on the following:

- Abalone are present in coastal waters to a maximum water depth of 40 m with the closest diving area approximately 36 km from the Duntroon OA boundary;
- If mortality impacts did occur to site-attached molluscs, mortality would be expected to be within natural mortality rates and unlikely to have long-term or population level effects.

Acceptability Statement: The Duntroon survey will not disturb abalone. Any impacts are localised, temporary and recoverable and not significant at a population level.

Crustaceans (Lobster, Crab, Prawns)

Species Sensitivity:

Physiological Sensitivity (including mortality): Recent comprehensive scientific reviews into the effects of invertebrate sensitivity into loud impulsive, low frequency sound, typical of seismic surveys, has been undertaken (Carroll et al., 2016; Edmonds et al., 2016). Studies specific to prawn species are limited, however some decapod studies observed a range of effects to ‘no-effect’. As both crustaceans belong to the same scientific order (Eucarida), the available studies have been used to provide an indication of the sensitivity of prawns to low frequency sound.

Edmonds et al., (2016) undertook a review and critical evaluation of crustacean sensitivity to loud impulsive, low frequency underwater noise and identified physiological sensitivity to the Norwegian lobster (*N. norvegicus*) and closely related crustacean species including juvenile stages. However, Edmonds et al.,

(2016) identified that the current evidence for physiological sensitivity relates to the "*local, particle motion effects of sound in particular*".

No lethal effects of underwater seismic noise have been described for the crab (*C. pagurus*) or lobster species (*H. gammarus, N. norvegius*) (Edmonds et al., 2016). This is also supported by no mortality impacts associated with reef associated invertebrates four days after exposure (Wardle et al. 2001); snow crabs up to 12 days after exposure (Christian et al., 2003); shrimps exposed to close-range airguns (Ostrensky 2002 in Andriguetto-Filho et al., 2005) or lobster weeks or years after exposure (Parry and Gason, 2006; Day et al., 2016). However, a range of physiological and behavioural effects has been reported amongst crustacean species.

A companion study to Andriguetto-Filho et al. (2005) tested the acute exposure effects on three species of caged shrimp placed at various distances from the airgun (Ostrensky et al., 2002). No mortality was observed even when airguns were operating at very close range from the caged shrimp in conditions more severe than the Andriguetto-Filho et al. (2005) study. Detailed histopathological studies on their gonads, branchiate and hepatopancreas showed negligible damage associated with airgun array exposure.

Day et al. (2016b) found that airgun exposure in rock lobsters (*Janus edwardsii*) damaged statocysts up to a year later. These effects were not observed in a study by Christian et al., (2003) who exposed the snow crab (*C. opilio*) to airguns in the laboratory (at close range) and in the field (at 50m water depth). In addition, no significant difference was found between acute effects of seismic airgun exposure upon adult snow crabs *(*haemolymph, hepatopancreas, heart, and statocysts) in comparison with control crabs (Edmonds et al. 2016). In a subsequent study to expand on the results of Christian et al. (2003), C. opilio was exposed to acoustic sound and animals were reported to suffer from bruised hepatopancreas and ovaries in comparison with control animals at another location (DFO, 2004). Subsequent analysis identifies that this effect was more closely correlated with length of animal caging in both the control and exposed animals (study design limitation) (DFO, 2004). The measured received sound levels of the test specimens were 209-212 dB re 1µPa (PK-PK) (Day et al., 2016b) and 197-220 dB re 1µPa (PK-PK) (Christian et al., 2003).

Payne et al. (2007), in a preliminary study into the impacts of seismic to the American lobster (*H. Americanus*), exposed animals to received sound levels of 202 dB re 1µPa (PK-PK) and 227 dB re 1µPa (PK-PK) and used 'turnover rates' to establish damage to statocyst organs. The study reported no difference in turnover rates between control and exposed animals 9, 65 and 142 days after airgun exposure. In contrast, Day et al., (2016) found rock lobsters showed delayed time to right themselves after exposure to airguns in three of the four study events (reflecting statocyst damage). For the study event that did not observe a difference in righting times, lobsters were sourced from an area of high anthropogenic (shipping) noise[66], where the population continues to thrive, making it unclear on the ecological implications of statocyst damage. Day et al. (2016b) also observed the potential for neural impairment (measured as tail extension reflexes) for the study events undertaken in summer where exposed lobsters had a reduced ability to maintain tail extension (23% after 14 days). There was no significant difference for tail extension reflexes for study events undertaken during winter.

Day et al. (2016b) established for a period of up to 120 days post exposure, haemolymph biochemistry (pH, electrolytes, mineral ions, organic molecules and enzymes) did not show a response potentially indicating that lobsters are physiologically resilient to air gun signal exposure. The haemolymph refractive index, a measure of nutritional condition, showed response in one study event (of four). At 120-365 days post exposure lobsters had a significant reduction in refractive index, an indicator of nutritional status. Additionally, the number of circulating haemocytes, an indicator of immune response and health, was significantly reduced in all four study events (23% to 60% across the study events). A reduction in haemocyte cell numbers was identified up to 120 days post exposure, indicating possible stress and the potential for negative impacts to nutritional capacity or chronic immunological impairment. Payne et al. (2007) found no effects on the American lobster haemolymph biochemistry, but in some trials a possible

[66] Lobsters were collected from Crayfish Point Reserve in the Derwent Estuary. This population is thought to be at carrying capacity (Kordjazi et al, 2015) and survival rates estimated through capture and release studies is around 95% (Gardner and Green, 2009).

reduction in calcium which may indicate a potential for disturbance to osmoregulation. Christian et al. (2003) found no chronic or long-term effects on stress bio-indicators in haemolymph in snow crabs.

There is no evidence of population level impacts to invertebrates from acoustic sound (Morris et al, 2018)[67]. McCauley et al (2000) extensively reviewed seismic surveys and their effects on marine life, reporting that the amount of exposure to air gun signals for the larvae of a given invertebrate species will depend upon its abundance, spatial distribution, depth distribution, seasonal timing and the number of seismic surveys in the region where it occurs. McCauley et al (2000) concluded that a single seismic survey has a negligible impact on larval supply by comparisons with the size of the larval populations involved. This has been supported by the conclusions of Day et al (2016b) and Przeslawski et al (2016). Przeslawski et al (2016) also note that various studies conducted in the 2000s detected no significant differences to marine invertebrates between sites exposed to seismic operations and those not exposed.

Behavioural Sensitivities: Behavioural changes have been observed in decapods (alarm response) when < 10 cm away from the sound source (Goodall et al., 1990) however showed no response to seismic sound at distances of 1 m or more (Goodall et al., 1990; Christian et al., 2003).

Christian *et al.* (2003) investigated the behavioural effects of sound exposure to eight tagged snow crabs. None of the tagged animals left the area after exposure with five captured in the fishery the following year and the remainder were within 35 km of the release location. A subsequent study on caged snow crabs exposed to airgun sound (~202dB dB re 1µPa (PK)) at a depth of 50 m identified that the species did not exhibit any overt startled response.

Celi et al., (2013) observed that shrimp did not move to avoid low frequency sounds. The confined (tank) basis of the experiment was identified as a study limitation in that the shrimp may not have been able to detect the direction of the sound (Carroll et al., 2016).

Studies into the effects of seismic sound on catch rates or abundances on crustaceans have identified no significant differences at sites exposed to seismic operations and those not exposed (Carroll et al., 2016). Parry and Gason (2006) studied the effects of thirty-three (33) seismic surveys on catch rates of adult rock lobsters in western Victoria between 1978 and 2004. The study identified no evidence leading to a decline in rock lobster catch rates for the study period on a long-term and short-term basis. However, in the absence of specific sound pressure levels received by fished stock, no reliable conclusions can be drawn.

La Bella et al. (1996) observed no effect on the short-term catch rates of the Norway lobster (*N. norvegicus*) and shrimp (*Squilla mantis*) from localised seismic survey operations (received sound level estimated at ≤ 147 dB re 1µPa SPL). Andriguetto-Filho et al. (2005) identified no significant difference with shrimp catch rates before and after airgun exposure to shrimp species with a source pressure of 196 dB re 1µPa PK in shallow waters (2-15 m), however the author identified post-exposure sampling was undertaken approximately 12-36 hrs after exposure where the possibility of shrimp mortality and adjacent recruitment to the area was possible.

These catch related studies provide site-specific insights into short-term effects of seismic sound on species but do not quantify sound exposure, particularly particle motion, to the test organism. Pressure waves arising from anthropogenic noise can spread many kilometres from the site of introduction however particle motion is far more localised (Urick, 1983 in Edmonds et al., 2017). As no study to date has confirmed the ability of crustaceans to sense pressure waves, caution must be exercised before assessing impacts based upon associated sound wave propagation. Sound exposure calculations for crustaceans must primarily consider the particle motion element of anthropogenic noise fields (Edmonds et al., 2016).

Adopted Assessment Criteria:

Based upon available literature, no mortality effects in crustaceans from airgun exposure are expected. Literature also identifies that behavioural and physiological responses in crustaceans are likely to be related to particle motion rather than sound pressure. Key factors influencing sound exposure to crustacean species is therefore water depth and size of the operating airgun array. Available scientific literature into

[67] Morris, C.J., D. Cote, B. Martin, and D. Kehler. 2018. Effects of 2D seismic on the snow crab fishery. *Fisheries Research* 197: 67-77. https://doi.org/10.1016/j.fishres.2017.09.012

the effects of sound on crustaceans is based on the sound pressure and is not a direct measure of particle motion effects. Carroll et al. (2017) concludes that "*particle motion should be considered in noise impact studies on fish and invertebrates, particularly those species lacking a gas-filled bladder (all elasmobranchs and marine invertebrates). Thresholds studies reporting only sound pressure may be of limited use for these species as they do not detect the pressure component of sound*".

Table 6-22: Observed sound effects on invertebrates present within the Duntroon OA (scientific studies)

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
SPONGES (*Aphrocallistes vastus*)	Sponge Pumping Rates	Bolt Airgun (164 cm^3)	226 PK-PK (Calculated)	~160 m	151 SEL 182 PK-PK 177 PK	One study, looking at possible acoustic impacts from seismic sources to (glass) sponge (i.e. porifora) feeding characteristics, identified no increased feeding rates within the species when exposed to an air-gun.	Wilmut et al., 2007
LOBSTER (*H. americanus)*	Mortality Physical trauma Stress bio-indicators Foraging/anti-predator characteristics Behavioural impacts	Airgun (18-31 Hz Peak) 10 in^3 (Lab) 40 in^3 (Field)	230 PK-PK	~2	Field: 227 PK-PK (E) Lab: 202 PK-PK (M)	A number of endpoints were assessed in animals exposed to a "low level" exposure of ~202 dB re 1 µPa (PK-PK) and a "high level" exposure of ~227 dB re 1 µPa (PK-PK). The endpoints included assessment of (a) lobster survival, (b) food consumption, (c) turnover rate, (d) serum protein, (e) serum enzymes, and (f) serum calcium. A small histopathological study was also carried out on lobsters from 1 of the 5 trials. Observations were often made over a period of a few days to several months. This study had the following results: • No effects on mortality several months after exposure (to 9 months); • No effect of major external deformities such as a loss of leg or other appendages; • No significant effect on food consumption from seismic survey although food consumption was observed to increase in exposed animals (not major); • No effect on haemolymph biochemistry but possible reduction in calcium in some trials which may indicate a potential for disturbance to osmoregulation (uptake of excess water); • No structural differences denoting cell or tissue rupture, necrosis or inflammation, as assessed by light microscopy, were noted in hepatopancreatic tissues of control and exposed animals. • No effects on turnover rate 9, 65 or 142 days after exposure to air gun sound. The author warns of over-interpretation of these results as they are preliminary. Further study is warranted.	Payne et al., 2007 Field/Laboratory Study

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Lobster (*Janus edwardsii*)	Mortality Physical trauma Stress bio-indicators Foraging/anti-predator characteristics Behavioural impacts	Airgun (45 in^3 @ 2000 psi)	223-227 PK-PK 200-205 SEL	5.2 (Water depth 10-12 m)	209-212 PK-PK	The study observed the following results: • No lobster mortality was observed during the study up to a year after the exposure even close to the airgun, however sub-lethal effects were observed; • Tail extension reflexes (potential neural impairment) showed no significant difference between control and exposed lobsters for winter surveys. For summer survey the ability of exposed lobsters to maintain tail extension was significantly reduced (32% immediately, persisting to 14 days after exposure where a decrease of 23% was observed). Stress in lobsters is known to be exacerbated in summer conditions. This disruption suggests that complex reflexes and behaviours such as escaping from a predator may be impacted although the ecological implications were not investigated in this study. • Righting response times significantly longer in three of the four study events. Times increased by 80-157% between exposed and control groups over 120 days in study events. Further investigation established statocyst damage to hair cells, which correlated with impaired righting times. For one experiment, the damage persisted for 365 days post-exposure and after lobsters had moulted indicating damage may be permanent. For the one study event which did not observe a difference in righting, lobsters were sourced from an area which was subject to higher levels of anthropogenic noise (e.g. sound from large cargo ships) and control animals had similar levels of damage. Lobsters in this area are monitored and are thriving, making the ecological implications of statocyst damage unclear. It also raises the possibility that lobsters can adapt to statocyst damage as the (fourth study) lobsters did not display impaired righting reflexes. • Haemolymph (invertebrate blood) assays for pH, electrolyte and mineral irons, organic molecules and enzymes showed no significant difference between the two groups indicating lobsters are physiologically resilient to air gun signal exposure. However, in one survey event, the haemolymph refractive index (measure of nutritional condition) showed a response. At 120-365 days post exposure exposed lobsters had a significantly reduced refractive index indicating a reduced nutritional status. This was not found in any of the other three survey events and no other condition indicators indicated the lobsters were negatively affected. • Haemocyte counts (immune response) showed a significant response to exposure in all four experiments had a sustained modification of total haemocyte count resulting in a reduction in cell numbers, suggesting a response to trauma or stress and leaving the lobster vulnerable to infection. In one experiment this reduction was progressive over time reaching a low at 120 days post exposure. In same experiment exposed lobsters maintained until 365 days post exposure had 100% increase in cells potentially indicating an immune response to pathogens. This result raises concerns that exposure may affect the immune system over a chronic (months post exposure) time period leaving then vulnerable to pathogens. Further study is required to evaluate if immune function is altered and if there is an impact to animals in the wild. Hatched larvae from berried female lobsters maintained until eggs hatched were found to be unaffected in terms of egg development, the number of hatch larvae, larval dry mass and energy content and larval competency. These results suggest that exposure during the embryonic stage did not impair the development and hatching of lobster larvae.	Day et al., 2016 Field Study

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Lobster (*Janus edwardsii*) Con't	Southern Rock Lobster (egg, larvae)	Single airgun ($45in^3$)	223-227 PK-PK 200-205 SEL	5.2	209-212 PK-PK 186-190 SEL	Study observed acoustic impacts on the larval stages of lobster development where egg-bearing female spiny lobsters (*Jasus edwardsii*) were exposed to a $45in^3$ airgun operating at 2,000 psi (SEL ~200 dB re $1\mu Pa^2.s$). The study concluded the following: • There was no difference in fecundity between control and exposed lobsters; • A small but significant difference in the length of the larvae was observed in the exposed lobsters. No difference was found in width or dry mass of the larvae and no hatches were found to suffer from high mortality rates or deformities; • No energy difference was identified between larvae from control and exposed lobsters; and • Larval activity/survival between control and exposed lobster groups was not significant. Overall there were no differences in the quantity or quality of hatched larvae, indicating that the condition and development of spiny lobster embryos were not adversely affected by air gun exposure. **No impact of airgun on quality or quantity of hatched larvae at any distance.**	Day et al., 2016 Field Study
Spiny lobster (*Palinurus elephas*)	Other behavioural effects	Recorded shipping noise	Various (peak ~105 SPL)	<2	Various	Study observed the following: • Lobsters exposed to boat movements showed significantly higher mobility (higher velocity, distance moved, mobility in comparison with controls.) • After acoustic stimulus there was an observed slight increased hyalinocytes and a (not significant) slight decrease of granulocytes and semigranulocytes; • The haemolymph glucose level increased significantly, four times, in single and grouped specimens exposed to acoustic stimulus; • The total serum protein concentration significantly increased ~1.7% after exposure to acoustic stimulus in both single and grouped lobsters. Not focussed on seismic surveys.	Filiciotto et al., 2014
Lobster (*Janus edwardsii*)	Change in Catch Effort	Airguns	Various Arrays	0-150	NS	Assessment of the effects of thirty-three (33) MSS on catch rates of adult rock lobsters in western Victoria (1978-2004) identified no evidence of a decline in rock lobster catch rates for the period both on a long-term and short-term basis. The study found that most rock lobster fishing occurred in water less than 50–70 m deep, while most seismic surveys occurred in water deeper than 50 m. The spatial separation of seismic surveys and areas with high rock lobster fishing effort limited the statistical power of analyses of short-term effects of seismic surveys in shallow water.	Parry & Gason, 2006
Lobster (*Neprops norvegicus*)	Change in Catch effort	Airguns	210 SPL	1150	≤ 149 SPL	Study was in 70-75 m water depths. No effect on short-term catch success in areas localised to the seismic operations was observed on the trawl catch success of cephalopods or Norway lobster (*Nephrops norvegicus*), or the gill netting success of mantis shrimp (*Squilla mantis*).	La Bella et al. 1996

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
CRAB Snow crab (*Chionoecetes opilio)*	Mortality Physical Trauma Stress bio-indicators Startle/escape response Change in catch effort Effects on eggs and larvae	40 in^3 airgun 200in^3 airguns	NS	2, 10 and 15 4, 50, 85 & 170	197-237 PK-PK 216 PK (eggs & larvae) 202 PK (caged crabs – startle test)	Field study to establish the acute effects of seismic airgun exposure upon adult snow crabs *Chionoecetes opilio* (haemolymph, hepatopancreas, heart, and statocysts) when compared with control crabs and behavioural impacts. Results include: • No immediate or delayed crab mortality during study; • No evidence of statocyst damage; • No significant difference in in refractive index, enzyme activity, haemolymph (stress indicators), organ or tissue pathology (heart and hepato-pancreatic); • Catch per Unit Effort (CPUE) greater post survey compared with pre-survey; • Field animals did not leave the vicinity after exposure to seismic energy. Caged animals did not exhibit any startled response at the onset of seismic shooting. • Eggs exposed to seismic showed an increase in egg mortality and delayed development to the big-eye stage. Tests conducted at distances 2 m from the source. Authors note in normal situations eggs would never be this close to array.	Christian et al., 2003 Field/Lab Study
Snow crab (*Chionoecetes opilio)*	Reproductive effects of seismic	1310 in^3 airgun array	NS	NS	NS	DFO (2004) looked at the impacts of seismic energy on the reproductive biology of female snow crabs expanding on the work of Christian et al. (2003). Results identified the following: • Survey did not cause any acute or mid-term mortality to crab nor evidence of changes in feeding; • Survival of the embryos carried by female crabs and locomotion of the larvae after they hatch were unaffected by the survey (findings differed from Christian et al. 2003 study); • In the short-term antennae, gills and statocysts were soiled in the test group but they were found to be completely clean when sampled 5 months later; • Metabolic indices and levels of enzymes in the blood were comparable between groups. Several significant differences were observed between the test and control group however it was uncertain whether it was due to environmental differences between the test and control sites (environmental conditions significantly different). This included: • The hepatopancreas and ovaries were found to be bruised in the test site (later found to have a high correlation with length of time in cage for both control and exposed group); • One test group, embryo hatch was delayed by 5 days on average and larvae were slightly smaller than control. Oceanic and habitat condition differences were confirmed in subsequent studies undertaken in New Foundland (Payne et al, 2008).	DFO, 2004 Field Study (Caged experiment)

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Snow crab (*Chionoecetes opilio)*	Catch Rate	4880 in^3	229 dB re 1µPa^2.s	Various	Various	A Before-After-Control-Impact study was undertaken over two years to assess the effects of industry scale seismic exposure on catch rates of snow crab along the continental slope of the Grand Banks of Newfoundland. Results did not support the contention that seismic activity negatively affects catch rates in shorter term (i.e. within days) or longer time frames (weeks). However, significant differences in catches were observed across study areas and years. While the inherent variability of the CPUE data limited the statistical power of the study, the results suggest that if seismic effects on snow crab harvests do exist, they are smaller than changes related to natural spatial and temporal variation.	Morris et al. (2018) Field Study
Shore crab (*Carcinus maenas*)	Foraging	Recorded Ship noise	N/A	0.1	148-155	Study showed the metabolic rate of shore crabs (*Carcinus maenas*) were affected by exposure to ship playback noise with subjects consuming 67% more oxygen in comparison with playback harbour noise [108–111 SPL]. The study also found that while ship noise did not impair the ability of *C. maenas* to find food, those undertaking feeding were more likely to suspend feeding activity following exposure to ship noise in comparison with ambient noise. Also, while there was no difference in recorded reaction to predator stimulus, crabs exposed to ship noise took longer time to return to shelter than those experiencing ambient noise. Not focussed on seismic surveys.	Wale et al., 2013
SHRIMP	Metabolic Rate (includes food consumption, respiration)	Ambient	Unspecified	<1	Unspecified	Higher levels of ambient noise have been found to be associated with increased levels of respiration among brown shrimp (*Crangon crangon*). Subjects were found to consume 15% more oxygen when exposed to elevated levels of ambient noise (versus silent controls) in laboratory trials (Regnault and Lagardère, 1983; cited in Edmonds et al. 2016).	Regnault and Lagardère, 1983
	Change in catch or effort	Airgun	196	2-5	Unspecified	Andrigetto-Filho et al. (2005) studied the yields of a non-selective commercial shrimp fishery before and after (12-36 hrs post survey) the use of a four air-gun array with a peak pressure of 196 dB re 1µPa (@ 1m) (PK) in north-eastern Brazil. The study found there was no statistically significant deleterious effect on shrimp fishing yields. The study suggests that the shrimp stocks are resilient to the disturbance by air-guns under the conditions of the survey. In companion experiments designed to assess acute effects of exposure to air-guns on shrimp, southern white shrimp (L*itopenaeus schmitti)*, southern brown shrimp (*Farfantepenaeus subtilis)*, and the Atlantic seabob (*Xyphopenaeus kroyeri)* were placed in cages at varying distances from the transect of the air-guns. No mortality was observed even when air-guns were operating at very close distances from the caged shrimp. A detailed study of their gonads, branchiae and hepatopancreas showed negligible histopathological damage attributable to exposure to the pressure wave from air-guns.	Andrigetto-Filho et al. (2005)
CEPHALOPODS	Mortality	NS	NS	NS	246-260 PK	Preliminary observations indicate short-term tolerance to high rise time shocks of up to 260 dB for the small *Alloteuthis subulata* while the larger *Loligo vulgaris* were fatally injured by peak pressures of 246-252 dB and died within 3-11 minutes.	Norris & Mohl, 1983

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
	Physical Trauma Behavioural	NS	NS	~2	157 SPL 175 PK 50-400Hz	Controlled experiments exposing animals to 50-400 Hz sinusoidal wave sweeps with 100% duty cycle and a 1 second sweep period over 2 hours, revealed lesions in statocysts of four cephalopod species consistent with trauma. This also included damage to cilia on hair cells and neuron swelling. Species showed immediately after the start of sound exposure, a light startle response (firing ink sacs on some occasions) before remaining motionless at the bottom of the tank for the remainder of the experiment. Immediately after exposure, all remained motionless, breathing regularly in the middle of the water column or close to the surface showing no activity (no eating, mating or laying eggs). Lesions on statocysts became more pronounced with increased exposure (12 to 96hrs). The author identified that there were limitations with this study with respect to seismic activity in that the animals were caged in a small tank and unable to move away; and the nature of the sound exposure was different to seismic impulses.	Andre et al., 2011 Sole et al., 2012 Tank Study
	Behavioural	0.33 Bolt PAR 600B @ 1500psi	192 SEL	5-800	120-184 SEL	Squid exhibited alarm responses, changes to swimming patterns and vertical position as a result of exposure. Squid responses occurred at lower SELs throughout the study indicating the animals became accustomed to noise at low levels (i.e. habituating). From the results it would appear that noise levels greater than 147 SEL are required to induce avoidance behaviour in this species. The results also suggest that a ramped (i.e. gradual increase in signal intensity) air gun signal and prior exposure to air gun noise decreases the severity of the alarm responses in this species. If damage to the statocysts was present in this study, it appears that any alteration in hearing ability resulting from the noise exposure was not permanent, as the same squid were used in later trials with a similar number of alarm responses observed in both trials.	Fewtrell and McCauley, 2012 Field (Cage) Study
	Behavioural	Underwater Speaker 80-1000Hz	110-165 SPL	~1	85-187 SPL	Squid responded to sounds from 80-1000 Hz with response rates diminishing at the higher and lower ends of the frequency range. Generally, animals were responsive to low frequencies below 1000 Hz, and were most sensitive to sounds below 300 Hz. Inking was confined to the lower frequencies/highest sound levels and jetting was more wide-spread across a range of frequencies and levels although responses were still concentrated at lower frequencies and higher sound levels. Lowest sound levels which induced inking occurred at 150 Hz. Startle responses were not observed very often and were concentrated at the lower frequencies. All responses (inking, jetting, pattern change) are clustered around similar sound levels. At higher frequencies, responses are more divergent and occur at relatively low sound levels, suggesting sound has a different function at these frequencies, perhaps orientation, soundscape assessment or other auditory scene analyses. Squid exhibited relatively few startle responses and were observed to habituate.	Mooney et al., 2016 Tank Study
CEPHALOPODS (Con't)	Catch data (Gould's Squid)	Airgun	215 SEL	36-61	146 (M) 170 (E)	Study looking into the effects of seismic on catch rates of commercial species in the Gippsland Basin. No change in catch rate for the squid was observed before and after a seismic survey.	Prezeslawski et al. 2016

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
	Startle/Escape Behavioural	Bolt 600B Air-gun		0.9-1.5 2.1-5	174 SPL 156-161 SPL	Study assessed the effects of air gun noise on caged squid (*Sepioteuthis australis*). No sub-lethal injury or mortality as a result of exposures in this study was observed. In the first trial, several squid showed alarm responses to the start-up of an air-gun by firing their ink sacs and/or jetting away from the source (at received level 174 SPL or 163 SEL) but this was not observed for similar or greater levels if the signal was ramped up. It is noted that general habituation was observed with a decrease in alarm responses with subsequent exposures. During this trial the squid showed avoidance to the air-gun by keeping close to the water surface at the end of the cage furthest from the airgun (within the sound shadow). During trials there was a noticeable increase in alarm responses once the gun level exceeded 156-161 dB re 1µPa (SPL) (or 145 – 150 dB re 1µPa^2.s (SEL)). There was no consistent avoidance behaviour observed but there was a trend for the squid to increase their swimming speed on air-gun approach and then to slow at the closest approach at air gun signals and remain close to the water surface during the operation. McCauley suggests a threshold of 166 SPL would give an indication of the extent of disruption of a survey by significant alteration in swimming patterns.	McCauley et al, 2000 Field (cage) Study
	Change in Catch effort	Airgun array (total volume 2500in3)	210 SPL	1150	≤ 149 SPL	La Bella et al. (1996) identified there was no change in the short-finned squid catch (*Illex coindetti*) in an area exposed to received SPLs greater than 149dB re 1µPa. Airgun operated for 10-12 hours at 25 s intervals in 70-75m of water	La Bella et al. 1996

In the absence of a suitable particle motion metric to establish impacts, the use of the pressure-related metric gives some mechanism for the understanding of potential impacts to crustaceans in the Duntroon survey area. As Payne et al. (2007) identified no effects on righting time in the lobster at 202 dB re 1µPa PK-PK and Day et al., (2016) found effects at 209 dB re 1µPa PK-PK, the threshold of 202 dB re 1µPa PK-PK (lower threshold) has been adopted as a precautionary threshold to assess possible impacts.

Table 6-23 provides the predicted horizontal distances from the 3260 in^3 acoustic source from the Duntroon acoustic modelling for four transects at different water depths in the OA. For assessment purposes, a horizontal radius of 718 m from the operating array is utilised to assess possible impacts. On this basis, all crustacean-related behavioural 'effect' levels therefore lie within the Duntroon OA, which in turn has a 10 km operational buffer around the survey acquisition areas.

Table 6-23: Maximum (R_{max}) horizontal distances (in m) from the 3260 in^3 array to the modelled seafloor PK-PK from four transects (Wladichuk et al, 2018)

PK-PK Threshold (dB re 1µPa)	Distance R_{max} (m)			
	Site C (200 m)	Site D (1099 m)	Site E (649 m)	Site F (160m)
202	718	120	396	669

Extent/duration of exposure and identified potential impacts (biomass):

<u>Habitats Present</u>:

There are no BIAs present in the Duntroon OA for crab, lobster or prawns.

The Duntroon OA spatially overlaps areas where active fishing for giant crab is undertaken however the effort is low (i.e. no catch recorded < 5 Licences).

The Duntroon OA lies adjacent to lobster fishing grounds which are actively fished.

Prawn fisheries are present in gulf areas and given their distance from the Duntroon OA not expected to be affected by sound.

<u>Predicted Impacts</u>:

Biomass Impacts

Based on acoustic modelling, the area where physiological impacts to crustaceans may occur is within a horizontal distance of 718 m[68] from the operating acoustic array. Spatially for the Duntroon survey, crab and lobster species lie in water depths less than 200m (lobsters) and 600m (giant crab).

A calculated impact area[69], based upon the Duntroon MC2D survey lines and MC3D survey polygons in water depths less than 200m and 600m respectively is as follows:

- *For lobster biomass*:

  The area affected within the Duntroon OA affected by sound levels > 202 dB re 1µPa (PK-PK) is 2543 km^2 for waters < 200m water depth [EPP41/42: 1840 km^2; EPP-46: 202 km^2 and MC2D seismic lines: 501 km^2). More conservatively, the Duntroon OA (which subsumes all buffers and lead-in/lead-out distances) which lies in waters < 200 m is 6611 km^2. From a total area of 133,160 km^2, this area equates to 1.9% (impact area basis) and 5.0% (OA basis) of the SGS bioregion. On a bioregional basis, impacts to lobster biomass affected by survey operations is small.

  Based on the available studies referenced within this section (refer Table 6-22), the following broad conclusions can be drawn about exposure from acoustic sources on southern rock lobster specimens recognising that these 'effect' studies are at very close range to test species:

  - Exposure is not expected to result in mass mortality to adult rock lobsters (Day et al, 2016; Payne et al, 2007);

[68] This is the maximum horizontal distance at any depth across the modelled survey areas.
[69] Calculated area allows for a 5 km lead-in/lead-out distance where arrays are assumed to be fully operational and a 718 m buffer around the polygons/survey lines.

- Impacts to lobster fecundity due to acoustic exposure is highly unlikely and increased mortality, delayed development or abnormal development to egg masses carried by 'berried' females, if present, or larvae produced by those eggs is not expected (Day et al, 2016);
- Changes to reflex behaviours (tail extensions) is possible over the short term (~ 14 days). Righting times due to damaged statocysts may impact on the survival of lobsters in the wild (Day et al, 2016), however statocyst damage is known to exist in wild southern rock lobster populations, close to areas of significant shipping sound (similar to the Duntroon OA location), that have very high survival rates and are at near carrying capacity (Kordjazi et al, 2015) so the significance of this impact has not been determined;
- Changes to haemocyte count, an indicator of immune response function, in adult lobsters located close to the acoustic source is likely (Day et al, 2016).

This assessment is considered conservative given the water depths present in the OA (>100m+), the depth at which scientific studies detecting impacts were undertaken (2-10m) and as literature identifies, that behavioural and physiological responses in crustaceans are likely to be related to particle motion effects rather than sound pressure effects which predominate in close range to the acoustic source (Carroll et al, 2017).

Within the context of the Duntroon OA seabed habitat at water depth of 100^{+}m, rock lobsters if present within a horizontal distance of 718 m from the operating array will be exposed to sound levels greater than those studied by Payne et al (2007) (202 dB re 1µPa (PK-PK)) who reported no difference in turnover rates or effects on haemolymph biochemistry. Impacts to lobsters are not expected beyond this range. The effects observed by Day et al, (2016) at 209 dB re 1µPa (PK-PK) are predicted to occur at a horizontal distance of 243 m from the operating array and may lead to increased stress and neurological impairment with a higher risk of shorter-term predation or long-term mortality, but not mass mortality. This distance of effect is localised around the seismic lines given their spacing (i.e. adjacent lines spaced approximately 5000m apart (2D) and 500-750 m (3D)).

Day et al (2016) identified that there was no effect from seismic exposure on lobster survival and only one study from four identified a reduced refractive index which showed reduced nutritional status to 120-345 days post exposure. No other condition indices suggested that exposed lobsters were negatively affected. They concluded that impacts to statocyst morphology, behavioural reflexes and immune response functions in adult lobsters with seismic exposure was relatively minor, but this depended upon the fitness of the exposed animal. Day et al (2016) did not explore the impacts associated with reduced mobility and immunity with respect to impacts on the survival of affected lobsters in the wild or whether these sub-lethal effects could reduce a lobster's ability to compete for food or avoid predation.

Lobster growth rates vary between regions however 3-10 years is the general period to reach the minimum size for harvesting (Southern Rock Lobster Limited, 2014)[70]. The Duntroon OA is subject to recruitment from natal spawning grounds in WA (Bruce et al, 2007). Recovery of any stock numbers detrimentally affected by sound exposure will be through recruitment from WA waters of puerulus larvae (12-24 months old). For lobsters spawning within the Duntroon OA, Day et al (2016) concluded that early stage embryos showed no effect to seismic sound exposure (i.e. were resilient) and subsequent recruitment from exposed animals within the Duntroon OA should be unaffected, however Day et al (2016) did not assess the impact of seismic exposure on hatched larvae in the water column. Factors which mitigate impacts on hatched larvae (and hence recruitment impacts) is the timing of the Duntroon survey which avoids peak puerulus settlement in SA (July and August), the location of natal spawning grounds and the significant dispersion of larvae by winds and currents before the puerulus settle in SA waters. Impacts to plankton and larvae, contained in Section 6.2.3.2, is assessed as SLIGHT.

In 2015/16, the available lobster biomass within SA waters has been estimated at 2073 tonnes, with the deep-water region estimated to contain 124 tonnes (Linnane et al, 2016). Based on Duntroon OA spatial

[70] Southern Rock Lobster Fact Sheet 1 - http://www.tasrocklobster.com/upfiles/trlfa/cont/industry_info/SRL_-_Fact_Sheet_1_-_April_2014.pdf

overlap with the deep-water region, 5.4%[71] of this biomass (6.68 t) might incur behavioural or stress related impacts from the Duntroon survey activity.

On a fishery basis, the SA lobster fishery has a TACC of 360 tonnes per year which is divided between the inner zone (300 t) and outer zone (60 t) (Linnane et al. 2016). Based on the area exposed to 202 PK-PK (2,543 km^2) and the size of the total fishery (302, 170 km^2), the Duntroon MSS might affect 0.84% (3.0t) of the TACC. On a more conservative basis based upon the larger Duntroon OA overlap with the outer zone MFA areas 25, 26, 37 and 38 (17, 647 km^2) the proportion of the outer zone[72] TACC which might be affected by the Duntroon survey is 4.8 t. As the TACC within this fishery has consistently not been filled for the past 5 years by at least 18-34 t, any impact to lobsters and subsequent loss of catch from Duntroon survey activities will not be detrimental to fishers or to lobster sustainability within the fishery.

Consequence:

Given the limited area of impact, the small amount of biomass affected, the limited impacts experienced by lobsters from seismic surveys and the external recruitment characteristics into the SA rock lobster fishery, PGS has assessed the potential impact to the local population of rock lobsters (if present) in the Duntroon OA as SLIGHT.

- *For giant crab biomass*:

  The area affected within the Duntroon OA affected by sound levels > 202 dB re 1µPa (PK-PK)[73] is 3456 km^2 for waters < 600 m [EPP41/42: 2228 km^2; EPP-46: 420 km^2 and MC2D seismic lines: 807 km^2). However again on a more conservative basis, the Duntroon OA which lies in water depths < 600 m is 7,944 km^2. From an impact perspective, this area equates to 1.9% of the SGS bioregion and 0.1% of the Southern Province bioregion[74]. Based on OA overlap, this area equates to 5.0% of the SGS bioregion and 0.17% of the Southern Province bioregion. Affected giant crab populations are small on a bioregional basis.

  Based on the available studies referenced within this section (refer Table 6-22), the following broad conclusions can be drawn about exposure from acoustic sources on giant crab:

  - Exposure is not expected to result in mortality (acute or chronic) to crabs (Christian et al, 2003; DFO, 2004; Payne et al; 2008);
  - Exposure is not expected to cause physiological or stress-related changes to crab species (Christian et al, 2003; 2004); and
  - No change to the development rate in exposed fertilised eggs/embryos is expected compared with unexposed eggs/embryos (Payne et al, 2008).

  Within the context of the Duntroon OA seabed habitat, impacts to giant crabs are expected to be incidental based upon scientific literature available. On this evidence, any impact would be localised, temporary and fully recoverable with the integrity of the seabed ecology preserved.

  The giant crab inhabits water depths between 20 – 600m, however as identified in Section 3.8.3.2 most of the commercial catch occurs in water depths less than 120 m particularly to the south of Kangaroo Island (refer Figure 3-70). The Duntroon OA lies within the Northern Zone for Giant Crab which has a TAC of 13.4 tonnes (PIRSA, 2015). The North Zone TAC is routinely not met with the 2013/14 years falling beneath the TAC by 2.05 to 2.92 tonnes (refer Section 3.8.3.2). The Duntroon OA has a spatial overlap with an area of active giant crab fishing in MFA-38 (~ 3,708 km^2 or 37% of MFA-38). No catch data is published for MFA-38 due to the confidential nature of fishing (i.e. < 5 licencees entering). A conservative estimate of catch potentially affected by this spatial overlap has been estimated at 1.85

[71] Deepwater region consists of MFA 61, 62, 12 ,13, 24, 25, 26 (50%), 37, 38, 47, 38, 49 (50%), 50 (50%) and 53. Total Area 126,634 km^2.

[72] Rock Lobster outer zone area is 220,873 km^2.

[73] Given no observed impacts have been observed in crabs from seismic exposure, this threshold is utilised as a conservative estimate of impact level given the giant crab and lobster are both crustaceans.

[74] Southern Province Bioregion has a total area of 770,270 km^2.

t[75]. Any possible sub-lethal impacts to crab within MFA-38, directly resulting in a loss of catch from the Duntroon survey activities is not expected to be detrimental to the sustainability within the giant crab fishery (based on TACC exceedance).

The Duntroon OA is subject to giant crab recruitment from spawning grounds to the west of the survey area (FRDC, 2017). For giant crabs spawning within the Duntroon OA, fertilised eggs/embryos are not expected to suffer any negative effects (Payne et al, 2008). For larvae entering the Duntroon OA, based upon the work of Pearson et al (1994) who exposed Stage II Dungeness crab to an airgun array (refer Table 6-15) no immediate or long-time survival or time to moult impacts are expected, even those exposed within 1 m of the acoustic array. Additional factors which also mitigate impacts on larvae (and hence recruitment impacts) is the significant dispersion of larvae by winds and currents before they enter SA waters. Impacts to plankton and larvae, contained in Section 6.2.3.2, is assessed as SLIGHT.

Consequence:

Given the limited area of impact and the resilience of crab species to sound impacts (even at very close range), impacts to giant crabs are expected to be incidental based upon available scientific literature. On this evidence, any impact would be localised, temporary and fully recoverable with the integrity of the seabed ecology preserved (SLIGHT Consequence).

Acceptability of Impact (Crustaceans – Biomass):

Impacts to crustaceans present within the Duntroon OA are considered acceptable based upon the following criteria:

- Sound exposure is not expected to cause mass mortality to lobster or crab species (Christian et al, 2003; DFO, 2004; Payne et al, 2008; Day et al, 2016; Payne et al, 2007);
- Impacts to crustacean fecundity is unlikely and increased mortality, delayed or abnormal development to eggs/embryos is not expected (Day et al, 2016; Payne et al, 2008);
- Physiological or stress-related changes to crab species from sound exposure is not expected (Christian et al, 2003; 2004);
- Short-term behavioural impacts (~14 days) and impacts to immune response function in adult lobsters is possible close to the acoustic source within the Duntroon OA (Day et al, 2016);
- Impacts to exposed stock biomass, together with stock harvest rates, do not result in TACs for either crustacean stock to be exceeded (PIRSA, 2015; Linnane et al. 2016) hence ensuring stock sustainability on a local and regional basis;
- Larval recruitment into the fisheries from western spawning grounds is wide-spread and impacts to larvae from acoustic operation is expected to be inconsequential compared with natural mortality rates in larvae exceeding 50% per day in some species and commonly exceeding 10% per day. A mean mortality rate for fish larvae of 21.3% per day has been identified (Houde & Zastrow, 1993); and
- Outcomes meet stakeholder criteria relating to ensuring stock sustainability within the fishery **[Stakeholder Record 44]**.

Acceptability Statement: The Duntroon survey does not damage crustaceans to affect the sustainability of the stock within the Duntroon OA or at a regional level. Impacts are localised, temporary and recoverable with no damage to ecosystem functioning.

Commercial Crustacean Fishery Catchability/Abundance:

Note assessment of fishing displacement is contained in Section 6.9.

[75] This calculation is conservative and adopts the adjacent MFA-48 catch (>4-6t; 5 t is assumed) proportioned according to the Duntroon OA spatial overlap in MFA-38.

Rock Lobster Fishery:

Commercial catch data for lobsters shows most catch is taken in water depths < 60 m (Linnane et al., 2015) (refer Section 3.8.3.2). As identified in Figure 3-69, while the Duntroon OA does not overlap any actively fished areas in 2016, a portion of the OA is located on the “outer zone” for the lobster fishery on the continental shelf and coincident with MFAs 25, 26, 37 and 38 (not actively fished). Review of the lobster catch depth classes for the past five years (refer Figure 3-68) also shows minimal catch taken from depths over 90 m. Based on this information, while the 2016 and 2017 catch data (due to its reclassification into the inner/outer zones) clearly shows that the Duntroon OA falls outside active lobster catch areas, this is also true for the preceding years. As identified also in Figure 3-69, all actively fished areas in the “outer zone” currently lie south of Kangaroo Island. No encounter with rock lobster fishermen is expected within the Duntroon OA (no displacement effects). In relation to catchability, the primary physiological response detected by Day et al (2016) which may translate into reduced mobility or sensory ability (and hence catchability) is damage to the statocyst. Impairment to spatial orientation due to statocyst damage may affect the lobster’s ability to enter baited traps and to locate food. However, studies into lobster populations where statocyst damage is known to exist has identified very high survival rates and are near carrying capacity (Kordjazi et al, 2015) which would indicate that lobster’s ability to locate food and survive is not impaired due to statocyst damage.

Studies undertaken into the effect of seismic sound on crustacean catch rates/abundance before and after seismic surveys have shown no significance difference between control and exposed populations (Carroll et al, 2017; Parry and Gason, 2006; La Bella et al, 1996; Andriguetto-Filho et al, 2005). On this basis, lobster capture within the Duntroon OA (if fishing occurred) or surrounding areas affected by lower levels of acoustic sound is not expected to be affected from Duntroon survey activities.

From this assessment, the following conclusions may be drawn with respect to catch, displacement, economic loss and sustainability of lobster within the Duntroon OA:

- The lobster population affected by acoustic sound in the Duntroon OA is not detrimental to the sustainability of the lobster fishery with any impacts to the stock in the Duntroon OA localised and short-term;
- No lobster fishing occurs within the Duntroon OA and fisher displacement or inability to operate in the area is not triggered; and
- The Duntroon survey is not expected to lower any catch rates (e.g. Catch per unit Effort (CPUE)) or catchability of lobster within the OA or in adjacent areas.

Summary:

Consequence: Based on catch information, fishery biomass reports and recent studies by Day et al (2016) into acoustic sound impacts on lobsters, any impacts to lobster catchability and fishery sustainability are assessed as incidental (SLIGHT consequence).

Giant Crab Fishery:

Giant crab fishing in the Duntroon OA is at low levels based upon published fisheries data, licencees present in the fishery and stakeholder feedback (< 5 licencees).

Results from studies undertaken into the effects of MSS activity on the catchability of snow crab species (Morris et al, 2017; refer Table 6-22) found MSS activity did not negatively affect catch rates in the short term (within days) or longer timeframes (weeks). Significant differences were found in catch across study areas and study years. These results suggest that if seismic effects on snow crab harvests do exist, their magnitude is smaller than changes related to natural spatial and temporal variation (Morris et al, 2017). Christian et al (2003) observed that CPUE was greater post-MSS survey and field animals did not leave the study area after exposure to seismic sound.

The Duntroon survey will be conducted in the timeframe September to November. November is the only month in this period whereby commercial fishing for crab can legally occur. Controls adopted (refer Section 6.9), including pre-survey notifications and on-water communication/information, will inform giant crab fishermen with an established fishing history in the OA of the pending survey to avoid spatial conflicts during the survey. The selected survey timeframe avoids the majority of the giant crab fishing season (November to April).

Based on catch information, giant crab fishery reports and studies undertaken by Christian et al (2003;2004), DFO (2004), Payne et al (2008) and Morris et al (2017) any acoustic sound impacts on giant crab catch, crab catchability and fishery sustainability are assessed as incidental (SLIGHT consequence).

Summary:

Catchability Impacts: Based on catch information, giant crab fishery reports and scientific studies undertaken into effects of catchability and abundance by seismic on crab any acoustic sound impacts are assessed as incidental (SLIGHT consequence).

Stakeholder Feedback

SARLAC [**Stakeholder Record 4**] expressed concerns regarding impacts to lobsters based upon the work of Day et al. (2016) and required compensation for any displacement and/or economic loss suffered by lobster fisheries. SARLAC provided details of previous arrangements that have been put in place in the Otway Basin for seismic surveys. SARLAC agreed that preventing displacement impacts and economic loss through planning would be best however required certainty and assurance through an agreed compensatory framework. SARLAC's position is that no party should suffer a detrimental economic impact from seismic if it is demonstrated that seismic survey activity has caused or contributed to any actual impact on rock lobster abundance, recruitment of catchability.

PGS responded to this concern by providing an assessment of impacts to lobsters based upon the available literature including the recent Day et al. (2016) literature reflecting the context of the study which was conducted in close proximity to the test species (i.e. near-field). These are not the conditions within the Duntroon survey. PGS has also provided information to SARLAC identifying, based upon publicly available information that there is no spatial overlap of the NZRLF and the Duntroon OA so impacts to catch, abundance, catchability of stock and displacement are not expected. PGS has advised that it does not propose to proceed with compensation arrangements given no impacts are predicted. SARLAC has not yet provided feedback to this information.

[redacted] [**Stakeholder Record 44**], a lobster and crab fisherman from Kangaroo Island expressed concerns around seismic impacts to the sustainability of the both the crab and lobster fishery. Key issue was the loss of sustainable fishing ground due to fishing closures for Marine Parks and placing more pressure on less sustainable grounds. PGS forwarded information to Andrew sent to SARLAC and has advised on the revised timeframe. No additional feedback has been received from this stakeholder.

The Wilderness Society (**Stakeholder Record 42**) requested information related to commercial species (e.g. scallops and lobster) and an assessment of the impacts of these classes of species within the ecosystem and the food chain. The Duntroon MSS Environment Plan has been sent to the stakeholder identifying little to no impact on the commercial species and the biomass of the stock. No scallop fisheries have been identified in the Duntroon OA. No additional feedback has been forthcoming from the stakeholder on lobsters.

[redacted] [**Stakeholder Record 72**] a giant crab fisherman identified that there may be a spatial conflict with Duntroon survey activities in April as he normally fishes directly south of Coffin Bay in water depths around 150 m to 300 m. PGS has contacted this fisherman with regards to the altered survey timeframe such that this temporal conflict will not occur. No feedback has been provided to PGS from this fisherman associated with this altered survey timeframe.

Fishermen will be contacted one month prior to survey commencement to ensure fisherman area aware of the survey. A daily updated forward plan and real-time web positioning will also be provided during survey activities to inform the fisherman. No other issues were raised. Refer to Section 6.9 for controls to avoid spatial conflict with fishers.

Controls assessment to limit impacts to decapod abundance and commercial catch:

An assessment of controls to limit impacts to decapods (& associated fishing impacts) from seismic activities is provided in Table 6-24.

Table 6-24: Assessment of Potential Control Measures to reduce impacts to decapods/fisheries

Control Measure	Practicable	Will it be Implemented?	Justification
Spatial Conflict in Activities: Consult with fisheries to provide awareness of activity and commencement and prevent spatial conflicts.	YES	YES	Spatial conflict is not anticipated based upon fishing catch data, preferred depth of fishing and revised survey timeframe. The new proposed survey timeframe, reduces the potential for spatial conflict in September and October, however fishing in November is possible. PGS has sought feedback from giant crab fishermen on fishing activity within the Duntroon survey area in November, however no feedback has been provided. Suggested notification periods prior to survey have been proposed. The previous option of notifying fishermen prior to survey activities so pre-fishing of area can occur does not offer any benefit with the revised timeframe as the fishery is seasonally closed between June and October.
Loss of Catch Compensation: Prepare Compensation Arrangements for stock damage associated with sesimic survey activities.	NO	NO	Scientific literature identifies that no mortality impacts or catch rate impacts have been experienced by decopods even in very close proximity to an operating array. Sub-lethal impacts are possible, however given the proportion of the fishery which may be affected and set TACCs the sustainability of the fisheries is not threatened. There is also very little overlap of the Duntroon OA with active fishing in the NZRLF based upon 2016 statistical obtained by SARDI and previous year's data on the quantity of lobster taken at depths >90m. Fish catch studies for both lobster and crab identify there is no significant change in catch attributable to seismic survey activities. Impacts to active fishing grounds should not arise.
Temporal Buffers: Temporal exclusion over fishing grounds during 'berried' period (June to October)	NO	NO	Survey activity will occur during the berried period for giant crabs. Studies identified that no impacts to berried females and their larvae should occur as a result of survey activities (Day et al, 2016; Payne et al, 2008).
Temporal Buffer: Temporal exclusion during 'peak' catch periods for giant crab (November to March)	Partial	Partial	PGS has positioned the survey between September to November which adopts temporal exclusion during the peak catch periods for giant crab in September/October. It is possible that spatial overlap may occur during November, however feedback from the giant crab fishermen have not identified that this is an issue. The Duntroon survey requires a period of three months to complete acquisition activities. PGS has selected weather-favourable months which prevent spatial overlap with fishing activities as far as possible.
Spatial Buffers: Adopt spatial buffer around shelf break area where giant crab fishermen obtain catch.	NO	NO	Acquisition across the area where giant crab are predominantly located (140 m to 270 m) is required within EPP-41/42 to achieve survey objectives and identify potential petroleum targets in the area. It is not possible to remove this segment from the survey scope.
Refer to Section 6.9 for controls to prevent spatial conflict with commercial fisheries.			

Acceptability of Impact:

Impacts to the catchability of commercial crustaceans in the Duntroon OA are acceptable based upon the following criteria:

- The potential effects of seismic surveys on crustacean catch rates and abundance Identify no significant differences detected between sites exposed to seismic operations and those not exposed (Parry & Gason, 2006; Carroll et al, 2017; Christian et al, 2003; 2004; Morris et al, 2017; DFO, 2004; Payne et al, 2008);
- Concerns regarding impacts to rock lobster abundance and catchability within the NZRLF are resolved given no overlap of fishing ground with the Duntroon OA and no impact is expected within active fishing areas [SARLAC - **Stakeholder Record 4**];
- Crab fishermen with interests in the Duntroon OA will be notified of survey activities at least one month in advance of survey commencement and provided with real-time web positioning to inform of the vessel presence to prevent spatial conflict and the potential for impacts to stock catchability and abundance (if they were present) when the season commences. No issues or concerns have been raised with the new proposed timeframe [Steven Clark - **Stakeholder Record 72**]; and

- The Duntroon survey has been positioned primarily in a period of no giant crab fishing, with a possible overlap of fishing in November. The survey period which overlaps giant crab fishing grounds (30 days) represents 14% of the fishing season.

Acceptability Statement: Catch and abundance of giant crab is expected to fall within the normal seasonal variation of catch within the Duntroon OA. Any impacts to catchability and abundance of local giant crab populations is localised, temporary and recoverable in the short-term.

Cephalopods (Mollusc)

Species sensitivity:

Cephalopods, a pelagic species, are also expected to be present in the Duntroon OA during survey activities.

Cephalopods respond to sound in the frequency band 80-1000 Hz with more sensitivity to sounds below 300 Hz. Differing behavioural responses have been observed at differing frequencies/intensities of sound (Mooney et al., 2016). Cephalopods have statocysts (as per crustaceans), and epidermal hair cells which help them to detect particle motion in their immediate vicinity (Kaifu et al., 2008) and are comparable to lateral lines in fish. Accordingly, the component of the sound field likely perceived by cephalopods is particle acceleration and not sound pressure (Mooney et al., 2016).

Cephalopods have also exhibited the potential for habituation in scientific studies however this has not been studied in detail. Samson et al. (2014) exposed *S. officinalis* (European cuttlefish) to repeated exposures at 200 Hz at differing sound levels. Habituation was observed as response intensity decreased but response elimination was not achieved.

It is likely that the mechanism of impact for cephalopods is not from sound pressure but particle motion. However what level of particle motion leads to a behavioural impact or potential mortality is unknown. Water depths and airgun array size determine particle motion levels at the seafloor. Larger volume arrays and shallow water depths serve to increase particle motion which can then be related to observed effects. Unfortunately, most literature identifies response in terms of sound pressure and not particle motion making the metric selection and threshold of potential impact complex in assessment terms.

Mortality Response: For cephalopods, preliminary observations undertaken by Norris and Mohl (1983) in laboratory conditions, identified that the European squid (A*lloteuthis subulata)* showed short-term tolerance to sound levels of 260 dB re 1µPa (PK), however the larger *Loligo vulgaris* was fatally injured by 246-252 dB re 1µPa (PK) within 3-11 minutes of exposure. The lowest impact sound pressure for the larger squid was not determined.

Guerra et al. (2004) also identified pronounced statocyst and organ damage in seven stranded giant squid (*Architeuthidae spp*.) after nearby seismic surveys (Guerra et al., 2004) however there was no direct evidence to establish cause and effect.

Andre et al., (2011), demonstrated in controlled experiments exposing four cephalopod species to a 50-400 Hz sinusoidal wave sweep with a period of 1 second over a period of 2 hours, lesions in statocysts consistent with trauma at received sound levels of 175dB dB re 1µPa (PK). Lesions became more pronounced with increased exposure (12 to 96 hrs) and alteration of the haemolymph was observed. This caged study design and the nature of the sound exposure was not representative of seismic surveys. It is noted that Frewtell and McCauley (2012) observed a decrease in the severity and number of cephalopod alarm responses to successive air gun signals over their study period. The author's noted that if statocyst damage was present, any alteration in hearing ability resulting from the noise exposure was not permanent, as the same squid were used in later trials with a similar number of alarm responses observed in both trials.

Behavioural Response: Studies have shown that acoustic sound can elicit a behavioural response in cephalopods. McCauley et al. (2000a, 2000b) in an experiment on caged squid (*Sepioteuthis australis*) did not observe injury or mortality, however observed squid alarm (inking, jetting) responses to airgun start-up at a received level 174 dB re 1µPa (SPL) or 163 dB re 1µPa^2.s (SEL). Fewer alarm responses were observed with subsequent exposures. Squid also showed avoidance behaviours by keeping close to the water surface (within the sound shadow) during exposures. For trials using ramped start-up (rather than near-by sudden start-up), the strong startle response was not observed but a noticeable increase in alarm responses occurred at received levels exceeding 156-161 dB re 1µPa (SPL). No consistent avoidance responses were seen in the trials but there was a general trend for the squid to increase their swimming speed on approach of the air-gun and then slow at the closest approach and to remain close to the water surface during the airgun operations. Fewtrell and McCauley (2012) noted that exposure modelling using thresholds of 161-166 dB re 1µPa (SPL) would give an indication of the extent of disruption for specific seismic surveys. This threshold is adopted to assess species displacement effects for the Duntroon OA.

La Bella et al. (1996) also assessed changes to catch rates for the squid species, *Illex coindetti;* bivalve species *Paphia a*ura (clam), *Anadara inaeqivalvis*; and gastropod *Bolinus bandaris* before and after a seismic survey. Results indicated no significant reductions in any catch rates except for *Bolinus bandaris* caught by the gillnet method, as opposed to the dredge methods which remained unchanged. La Bella et al. (1996) identified the received levels of test species during this study were < 147 dB re 1µPa (SPL).

<u>Extent and Duration of Exposure and Identified Impact:</u>

Habitats:

There are no BIAs present in the Duntroon survey area for cephalopods and the Duntroon OA does not overlap any cephalopod fisheries (i.e. calamari fishery).

The Duntroon OA overlaps a BIAs for the sperm whale and the male Australian sea lion who consume cephalopods as prey.

Potential Impacts:

Based upon research to date, immediate mass mortalities of the species exposed to operational seismic arrays have not been reported in studies.

Cephalopods, a pelagic and highly mobile species, can inhabit deep waters off the continental shelf (500-1000 m deep) preying on fish and other molluscs, and are known to inhabit the canyon systems which lie to the south and west of Kangaroo Island. Cephalopods are target prey for sperm whales, Australian sea lions and SBT. Damage to cephalopods would only occur if an acoustic array started at full power adjacent to the animal. In reality, with soft-start procedures adopted in the survey mortality to cephalopod species is not expected, however avoidance behaviour is possible.

Acoustic modelling predicts, based upon a 160 dB re 1µPa (SPL)[76] threshold, behavioural impacts such as avoidance might be observed up to 13.05 km horizontal distance from the operating array. At any one time the ensonified area associated with this SPL is 105 km^2 (largest predicted area is assumed). Based upon the observed catch data for cephalopods during seismic survey activities, it is likely the species will move back into the area once the acoustic array has passed. Given the constant movement of seismic vessel, sound impacts will be temporary and recoverable in any one location.

This area of impact should be viewed in the following context:

- On a per-shot basis at any one time, this area represents in a bioregional context 0.08% and 0.01% of the SGS and Southern Province bioregions respectively. These bioregions are representative of the broader area in which the survey is being undertaken and representative of the water depths and habitats for cephalopods.
- The horizontal distance and area affected by sound above 160 dB re 1µPa selected is the maximum observed over all topographical features within the Duntroon OA. Predicted horizontal distances range from 7.6 km (deep water) to 13.05 km (continental slope) using maximum over depth isopleths.
- On a per-shot basis at any time this area may overlap, and would constitute, 0.18% of the sperm whale foraging (abundant food source) BIAs[77] which are intersected by the Duntroon OA. An indirect effect of cephalopod displacement may also result in the temporary displacement of

[76] This uses the $R_{95\%}$ and maximum over depth SPLs due to the depths utilised by cephalopods.
[77] Area of western foraging BIA is 12,519 km^2 and for the slope off GAB BIA is 44,927 km^2. Total Sperm Whale BIA area is 57,446 km^2.

foraging sperm whales although the sperm whale consumes other prey (e.g. demersal fish). If foraging displacement occurred it is expected to be localised, temporary (given the constant vessel movement over differing topographical features in the OA) and affect only a small portion of the population. Sperm whale presence is recorded in literature to peak in August/September with observed higher encounter rates from other survey data also observed in October and November.

- This area may overlap, and would constitute, 0.04% of the male Australian sea lion foraging BIA on a per-shot basis. An indirect effect of cephalopod displacement may result in the temporary displacement of foraging male Australia sea lions. As per details for the sperm whale, if foraging displacement occurred this would be expected to be localised, temporary and affect a small portion of the population. Male Australian sea lions are present in the area throughout the year and have a diversity of prey species they target generally in waters to 100m.
- This area overlaps or lies adjacent to seabird [foraging, foraging (provisioning young)] BIAs. Bird species feed on multiple prey species and have widespread foraging areas. While cephalopod displacement may result in the displacement of foraging birds, this impact is localised, temporary and given their widespread foraging areas, impacts are not expected to be significant at a population level.
- Other species such as the SBT also consume cephalopods as a prey species. As above, displacement of cephalopods would be expected to displace wide-ranging SBT species if present in the area, however net foraging opportunity loss is not expected. As the survey avoids juvenile SBT migration into the eastern GAB, no foraging impacts are expected.

Summary:

Cephalopod Impacts: Cephalopod displacement is localised and temporary, with short recovery timescales (SLIGHT consequence).

Stakeholder Feedback:

ASBTIA **(Stakeholder Record 6)** identified that squid is particularly abundant through upwelling periods and there is considerable uncertainty about the impact that high-energy sound impulses have on these components of the SBTs diet. This needs to be accounted for in the ALARP and assessment process.

PGS has undertaken this assessment.

Controls assessment to limit impacts to cephalopod abundance:

An assessment of controls to limit impacts to cephalopod from seismic activities is provided in Table 6-25.

Table 6-25: Assessment of Potential Control Measures to reduce impacts to cephalopods

Control Measure	Practicable?	Will it be Implemented?	Justification
EPBC Policy Statement 2.1 (Part A): Implement soft-start procedures to limit injury impacts to cephalopods.	YES	YES	Control measure adopted to limit impacts to all sensitive sound species.

Acceptability of Impact:

Impacts to cephalopods in the Duntroon OA are acceptable, with soft-start controls adopted, based upon the following criteria:

- Cephalopods are sound sensitive and are known to respond to sound in the environment through displacement (McCauley et al, 2000; Mooney et al, 2016; Frewtrell and McCauley, 2012; Andre et al, 2011; Sole et al, 2012);
- Responses to unacceptable sound are temporary based upon catch rates of commercial species (Prezeslawski et al, 2016; La Bella et al, 1996).

- Impacts to foraging predators will be limited to localised displacement of prey (with predators also potentially displaced) with no net loss of foraging opportunity [**ASBTIA Stakeholder Record 6**].

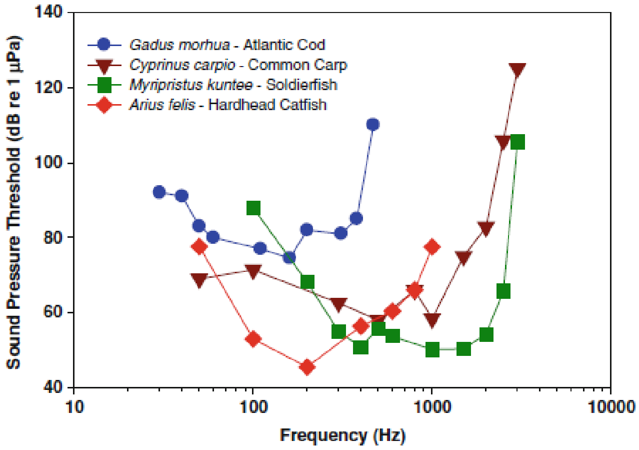
Acceptability Statement: No injury to cephalopods are expected with displacement impacts localised, temporary and recoverable.

6.2.3.4 Fish (including sharks and rays)

Sensitivity:

All fish studied to date identify fish can detect sound. Most fish species detect sounds from below 50 Hz up to 500–1,500 Hz. A smaller number of species can detect sounds to over 3 kHz, while a very few species can detect sounds to well over 100 kHz (refer Figure 6-9). The predominant frequency range of the Duntroon seismic array is below 500 Hz which is in the hearing range of most fish.

Figure 6-9: Underwater hearing threshold for the Atlantic Cod, Common Carp, Soldier Fish and Hardhead Catfish (Popper et al. 2014)



The main auditory organs associated with teleost (bony) fish are the otolithic organs. The inner ears of cartilaginous fish (sharks, rays and their relatives) possess similar structures with the addition of a macula neglecta. Hearing in fish primarily involves the ability to sense acoustic particle motion via inertial stimulation of the otolithic organs or their equivalent. There has been no demonstration to date of damage to lateral line systems resulting from exposure to intense man-made sounds or other signals although it is conceivable that damage may occur (Popper et al., 2014). Many species also detect sound using an indirect path of sound stimulation involving gas-filled chambers such as a swim bladder. In these species, fluctuations in sound pressure generate particle motion causing the gas-holding chambers to oscillate in volume which in turn stimulates the inner ear. The proximity of the gas-filled chamber and/or their direct mechanical connection to the inner ear improves hearing enhancing their detectable frequency range and lowering their sound pressure threshold. Swim bladders also make fish more susceptible to pressure-related injuries compared with species lacking a swim bladder (Carroll et al., 2016).

There are substantial differences in auditory capabilities for one fish species to another and anatomy is used to distinguish the different sensitivity groups. Popper et al., (2014) has categorised fish into three main categories to assist in assessing the effects of sound to the species. Categorisation is based upon the presence or absence of gas-filled structures and the ability for those structures to improve hearing range and sensitivity. They are:

- Fish that detect particle motion only. This includes cartilaginous fish (elasmobranchs) which detect the particle motion component of sound only. Evidence suggests that pelagic species have more sensitive hearing than demersal species however the hearing sensitivity of most elasmobranchs is poorly understood. The lateral line system is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg, 2001);

- Fish with swim bladders which is close to the ear but not internally connected and hearing does not involve the swim bladder. This group are susceptible to physical injury such as barotrauma, although hearing is through particle motion not sound pressure. This group can hear up to about 500 Hz.

- Fish with swim bladders which contributes to hearing. This group is sensitive to particle motion and sound pressure through the gas bladder connection to the inner ear. This serves to increase hearing sensitivity and broaden hearing bandwidth extending to several kilohertz. This group is generally more sensitive to sound pressure than other groups (Hawkins and Popper, 2016)

The Working Group on the Effects of Sound on Fish and Turtles reviewed studies of sound on fish. Sound Exposure Guidelines for Fishes and Sea Turtles developed on that review (Popper et al., 2014) and accredited with the American National Standards Institute (ANSI) provides sound exposure criteria, for the different categories of fish, for three types of immediate effects:

- Mortality, including injury leading to death;

- Recoverable injury including injuries unlikely to result in mortality such as hair cell damage and minor haematoma; and

- Temporary Threshold Shifts (TTS) in hearing.

Within these guidelines, where insufficient data exists to make a guideline 'threshold' recommendation a subjective approach using 'relative risk' is utilised to assess risk at three distances from the source. Masking and behavioural effects are therefore assessed using a 'relative risk' approach and because the presence or absence of a swim bladder has a role in hearing, fish susceptibility to injury from noise has been classified based on the role of any swim bladder in hearing (refer Table 6-26). The following is relevant to the guidelines:

- Despite mortality being a possibility for fish exposed to airgun sounds, Popper et al. (2014) does not reference an actual mortality and no lethal effects of seismic surveys have been reported. In Popper et al. (2014), mortality and recoverable injury guidelines are derived from impulsive sounds established during pile driving studies by Halvorsen at al., (2012). This proxy has been used as research to date has not identified a threshold level from seismic where mortality has been observed. Since the issue of these guidelines, Popper et al. (2016) has added further information into the threshold levels of impulsive airgun sound to which adult fish can be exposed without immediate mortality. The study found that two fish species (pallid sturgeon and paddlefish) with body masses in the range 200-400 g, exposed to a single shot of maximum received level of 231 dB re 1µPa (PK) or 205 dB re 1µPa^2.s (SEL) remained alive for seven days after exposure and the probability of mortal injury did not differ between exposed and control fish. They also found no difference in injuries between fish exposed at closer distances to the source compared to those further away. Accordingly, this study using an actual seismic source, shows no mortality at higher sound thresholds than the "mortality, potential mortal injury and recoverable injury" thresholds for fish published by Popper et al. (2014) and applied to the Duntroon survey. Carroll et al (2017) from a review of studies into impacts of seismic airgun exposure on fish also support this observation of no lethal impacts.

- To date there are no scientific studies on seismic sound impacts to elasmobranchs. The Popper et al. (2014) sound exposures for fish without a swim bladder have been adopted for sharks in the absence of other information.

- Guidelines for TTS within Popper at al. (2014) are based upon data from Popper et al. (2005) for exposure of several riverine species to an airgun array.

Table 6-26: Sound exposure guidelines for mortality, impairment and behavioural change in fish (Popper et al. 2014)

Type of Fish	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Fish: no swim bladder (particle motion detection)	> 219 dB SEL_{cum} or > 213 dB PK	>> 216 dB SEL_{cum} or > 213 dB PK	>> 186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	> 210 dB SEL_{cum} or > 207 dB PK	203 dB SEL_{cum} or > 207 dB PK	>> 186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	> 207 dB SEL_{cum} or > 207 dB PK	203 dB SEL_{cum} or > 207 dB PK	186 dB SEL_{cum}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Definitions:					
Mortal and mortal injury	Immediate or delayed death.				
Recoverable injury	Injuries including hair cell damage, minor internal or external haematoma, etc. None of these injuries are likely to result in mortality.				
Temporary Threshold Shifts	Short or long-term change in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6 dB or greater that persists and has been selected as the working group considers that anything less than 6 dB will not have a significant effect from a hearing standpoint.				
Masking	Impairment of hearing sensitivity by greater than 6 dB in the presence of noise.				
Behavioural effects	Substantial change in behaviour for the animals exposed to sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction or alteration in migration patterns. This criterion does not include effects on single animals or where animals have become habituated to the stimulus or small changes in behaviour such as a startle response or small movements.				
Note: Peak and rms pressure levels are dB re 1µPa; SEL dB re 1µPa^2.s. All criteria are presented as sound pressure since no data on particle motion exists. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) (tens of metres), intermediate (I) (hundreds of metres) and far (F) (thousands of metres) (Popper et al. 2014).					

Note: For this survey the time standard applied to the SEL cumulative metric is 24 hours.

Note there are no natural topographical features such as shoals, reefs, banks, pinnacles or islands within the Duntroon OA area which may attract fish aggregations or reef-associated demersal fish. The nearest island system to the Duntroon OA area is Rocky (South) Island located approximately 10 km from the nearest Duntroon OA boundary and 25 km from the nearest MC2D survey line.

Mortality, including injury leading to death and recoverable injury (ecological assessment)

Research Results (Fish):

No studies to date have demonstrated direct mortality of adult fish in response to airgun emissions under field operating conditions (DFO, 2004; Carroll et al., 2017; Popper et al., 2014; Popper et al., 2016). DFO (2004) notes that for some seismic surveys, fish kill detection has been undertaken by 'follow-on vessels' instructed to watch for fish kills and none have been observed. Fish deaths have been reported during cage experiments (Hassel et al., 2003) however this was the result of the closing jaw of the grab sampler (and is similar between control and exposed groups) rather than an acoustic impact. No significant difference in mortality was observed between control and exposed sandeel groups (demersal Type I fish) from a 3090 in^3 acoustic array of source pressure 256.9 dB re 1µPa (PK) (vertical) and 247.7 dB re 1µPa (PK) (broadside) in approximately 54 m water depth (Hassel et al., 2003).

For free-swimming pelagic fish which can move away from acoustic sound sources as they approach, the potential for lethal physical damage from airgun emissions is further reduced. Reef or demersal fish, particularly those which show greater site attachment, may be less inclined to move away from acoustic sound and may exhibit greater effects. The following studies support these observations:

- McCauley et al. (2003) in field trials of seismic gun exposure to caged fish demonstrated that airgun shots caused some damage to the sensory hair cells of the pink snapper (*Pagrus auratus*) (a demersal fish) and increased for at least 54 days post exposure. There was no evidence of repair or replacement up to 58 days of exposure. The captive fish were located 5-15 m from the operating array (at the airgun's closest approach) with a source level of 222.6 dB re 1µPa (PK-PK) or 203.6 dB re 1µPa (SPL). No mortalities were observed during the trials and no physiological changes to blood cortisol or glucose levels were observed.

It is to be noted that the functional hearing of snapper was not tested. Study limitations identify the fish in cages were not able to swim away from the sound source (the monitoring video suggested that fish would have fled the source if possible). The impact of exposure on the survival of fish was also unclear. In addition, no statistically significant stress increases could be directly attributed to airgun exposure with no change in blood cortisol and glucose levels in blood smear cell counts.

- Boeger et al. (2006) conducted a series of observations on coral reef fish in enclosures before during and after seismic source exposure to assess disturbance. The 635 in^3 airgun source had a source pressure of 196 dB re 1µPa (PK) with species distance from the airgun varying from 0-7 m. Three configurations of exposure were undertaken varying the number and fish species, depth of the cage and distance from the guns. Despite the severe conditions the experiments did not result in mortality or obvious external damage. While the sound levels were below the guideline levels for mortality and recoverable injury thresholds, this study supports 'no mortality effects' at 196 dB re 1µPa (PK) but does not rule out possible physiological effects.
- Wardle *et al*. (2001) exposed marine fish (juvenile saithe, juvenile cod (demersal), adult pollock (demersal) and mackerel (pelagic)) to received pressure levels of 229 dB re 1µPa PK (@ 1.5m) and 218 dB re 1µPa (PK) (@ 5.3 m) using a triple G. air gun and detected little effect on the "day–to–day" behaviour of resident reef fish. The fish were not restricted inside field enclosures and could potentially swim away. Neither the fish, nor the invertebrates, showed any signs of movement away from the reef nor was any mortality recorded. These received pressure levels are above the thresholds nominated by Popper et al. (2014).
- Popper et al. (2005) exposed three caged fish species (northern pike (demersal), broad whitefish (pelagic) and lake chub) to a 730 in^3 array varying in distance from 13 – 17 m from the cages. Received levels at the fish cages varied from 205.2 dB re 1µPa (PK) to 209.9 dB re 1µPa (PK). A general examination of the fish anatomy post exposure did not show any apparent effects. Fish swam normally post exposure and all fish held 24 hours post exposure survived with no apparent adverse effects.
- Song et al., (2008) extended the work of Popper et al., (2005) exposing three fish species to 5 or 20 pulses from a 730 in^3 airgun array with the mean received sound per shot from 205 to 209 dB re 1Pa (PK). Results show there was no damage to the sensory epithelia in any of the otolithic end organs in any of the fish species exposed. At the same time, both the adult northern pike and lake chub exhibited TTS demonstrating that hearing loss in fish is not necessarily accompanied by morphological effects on the sensory hair cells.
- Santulli *et al* (1999) exposed caged European sea bass (*Dicentrarchus labrax*) (demersal) to a moving seismic airgun array of volume 2500 in^3 and a source of about 256 dB re 1µPa (PK). The airguns were discharged every 25 s during a 2-hr period and the minimum distance between fish and seismic source was 180 m. The received sound was not reported but were estimated to be approximately 195 dB re 1µPa^2.s (SEL). Samples were collected from both exposed fish (6 hr post-exposure) and control fish (6 hr pre-exposure). The study reported an absence of mortality both during and 24 hours after the test and did not indicate any observed pathological injury to the sea bass but found evidence of biochemical stress responses as measured by serum adenylates, cortisol, glucose, and lactate levels. The was a decrease in serum adenylates and elevated levels of cortisol, glucose, and lactate returned to pre-exposure levels within 72 h of exposure.
- Studies undertaken as part of Woodside's Maxima 3D MSS at Scott Reef in 2007 evaluated the impacts of marine sound on tropical reef fish. This MSS utilised dual airguns each with a total capacity of 2055 in^3 with a source of 220-240 dB re 1 µPa^2.s @ 1 m (SEL). Target fish species utilised within experiments included the: blue-green damselfish (*Chromis viridis*) - non-fleeing, Type II fish; bluestripe seaperch (*Lutjanus kasmira*) - fleeing, Type II fish; sabre squirrelfish (*Sargocentron spiniferum*) - non-fleeing, Type II fish; pinecone soldierfish (*Myripristis murdjan*) -

non-fleeing, Type III fish; and miscellaneous species from the Family Holocentridae, primarily from the genus *Sargocentron.* Results on experiments into fish pathology, physiology and hearing sensitivity identified the following outcomes (Woodside, 2008):

- *Hair cell damage*: There was a significantly greater level of damaged hair cells on fish that had been exposed to airgun sound - implying that the exposed fish had suffered some ear tissue damage. This damage was marginal (i.e. involved only small numbers of hair cells) and appeared to be confined to one treatment group. There was no apparent or statistically significant trend in epithelia damage with cumulative SEL or fish grouping. Assuming a linear relationship between hair cell density and hearing capability, these results implied << 1% of hearing capability was likely to have been impaired in the species tested. While minor damage in exposed fish was evident after initial exposure to airgun noise emissions, the damage appeared to have been repaired 60 days after exposure.

- *Clinical and pathological damage*: Comparisons between exposed and control fish did not reveal any anomalous pathology. No structural abnormalities or tissue trauma or lesions commonly associated with high intensity noise emissions were found. Ulcerative and necrotising lesions and mortalities were observed in some experimental and control subjects - these were attributed to myxobacterial infection in some of the test fish unrelated to the experimental sound exposures.

- *Auditory Brainstem Response (ABR) of fish hearing sensitivity:* No significant differences in auditory thresholds were found among exposure groups, or between exposure groups and baseline or control thresholds, at any test frequency for the bluestripe sea-perch or the pinecone soldier-fish. The pinecone soldier-fish (Type III fish) did not exhibit any TTS within the first six hours after receiving airgun noise emissions at the highest exposure level (cumulative SEL of 190 dB re: 1 μPa^2-s).

Other studies undertaken at lower received levels than the Popper et al. (2014) guideline thresholds showed no mortality impacts (Padford et al, 2016; Thomsen, 2002, Dalen and Knutsen, 19879).

Elasmobranchs (Sharks):

Sharks and rays differ from bony fish in that they have no accessory organs of hearing (i.e., a swim bladder) and therefore are unlikely to respond to the pressure component of the sound field (Myrberg, 2001). Elasmobranchs sense sound via the inner ear and organs and as they lack a swim bladder it is thought that only the particle motion component of acoustic stimuli is detected (Myrberg, 2001). Elasmobranchs have the highest sensitivity to low frequency sound (~20Hz to 1500 Hz) particularly in the range 100-150 Hz and can respond to a low frequency source from up to 250 m (Myrberg, 2001) with evidence suggesting that pelagic species have more sensitive hearing than demersal species (Carroll et al., 2017). However, studies have only been conducted on a small number of species to date and the hearing sensitivities are generally very poorly understood (Carroll et al, 2017).

Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1 µPa above background ambient noise levels) when approaching within 10 m of the sound source. Free ranging sharks are attracted to sounds possessing specific characteristics – irregular pulse, broadband frequency and transmitted with a sudden increase in intensity (i.e. resembling struggling prey). At very loud levels an elasmobranch can discriminate between sounds based upon the phased difference between particle motion and acoustic pressure (Lobel, 2009).

The US Navy observed that coastal and oceanic sharks (18 species) would often approach underwater speakers broadcasting low-frequency, erratically pulsed sounds as far away as several hundred meters. They found that the sudden onset loud (20-30 dB above ambient) sounds played when a shark approached a location would result in startling the shark and it would turn away from the area. In most cases involving attraction and repelling, the sharks would habituate to the stimuli after a few trials (Casper et al, 2010). The available evidence indicates sharks will generally avoid seismic sources, so the likely impacts on sharks are expected to be limited to short-term behavioural responses, such as avoidance of waters around the operating seismic array (Carroll et al, 2017).

There is a dearth of information worldwide on the effects of sound on sharks and rays. For the purposes of this assessment sharks are considered as fish without swim bladders (Type 1 fish).

PGS considers that the Popper et al. (2014) threshold of 213 dB re 1µPa (PK) for elasmobranchs and 207 dB re 1µPa (PK) for fish with swim bladders suitable, justifiable and conservative thresholds for the Duntroon survey to assess for possible mortality (including injury levels leading to mortal impact through stress responses).

Extent and duration of exposure and Identified Potential Impact:

Modelling Results:

Acoustic sound modelling results for the Duntroon survey, measured in PK metrics for possible mortality, mortal injury or recoverable injury are provided in Table 6-27. The SEL_{24hr} metric associated with possible mortality, potential mortal injury, and recoverable injury to fish, turtles, fish eggs and larvae from Popper et al. (2014) was not reached. As per the Popper et al (2014) criteria, the PK metric was applied to assess for possible impacts to fish, turtles, fish eggs, and fish larvae. Popper et al. (2014) also identifies one major difference between pile driving, the basis of the threshold, and seismic airguns is that it is harder to determine SEL_{24hr} for airguns. This is due to the received SEL changing from shot to shot due to the seismic vessel movement and varying distances of the source to the fish. On this basis, utilising the PK guideline is potentially more useful than one based on the SEL_{24hr} and has been used to assess possible mortal injury to fish. Modelling was performed at four sites, representative of different topographical features in the Duntroon OA as shown in **Table 6-27**.

Table 6-27: Maximum (R_{max}) horizontal distances from the 3260 in^3 array to modelled seafloor PK from four transects. A dash indicates the threshold was not reached (Wladichuk et al, 2018)

Type of Animal	Mortality, Potential Mortal Injury or Recoverable Injury	Distance R_{max} (m)			
		Site C (200m)	Site D (1099 m)	Site E (649 m)	Site F (160 m)
Type 1 Fish: no swim bladder (particle motion detection)	> 213 dB PK	-	-	-	28
Type 2 Fish: swim bladder is not involved in hearing (particle motion detection)	> 207 dB PK	123	-	-	150
Type 3 Fish: swim bladder involved in hearing (primarily pressure detection)	> 207 dB PK	123	-	-	150

Modelling results predict that only in the shallow depths of the survey area (i.e. on the continental shelf) the PK thresholds for mortal injury to fish (with and without swim bladders) might be exceeded. At all other water depths, thresholds were not reached.

Specific Duntroon OA Fish and Elasmobranch Sensitivities:

BIAs:

The NCVA (DoEE, 2017) does not list any BIAs in the Duntroon OA for fish species.

The NCVA (DoEE, 2017) lists a BIA for the white shark to the northern section of the MC2D survey area around Rocky (south) Island (refer Figure 3-26). The recovery plan for the white shark does not identify sound as a threat to the species recovery.

Spatially defined fish-related KEFs:

Portions of the MC2D seismic lines in the northern section of the Duntroon OA overlap the ancient coastline KEF. This KEF is identified as supporting demersal fish communities of conservation value which provide ecological connectivity between the slope and upper slope environments.

Other Protected Species:

Two other 'conservation-dependent' shark species have a presence within the Duntroon OA which have been depleted through overfishing and low fecundity rates - the site-attached demersal gulper shark located on the continental slope; and the primarily demersal school shark which is widespread across continental shelf and slope areas to 550 m. Conservation advices for these species do not identify any sound-related threats to these species recovery. A closure area for gulper shark breeding is present within the Duntroon OA. No school shark pupping grounds are present in the Duntroon OA (refer Section 3.8.3.1).

SBT, a commercial pelagic fishing stock listed species under the EPBC Act as 'conservation-dependent', is present in the Duntroon OA. The SBT Conservation advice does not list anthropogenic sound as being a threat to the species however the South-west Bioregional Plan identifies noise pollution of 'potential' concern along with changes to sea temperature and oceanography (SEWPC, 2012).

Commercial/Recreational Fisheries (including sharks):

The Duntroon OA also overlaps commercial/recreational fisheries. This includes the small pelagic fish of the south-west region KEF, which is important for providing critical links between primary production and higher predators and to ecosystem functioning and integrity.

Modelling Results:

Modelling predicts for fish with a swim bladder (i.e. Type 2 or 3 fish), mortality, potential mortal injury, and recoverable injury effects might be expected in water depths < 200 m within a maximum horizontal distance of 150 m from the operating array. For fish species, the affected area[78] where the array is at full power in water depths ≤ 200m is approximately 2,075 km^2 (or 1.56% of the SGS bioregion). More conservatively based on the spatial overlap of the Duntroon OA coincident with waters < 200 m (7,134 km^2), is ~5.3% of the SGS bioregion. Acquisition on the shelf environment is estimated to be up to 24 days during the Duntroon survey. Affected fish populations are predicted to be localised and small on a bioregional basis.

Modelling predicts for fish without a swim-bladder (e.g. sharks, Type 1 fish) mortality or recoverable injury sound thresholds would be experienced in water depths < 160 m within a maximum horizontal distance of 28 m from the operational array. Species located in water depths >160 m are not predicted to be exposed to these sound thresholds. For Type 1 fish species present, the affected area where the array is at full power in water depth <160 m is ~1974 km^2 or 1.5% of the SGS bioregion. More conservatively, the proportion of the Duntroon OA which lies in waters < 160 m is ~ 6,612 km^2 (or < 5% of the SGS bioregion). Affected fish population within this area are expected to be very localised given the limited impact range from the operational array.

Predicted Impacts:

Based on the available 'mortality' studies referenced within this section, the following broad conclusions can be drawn about acoustic source exposure on fish:

- Exposure is not expected to result in immediate mortality to fish (McCauley et al, 2003; Boeger et al, 2006; Wardle et al; 2001; Popper et al, 2005; Santulli et al, 1999). Limited studies are available for sharks however injury impacts are considered remote given their biology (i.e. no swim bladder), their observed response to sound through near-field particle motion and their unlikely potential to remain close enough to the operational source to suffer physical injury or changes in hearing. There are no documented cases of mortality in the more 'sound-sensitive fish' types (i.e. with swim bladders) from seismic exposure under experimental or field conditions (Carroll et al, 2017) which supports this

[78] This is based upon the Duntroon MC2D survey lines and MC3D survey polygons in water depths less than 200m allowing for a 5 km lead-in/lead-out distance where arrays are assumed to be fully operational and a 150 m buffer around the polygons/survey lines.

conclusion. In addition, the Recovery Plan for the white shark and conservation advices for the school and gulper shark do not identify noise as a potential threat to the species recovery.

- Pelagic fish species present on the continental shelf are likely to move from areas of high sound (Slotte et al, 2004; Carroll et al, 2017 refer also *behavioural effects*). Injury impacts might only occur in pelagic species if an acoustic array commences at full power adjacent to the fish. In reality, soft-start procedures allow for the detection of increasing sound and for displacement of species. Accordingly, mortality in pelagic fish species is very unlikely given their mobility in the environment with impacts more likely to be behavioural (localised avoidance). It is noted that the lack of significant impacts observed in sensitive species due to their site fidelity requirements (i.e. reef habitats) indicates that pelagic fish which displace from sound disturbance are unlikely to be at risk of impact from seismic sound.
- Demersal or site attached fish species may be less inclined to move away from high levels of sound and it is possible damage to fish hearing hair cells (McCauley et al, 2003; Woodside, 2008) or short-term biochemical stress responses (Santulli et al, 1999) might occur. It is noted that sensory hair cells are constantly added in fishes (Popper and Hoxter, 1984; Lombarte and Popper, 1994) and are also replaced when damaged (Lombarte et al, 2003; Schuck and Smith, 2009). Therefore, the impacts to hair cells of fish which cannot avoid the seismic source would be temporary. However, the effect of these temporary stressors on survival of fish is unclear and they may be more susceptible to predation or other environmental stressors than non-stressed fish through lower fitness depending on the fish life history (Hastings and Popper, 2005).

Within the context of the Duntroon survey activities, acoustic sound may have the following impacts to OA marine and seabed habitat on the continental shelf (depths 100 - 200m):

- Elasmobranchs:
    - Within the Duntroon OA in water depths < 160m, sharks are expected to respond to low frequency sound within ~250 m (Myrberg, 2001) and withdraw from sudden high intensity sound sources (Klimley and Myrberg, 1979) close to the operational array where particle motion is high (i.e. localised avoidance). Given their anatomy (i.e. no swim bladder) and the lack of observed injuries to more sound-sensitive fish species, mortality and recoverable injury impacts to shark species is considered very unlikely with impacts more likely to be behavioural through localised avoidance or responding to prey displacement (SLIGHT Consequence).
    - *BIA (White Shark)*: The Duntroon OA intersects this foraging BIA with an overlap of 370 km^2 in a total foraging BIA of 119,196 km^2 (0.3% foraging BIA). Within this area, 17.2 km[80] of MC2D seismic lines are planned which results in a possible impact area above adopted mortality thresholds of 1.00 km^2 (0.001% foraging BIA). The white shark, a pelagic species, is found in continental waters to 100 m and is regularly observed foraging around pinniped colonies with the closest white shark foraging area, Rocky Island (south), located ~ 10 km NE from the nearest OA boundary. Given the distance from this foraging location and the depth of the survey (100m+) only low-level encounter with white sharks are expected in the OA. As per the pinniped evaluation in Section 6.2.3.5, sound exposure due to Duntroon survey activities at Rocky Island (south) is not expected to result in pinniped displacement and no impact to white shark foraging is expected.

      The Duntroon OA does not lie in proximity to any white shark breeding or juvenile aggregation areas. Accordingly, early lifecycle stages for the species are not expected to be affected by survey operations. On this basis, while localised and temporary displacement might occur around the operational array, no impacts to foraging or breeding grounds are expected and no impacts to species recovery are expected.
    - *Conservation Dependent School Shark:* This primarily demersal shark is widespread in continental shelf/slope environments to 500 m; ranges through the water column to

[80] This includes a 5 km run-in/run-out at full power using a maximum horizontal distance of 41 m radius from the array.

forage; and undergoes migration of up to 1400 km to natal mating and pupping grounds in coastal areas of South Australia, Victoria and Tasmania. As per the white shark, given observed shark behaviour to sudden sound increases, localised displacement around the moving sound source is possible, together with its prey species (fish, cephalopods) so reduction in foraging 'opportunities' is unlikely. The Duntroon OA does not overlap inshore nursery areas for the school shark and the survey period is not within the species breeding periods (December-January). Note that area exposed to mortality/recoverable injury sound thresholds is limited to a 28 m horizontal distance from the operating array and is not present in water depths > 160 m (very limited area). Accordingly, impacts to the school shark are expected to be limited to temporary localised avoidance around the operational array. No impacts are expected with respect to species recovery.

  - *Conservation Dependent Gulper Shark:* This demersal shark has a core range of 7,269 km^2 (TSSC, 2013) and inhabits continental slope areas between 200 - 850m (refer Section 3.8.3.1). Modelling predicts the gulper shark habitat will <u>not</u> receive sound levels which may cause mortality (immediate or delayed) or recoverable injury impacts.

- Pelagic fish species:
  - Within the Duntroon OA, as previously identified, pelagic fish species (including the conservation-dependent SBT) are likely to undergo temporary, localised displacement around the operational array, which as prey species of higher trophic levels (sharks, pinnipeds, seabirds, dolphins) may also lead to localised predator displacement; or reduced catchability or stock availability of commercially targeted species (Slotte et al, 2004; Carroll et al, 2017). Mortality or recoverable injury impacts to these pelagic species is very unlikely.
  - *Reproductive success (pelagic species*): As identified in Table 6-18, most key commercial pelagic species are batch spawners or broadcast spawners and have spawning periods outside the Duntroon OA location/timeframe. The survey area is also not located within key spawning areas for fish species. As identified in Section 6.2.3.2 (plankton), impacts to eggs are likely to be restricted in range to < 10 m from the operating array (Kostyuchenko, 1973; Dalen and Knutsen, 1987; Matishov, 1992; Pearson et al, 1994; Boorman et al, 1995; Payne et al, 2009; Cox et al, 2011; Bolle et al, 2012) although more recent studies identify plankton impacts at greater received sound levels (McCauley et al, 2017). As assessed in Section 6.2.3.2, localised relative plankton biomass depletion (0.75) may occur within the survey area for the period of the survey with plankton recovery expected within days of survey completion. This simulation was based upon an increase in zooplankton mortality from a natural rate of 19% to 45% within the survey area (Richardson et al, 2017). Given these localised, temporary impacts on a bioregional basis, recruitment from adjacent waters (e.g. western spawning areas, Eyre Peninsula meso-eddy) is expected into the survey area. On this basis, impacts will be localised, temporary and incidental to total stock levels (rapidly recoverable) (SLIGHT Consequence).

- Demersal fish species:
  - The <u>continental shelf</u> portion of the Duntroon OA does not contain any features (*except the Ancient Coastline KEF (assessed below)*) which would lead to aggregations of demersal fish (i.e. species are wide-ranging). Across the Duntroon OA impacts to demersal species would be localised around the array to 150 m[81]. For demersal fish species present in the Duntroon OA (on continental shelf) exposed to this sound, mortality impacts are not expected however there may be a greater risk of fish stress and reduced fitness leading to activity impairment or increased predation. One demersal fish example is syngnathid species recorded as present in the Duntroon OA, however unlikely to be a significant fish species given the water depths of the survey (100 m+) and the lack

[81] This distance is applied as it is the greatest modelled distance for potential mortality impacts. For demersal fish without a swim bladder this distance is reduced to 28m with the species affected in water depths less than 160 m.

of recorded presence in SA waters. As per Section 3.7.4.4, only one listed pipe-horse has a depth range which may be coincident with the Duntroon OA (30-240m) and, if present, is expected to be widespread throughout the bioregion at this depth range. Impacts to the species, from mortality/recoverable injury sound levels, based upon Woodside studies (2008) on site attached species may include temporary, minor hearing hair cell damage which is repairable. From this study no mortality in fish species and site-attached fish species are expected and impairment to demersal fish species is expected to be localised, short-term and recoverable (MINOR Consequence).

Table 6-18 provides details of the key commercial/recreational fish, their reproduction method, timeframe and location of reproduction. Most demersal species are serial spawners in periods which do not overlap the Duntroon survey. On this basis, impacts to demersal fish eggs will be limited to eggs/larvae which drift into the Duntroon OA. As per pelagic species impacts (above), impacts to fish eggs are localised and temporary on a bioregional basis with recruitment from adjacent waters expected into the survey area. On this basis, impacts will be localised and temporary incidental to total stock levels (SLIGHT Consequence).

- *Ancient coastline KEF*: Approximately 56 km (5 affected lines) of MC2D seismic lines are planned within the ancient coastline KEF affecting an area of 24.3 km^2 [82] which may affect demersal fish habitats. This represents 0.05% [83]of the ancient coastline KEF along the southern margin and given such a small and localised area, impact in the context of the KEF size is not expected to lead to a significant impact on ecological functioning. Notwithstanding this, the requirement for these MC2D seismic lines has been reviewed and PGS has determined they are not required. Accordingly, the survey will implement a spatial buffer of 150 m to the ancient coastline boundary to eliminate demersal fish impacts within this KEF. No injuries to demersal fish are predicted within this KEF.

- *Commercial/Recreational Fish impacts (Indirect Impact)*:

A conservative assessment of possible commercial fishery (biomass) impacts (pelagic and demersal) from the Duntroon survey, assuming impacts leading to mortality in the area across the Duntroon OA overlapping South Australian MFAs and Commonwealth fishing management areas (i.e. not only within 150 m of the operational array in shelf environments) is provided in Table 3-60. Potential impacts to commercial stock (including Charter Boat Fishery (recreational) stock) identify that catch together with the estimated ‘stock affected by the Duntroon survey’ do not exceed the TAC/TACC for the fishery, or in the case of SA Fisheries without TACCs, the estimated ‘stock affected’ would not cause the management arrangements to be reviewed based on the latest fishery performance indicators. On this basis, impacts to fish stock (including shark) from Duntroon survey activities is not expected to affect fish stock sustainability. *Refer to catchability section on impacts to commercial fish species*.

While this assessment relates to key commercial and recreational species, the assessment is also considered valid for other non-target non-commercial species which have a similar widespread distribution across the OA. These species are considered to have less sustainability pressure as they are not the subject of a commercial/recreational catch placing additional pressure on the fish biomass (i.e. stock biomass carries less sustainability threats).

Table 6-18 summarises the spawning timeframes, locations and spawning methodology for the key fish species in the Duntroon OA. For demersal fish, the timing of the Duntroon survey avoids the peak fish spawning periods and larval recruitment impacts is expected to be slight. *Reproductive success (pelagic species) (above)* provides an assessment of impacts to fish eggs in proximity to the array. For demersal commercial shark species, pupping areas lie in shallow coastal areas which will not be affected by Duntroon survey activities.

[82] This includes run-in/runout distances of 5 km for each line and a horizontal distance of 150 m from the operational array.
[83] Southern margins ancient coastline area is 45,133 km^2

Summary:

Consequence:

- *For shark species*: Impacts are expected to be localised, temporary displacement around the operating array recoverable within very short timeframes (SLIGHT consequence).
- *For pelagic fish*: Impacts are expected to be localised, temporary displacement around the operating array recoverable within very short timeframes (SLIGHT consequence).
- *For demersal fish*: Recoverable injury impacts might be found in the localised fish which are exposed to these high sound levels. Impacts are localised, with short-medium term effects but full recovery would be expected (MINOR Consequence).

Temporary Threshold Shifts (ecological assessment)

TTS, as defined in the Popper at al. (2014) guidelines, is the temporary reduction in hearing sensitivity caused by exposure to intense sound. TTS has been demonstrated in some fish with variable magnitudes and durations. TTS results in temporary changes to the sensory hair cells of the inner ear and/or damage to the auditory nerve. Popper et al. (2014) identifies that sensory hair cells are constantly added and replaced in fish hence effects may be mitigated over time by the addition of new hair cells. After sound termination which causes TTS, normal hearing returns over time dependent on the sound exposure (intensity & duration). While in a TTS condition, fish may have decreased fitness in terms of communication, detecting predators or prey and assessing their environment.

Guideline thresholds for TTS developed by Popper et al. (2014) are based upon exposure of several riverine species to a variable number of seismic array pulses over five minutes with a SEL_{24hr} of 186 dB re 1 µPa^2.s (Popper et al., 2005). This exposure in caged outdoor tanks resulted in up to 20 dB of TTS loss in the lake chub (*Couesius plumbeus*) with a maximum TTS loss at 200 Hz and 400 Hz (species has a connection between the swim bladder and inner ear). Approximately 20 dB of TTS occurred at 400 Hz in adult northern pike (*Esox lucius*), a species that does not have such a connection. TTS did not occur at other frequencies. Another species without a connection between the ear and swim bladder, the broad whitefish (*Coregonus nasus*), showed no TTS to sounds after exposure at the same level. These effects were seen only in adults and not juvenile pike. In all cases fish with TTS recovered to normal hearing levels in 18-24 hours (Popper et al., 2005).

As identified in Table 6-26, Popper et al., (2014) recommends a threshold of >>186 dB re 1µPa^2.s SEL_{24hr} for fish with no swim bladder (e.g. Type 1 fish, elasmobranchs) and fish with a swim bladder which is not involved in hearing; and for fish with a swim bladder involved in hearing a threshold of 186 dB re 1µPa^2.s $SEL_{24hr.}$ Woodside (2008) studies are consistent with the Popper et al. (2014) studies, while other studies indicate that TTS may occur at levels as high as 205-209 dB re 1µPa (PK) (Song et al, 2008; Popper et al., 2005).

Extent and Duration of Exposure and Identified Potential Impact:

Modelling Results:

Table 6-28 provides results for the maximum range and area affected by TTS sound criteria for fish with a swim bladder involved in hearing (i.e. most sensitive at 186 dB re 1µPa^2.s SEL_{24hr}). TTS in fish is predicted to occur within a horizontal radius of 4.97 km from the operating array for pelagic species (i.e. maximum over depth) and 4.92 km of the operating array for seabed (demersal) receptors such as the gulper shark. For the considered 24 hr modelling scenario, based upon an estimated R_{max} radius of 4.97 km, the maximum area over the water column where TTS ensonification may occur is 823 km^2. This represents 2.7% of the Duntroon OA and on a bioregional basis represents 0.6% of the SGS bioregion and 0.11% of the Southern Province Bioregion over the 24-hour period.

Table 6-28: Modelled distances and areas ensonified to SEL_{24hr} fish TTS criteria (Wladichuk et al, 2018)

SEL24hr Isopleth (dB re 1µPa².s)	Location	Rmax(km)	Area (km²)
186	Maximum-over-Depth	4.97	823
	Seafloor (shallow)	4.92	780
	Seafloor (deep)	2.88	-

Predicted Impacts:

Based on the available TTS studies referenced within this section, the following broad conclusions can be drawn about acoustic source exposure on fish and elasmobranchs:

- Shark species are thought to respond to the particle motion component of the sound field, which is most pronounced in the near-field, and are less sensitive to sound pressures (Myrberg, 2001). The TTS threshold metric adopted to determine the TTS SEL_{24hr} ensonification area relates to the most sensitive fish type ('species with air bladder used in hearing'). For elasmobranchs, TTS thresholds are much greater >> 186 dB re 1 µPa².s (SEL_{24hr}) and distances leading to TTS impacts are expected to be closer to the array. However, from modelled results, an elasmobranch would need to remain within a horizontal distance of less than 5 km from an operating array for a 24-hr period to incur TTS. More realistically, pelagic elasmobranchs would not stay in the same location or at the same range for 24 hours. The radius reported does not mean that the shark species travelling within that distance of the operating source will suffer TTS, but rather the animal could be exposed to a sound level associated with TTS if it remained in that range for 24 hours. For demersal shark species, as the survey vessel is in constant movement across different areas within the OA, TTS impact to shark species which are site attached or demersal is possible, however unlikely. If experienced, TTS would be temporary and recoverable.
- Popper et al. (2014) identified that fish with TTS recovered to normal hearing levels in 18-24 hours (Popper et al., 2005). The US National Marine Fisheries Service (NMFS) applies a resetting of SEL_{cum} after 12 hours of non-exposure (Stadler and Woodbury, 2009; in Popper & Hawkins 2012).
- As per the mortality/recoverable injury assessment, pelagic fish species are likely to move from areas of high sound (Slotte et al, 2004; Carroll et al, 2017).
- As per the mortality/recoverable injury assessment, demersal or site attached fish species may be less inclined to move away from high levels of sound and it is possible TTS may occur, however as per demersal shark TTS this is considered unlikely.

Survey Design:

The Duntroon MC2D survey design consists of adjacent seismic lines spaced 5 km apart. Acquisition across this area is undertaken in one direction (e.g. NW-SE) before cross lines are undertaken (e.g. NE-SW). Spacing between MC2D lines ensures that cumulative SEL_{24hr} impacts at any one location, given 24-hour exposures are required, does not occur.

The Duntroon MC3D survey design consists of "racetracks" with the MC3D survey design in EPP-41/42 expected to take 18+ hours before any adjacent line[84] is acquired. Any site-attached or demersal species have low levels of cumulative sound impact. If MC3D survey acquisition is undertaken within EPP-46 as an extension to the EPP-41/42 survey, the time for adjacent line acquisition will increase accordingly and the potential for TTS impacts will correspondingly reduce.

Within the context of the Duntroon OA, survey activities would have the following TTS impacts to marine and seabed habitats:

- Pelagic species (e.g. sardines, whiting, SBT, white shark, mako shark) present in the Duntroon OA, are likely to displace from areas of high sound (Slotte et al, 2004; Carroll et al, 2017) limiting the potential exposure time to cause TTS. With the constant movement of the survey vessel and the small area (823 km²) affected over each 24-hr period, TTS in pelagic species within the OA is extremely unlikely (SLIGHT Consequence). The following applies to specific Duntroon OA pelagic sensitivities:

[84] Based upon the size of the array and the spread of hydrophone steamers.

  - *White Shark BIA:* The white shark BIA, located in the north of the Duntroon OA, lies adjacent to MC2D seismic lines. Given the spatial separation of MC2D lines (5 km) and the low density of lines present in that area, TTS impacts to white sharks if present in the BIA at that location are not expected;
  - *SBT:* SBT capture and pontooning occurs at stationary locations on the continental shelf during December to March. Given the temporal separation of the survey activity with SBT pontooning no TTS impacts to SBT (pelagic and site-attached in pontoons) is expected.
  - *Reproductive success (pelagic species*): This impact has been assessed as part of the mortality/recoverable injury assessment.
- Demersal species present in the Duntroon OA are less mobile than pelagic species and at a greater risk of TTS impact. Species within the Duntroon OA experiencing TTS may suffer from decreased fitness in terms of communication, detecting predators, obtaining prey and assessing their environment (Popper et al, 2014). This may lead to increased predation or foraging impacts however TTS effects are temporary and fully recoverable. It should be noted that for demersal species located in the MC2D area, spacing between adjacent seismic lines is not expected to cause TTS exposure to adjacent line locations and TTS impacts are very unlikely (MINOR consequence). The following applies to specific Duntroon OA demersal sensitivities:
  - *Ancient coastline KEF (Demersal Fish):* This KEF lies outside the MC2D acquisition area. Given the spatial separation of MC2D lines (5 km) and the time required to incur TTS impacts, TTS impacts to demersal fish within this KEF adjacent to the MC2D area is not expected.
  - *Syngnathids (site attached)*: As previously identified, it is not expected that syngnathid species are a significant site-attached fish species within the Duntroon OA. It is possible that syngnathid species might lie in the MC3D survey area on the continental shelf within 4.92 km of the operational array if present. However, given the constant movement of the vessel and the length and spacing of seismic lines, TTS impacts to syngnathid species are very unlikely.
  - *Gulper Shark closure area*: MC2D survey lines are expected to cross the closure area, perpendicular to the slope on a widely spaced, low density grid of typically 5 km spacing (refer Figure 6-10). Vessel movement across the closure area (up/down the slope ~11 km) to acquire data is expected to take less than 1.5 hours with adjacent MC2D line acquisition undertaken a number of hours after the first line. No MC2D acquisition will occur in the closure area on seismic lines running along (parallel to) the continental slope. On this basis, given the limited lines in this area and their distance apart, cumulative TTS impacts are not expected within the closure area from MC2D activities. No EPP-46 MC3D survey lines will be acquired in the gulper shark closure area.

    The EPP41/42 MC3D survey area spatially overlaps by approximately 10 nm the eastern buffer of the gulper shark closure area (~15 nm). The closure area is centred around a 30nm area where the southern dogfish is concentrated and mature females have been observed, with closure 'buffers' on either side of this central area. Detections in the edge areas are 8 times lower than in the centre (Williams et al, 2012). The spatial overlap of the EPP41/42 MC3D with the closure area, therefore lies over an area with low densities of gulper shark.

    Modelling predicts that fish hearing could be temporarily impaired (TTS) (SEL_{24hr}) within a maximum horizontal distance of 2.88 km of the airgun array. The 24-h SEL is a cumulative metric that reflects the dosimetric impact of noise within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. More realistically, fish would not stay in the same location or at the same range for 24 hours. Therefore, a reported radius for 24-h SEL criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (TTS) if it remained in that range for 24 hours. Approximately 70% of the southern dogfish have a home range of > 10 nm and estimated foraging range is 50 nm along the slope (TSSC, 2013) and are therefore not site attached.

    Given the small spatial overlap of the EPP41/42 MC3D survey area with the closure area (approx. 14% of total closure area of 7269 km^2 (TSSC, 2013)); the lower density of shark presence within that buffer area (Williams et al, 2012); the movement of gulper sharks for foraging (TSSC, 2013), TTS impacts, which are temporary and recoverable, may be observed within a small portion of the population (10.3% of total central population). Note that the Conservation Advice for the Gulper shark does not identify noise as a threat to species.

Summary:

Consequence:

- *For pelagic fish/shark species*: TTS impacts are very unlikely as pelagic species displace on a temporary and localised basis from areas of high sound (SLIGHT Consequence).
- *For demersal fish/shark species*: TTS impacts are possible but limited and localised due to the design of the survey (MC2D and MC3D). TTS is temporary and full recovery would be expected over a short timeframe (~days) (MINOR Consequence).

Behavioural impacts (ecological assessment)

Available Research:

Behavioural sound thresholds for fish have not been established. This is due to limited and varying scientific data and the specific nature of behavioural responses amongst fish species which is context specific (i.e. one threshold does not fit all). Behavioural responses are observed to vary by species, size, age class and motivation and may be linked to the circumstances of the animal, the activities in which it is engaged and the context in which it is exposed to sounds (Pena et al., 2013). Behavioural effects are considered more likely than physical and physiological effects at lower sound levels and may provide a more useful indicator of sound impacts over a large spatial scale.

Behavioural responses to sound are variable but include:

- Startle/alarm responses;
- Leaving the area of the sound source (avoidance);
- Spatial changes in schooling behaviour/swimming patterns;
- Changes in depth (vertical distribution).

These effects are expected to be short-lived, with duration of effect less than or equal to the duration of exposure, and are expected to vary between species and individuals, and be dependent on the properties of received sound (DFO 2004). The ecological significance of such effects is expected to be low, except where they may influence a dispersion of spawning aggregations or deflections in migration paths, however, the magnitude of effects will be dependent on the biology of the species and the extent of the dispersion or deflection (DFO, 2004).

Studies identify that a sudden onset of sound may cause a startle response in fish. This has also been observed by Myrberg (2001) where elasmobranchs can withdraw immediately if sound intensity suddenly increases by 20 dB re 1µPa (10 times) or more above the previous transmission close to a sound source. However, it is also noted that behavioural response studies for elasmobranchs are limited. Startle responses have also been observed in captive fish however sound thresholds have been shown to vary amongst species. For example:

- Pearson et al. (1992) identified for caged olive and black rockfish (*S. serranoides* and *S. melanops*), the threshold for startle responses was between 200 and 205 dB re 1µPa (PK). Other rockfish species also responded to sound at different thresholds with the general threshold for alarm responses identified was 180 dB re 1µPa (PK) and more subtle responses at 161 dB re 1µPa (PK) based upon regression analysis.
- McCauley et al. (2000) in tests on captive fish showed a common fish 'alarm' response of swimming faster, swimming to the bottom, tightening of school structure or all three at sound exposures of 161-166 dB re 1µPa (SPL) at 2 – 5 km from the operating seismic airgun.
- Caged European sea bass also started to exhibit a startle response to an approaching seismic source at 2500 m (i.e. a few individual fish) and at 800 m a larger proportion of fish were also exhibiting this

behaviour. After exposure and with the source at 1 nm startle responses were no longer evident and within 1 hr the fish were reoriented with stream flow (Santulli et al., 1999).

- Woodside's Maxima 3D MSS studies on caged fish at Scott Reef observed alarm responses and agitation in all four-caged species when passed by the seismic airgun. Alarm responses (including startle responses) were too infrequent to analyse. Agitation levels increased with increasing exposure, at 155-165 dB re 1µPa^2.s (SEL), for three of the caged species, but were not detected for one species the bluestripe perch (Woodside, 2008b).

Collectively, caged studies provide an indication of acoustic and environmental conditions where fish may show behavioural responses to seismic noise, but captive fish may have little or no resemblance to response in open conditions. Behavioural studies on unrestrained fish exposed to airguns sound are scarce. Wardle et al. (2001) observed free ranging fish behaviour (primarily juvenile saithe, adult pollock, juvenile cod, and adult mackerel) on a reef system exposed to operating airguns (195-218 dB re 1µPa (PK)). Fish exhibited startled responses to received sound but no avoidance behaviours were observed. Fish did not move away from the reef in response to sound, and their diurnal rhythm did not appear to be affected. When the source was placed on the seabed (depth 14 m) visible to the fish, fish were seen to turn and flee during airgun shots. When the source was suspended midwater (5 m depth) and just outside visible range, the fish exhibited a C-start and then continued to swim towards the source position, their intended swimming track apparently unaltered.

Woodside's Maxima 3D MSS studies on free swimming fish at Scott Reef also observed that the species type, their abundance and behaviour had only immediate and short-term effects with no lethal or sub-lethal effects near the operating array. At close range, 50-240 m, the airgun sounds appeared to cause a prominent, short-term effect on fish behaviour with the fish ceasing normal behaviours and moving downward from the water column to the seabed. Fish began to feed and behave normally within 20 minutes after the passage of the vessel. Once the vessel had travelled beyond ~1.5 km, fish numbers and behaviour returned to baseline levels (Woodside, 2008b).

Changes in depth distribution due to acoustic exposure has been observed in studies which may indicate that vertical rather than horizontal movement could be a short-term reaction to seismic sound:

- Chapman and Hawkins (1969) observed a changed depth distribution of free-ranging whiting (*Merluccius bilinearis*) expose to an airgun at estimated received sound levels of 178 dB re 1µPa (SPL). The fish shifted vertically to a depth of ~ 55 m where they formed a compact layer. Habituation to sound was observed after 1 hour of exposure.
- Pearson et al. (1992) observed on sound exposure, caged blue rockfish (*S. mystinus*) milled in increasingly tighter mills and schools of black rockfish collapsed to the bottom of the cage. Vermilion (*S. miniatus*) and olive rockfish formed stationary schools near the bottom of the cage and on sound exposure either rose in the water column or moved to the bottom and became almost motionless. All species returned to pre-exposure behaviour within 20-60 minutes of sound ceasing.
- Slotte *et al* (2004) examined effects on pelagic fish abundance (herring, blue whiting and mesopelagic species) from a seismic airgun array (source 222.6 dB re 1µPa (PK-PK)) prior to and after seismic transect acquisition. No difference was found indicating seismic operation had insignificant short-term scaring effects, however blue whiting and mesopelagic species were found approximately 10 m and 50 m deeper respectively in periods of seismic acquisition indicating vertical rather than horizontal movement could be a short-term reaction to this noise.
- Fewtell and McCauley (2012) assessed impacts of sound on captive trevally (*Pseudocaranx dentex*) and pink snapper (*Pagrus auratus*)) from a single airgun of source 192 dB re 1µPa^2.s (SEL) with received sound ranging from 120-180 dB re 1µPa^2.s (SEL). Changes to the caged trevally schooling behaviour and vertical positioning commenced at 147-151 dB re 1µPa^2.s (SEL) where the fish were observed to swim faster and form more cohesive groups towards the bottom of the cage. The pink snapper also moved to the lower section of the cage, however loose cohesive groups were observed more often during the exposure to noise. Pink snapper also appeared to habituate to the sound compared to trevally.
- Woodside (2008b) detected via sonar during studies at Scott Reef that free swimming fish tended to move lower in the water column towards the seabed on approach of an operating array consistently out to 400 m of either side of the survey test line. Within 200 m of the survey test line, fish schools

moved to the seabed after passage of the operating airgun array and stayed significantly closer to the seabed out to 63 minutes post exposure.

- Przeslawski et al. (2016) observed tagged tiger flathead which increased their swimming speed during the survey period and changed diel movement patterns after the survey but showed no significant displacement.

Studies into the behaviour of Bluefin tuna identified localised noise produced by vessels resulted behavioural deviations in tuna schools (Sara et al. 2007). Schooling behaviour in bluefin tuna has been considered a behavioural strategy in the species to enhance the accuracy of migration and efficiency of locating food. In the absence of boat noise, tuna assumed a concentrated coordinated school structure with unidirectional swimming. Under control conditions tuna swam horizontally rarely moving from mid-water (~ 12m to 15 m from the surface). On boat approach, the tuna significantly increased their vertical movement, showed changes in swimming direction, a modest increase in swimming speed with an effect on the structure of the schools. Tuna also appeared to increase interactions amongst themselves when exposed to higher frequencies (i.e. small boat passage).

Masking: Masking impairs an animal's hearing with respect to the relevant biological sounds normally detected within the environment. In effect, masking raises the threshold for detection by an animal. While the consequences of fish masking have not been fully examined, long lasting effects on survival, reproduction and population dynamics may result (Popper et al. 2014). Data on hearing for all vertebrates tested to date, including fish, show that the degree of masking relates both to the level of the masking noise and the frequencies it contains. In fish, pure tone sounds are masked most readily by noise at the same and immediate adjacent frequencies, falling within a critical band (Popper et al. 2014).

Masking may occur where a noise exceeds the absolute hearing thresholds of an animal and is likely to occur for most fish at some locations and times due to the varying level of background noise that occurs in all aquatic environments. Data on masking by seismic airguns are not available for any species. Masking is possible for the time that fish are exposed to airgun sound and may occur when animals are sufficiently far from the source where sounds merge and become more or less continuous (Nieukirk et al. 2004). Popper et al. (2014) surmised that "*It is likely that increments in background sound within the hearing bandwidth of fish may render the weakest sounds undetectable, render some sounds less detectable, and reduce the distance at which sound sources can be detected. Energetic and informational masking may increase as sound levels increase, so that the higher the sound level of the masker, the greater the masking*".[85] However, masking only occurs while the interfering sound is present, and therefore masking resulting from a single pulse of sound (such as an airgun shot) or widely separate pulses would be distinguishable and unlikely to significantly affect an individual's overall fitness and survival.

<u>Extent and Duration of Exposure and Identified Potential Impact:</u>

Threshold Criteria:

There are no recommended exposure criteria for fish behaviour or masking. The expert working group into sound impacts to fish (Popper et al. (2014)) did not find sufficient data trends to recommend behavioural or masking sound thresholds and instead recommended "relative risk" criteria to determine masking and behavioural effects (refer Table 6-26). This qualitative criterion describes risk potential for the observed behaviour or masking at distances relative to the source. The ranges, relative to the source, were quantified as **near** (within tens of meters); **intermediate** (within hundreds of metres) and **far** (in thousands of meters). Based upon the criteria posed by Popper et al. (2014) and the information assessed, behavioural responses are likely to occur near the seismic source with diminishing responses further from the source. Behavioural effect in the context of this risk criterion is defined as *"substantial change in behaviour for the animals exposed to a sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion*

[85] Popper et al (2014) p18

does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements".[86]

Literature also identifies that it is difficult to predict the population impacts due to behavioural response given behaviour is context dependent. Responses are likely to vary by species, size, age, motivation and environmental context. Behaviour may be more strongly related to the particular circumstances of the animal, the activities in which it is engaged and the context in which it is exposed to sounds (Ellison et al., 2012; Pena et al., 2013).

Predicted Impacts:

Based upon the available behavioural scientific literature referenced in this section, the following broad conclusions can be drawn about behavioural responses in fish when expose to acoustic sound:

- High levels of sound can elicit various types of behavioural responses, some of which may negatively affect a population (reduced rate of foraging or predator avoidance) and others which may pose no overall risk (e.g. startle response) (Carroll et al, 2017). The degree of behavioural response to acoustic sound varies by species, age and motivation and is linked to the particular circumstance and environmental context of the affected animal (Pena et al, 2013).

- A range of responses has been observed when the behaviour of wild fishes has been studied in the presence of man-made sounds. Some fishes have shown changes in swimming behaviour and orientation, including startle reactions (Pearson et al. 1992; Wardle et al. 2001; Hassel et al. 2004). The response may habituate with repeated presentations of the same sound. Sound can also cause changes in schooling patterns and distribution (Pearson et al. 1992). For example, the horizontal and vertical distributions of both pelagic and demersal fishes were altered during and after airgun operations (e.g., Dalen and Knutsen 1987; Engås et al. 1996; Engås and Løkkeborg 2002; Slotte et al. 2004; Løkkeborg et al. 2012 a, b).

Within the context of the Duntroon survey activities, the following behavioural impacts (direct and indirect) to marine species may be observed:

- *Sharks:*

  Popper et al (2014) identified the behavioural response to sound for fish without swim bladders (i.e. elasmobranchs) **near** the acoustic source is high with a low risk of behavioural response at **far** distances.

  Shark species are known to respond via the lateral line to the relative motion between its body surface and surrounding water. This relative motion takes place very close to the sound source where there is a steep gradient of sound pressure and particle motion (Popper et al, 2014). Consequently, the operational range of the lateral line is usually restricted to no more than one or two body lengths away from the source (Popper et al. 2014). This is also consistent with shark bites on hydrophone cables which lie in proximity to the source array. On this basis, PGS considers the adopted Popper et al. (2014) criteria to be very conservative for the assessment of behavioural responses in elasmobranchs. In addition, the Recovery Plan for white shark and conservation advices for the school and gulper sharks do not identify noise as a potential threat to the species recovery. On this basis, given the observed behavioural response to sudden sound increase close to sound sources (Myrberg, 2001), behavioural impacts to sharks are expected to be localised and temporary.

  - *Gulper Shark (Closure area - breeding)*:

[86] Popper et al (2014) p36

On a precautionary basis, given the conservation-dependent nature of the gulper shark and the location of the 'breeding' closure area within the OA, PGS has assessed MC2D and MC3D survey lines across the 30 nm central 'breeding' zone to limit possible behavioural impacts to breeding sharks. PGS will acquire MC2D data over this area running seismic lines (spaced approximately 5 km apart) perpendicular to the central 30 nm closure area (i.e. up/down the slope area) and MC2D survey lines which run parallel to the closure area (i.e. along the slope) will be positioned outside the closure boundary (refer Figure 6-10) to limit sound over this area. MC2D acoustic operations on each line perpendicular to the slope is expected to traverse the closure area in less than 1.5 hrs (9 lines in total).

Based upon the Popper et al (2014) risk criteria, a moderate risk of behavioural disturbance to sharks lies within hundreds of meters of the operating array with a low risk at greater distances. By adopting this line layout, PGS has reduced to a minimum the number of lines to be acquired over this closure area while achieving survey objectives. Based on Popper et al (2014) criteria, the breeding area carries a low risk of behavioural response (i.e. displacement from breeding area) (SLIGHT consequence).

As PGS is currently unaware of any prospects beneath the gulper shark closure area, any EPP-46 MC3D activities will spatially exclude this closure area from survey activities under this EP (refer Figure 6-10).

- *White Shark BIA*:

  Approximately 17.2 km of MC2D seismic line is planned at the boundary of the white shark foraging BIA. In accordance with Popper et al (2014) criteria, this carries a moderate risk of behavioural impact within hundreds of meters of the operational array if sharks are present. This foraging BIA subsumes known pinniped breeding areas (white shark prey) and water depths are at the nominal range (100 m) for the white shark. The presence of the species will be low and concentrated further north around pinniped colonies. Any behavioural impacts, if the species is present, are localised and temporary with no expected impacts on foraging within the BIA (SLIGHT consequence).

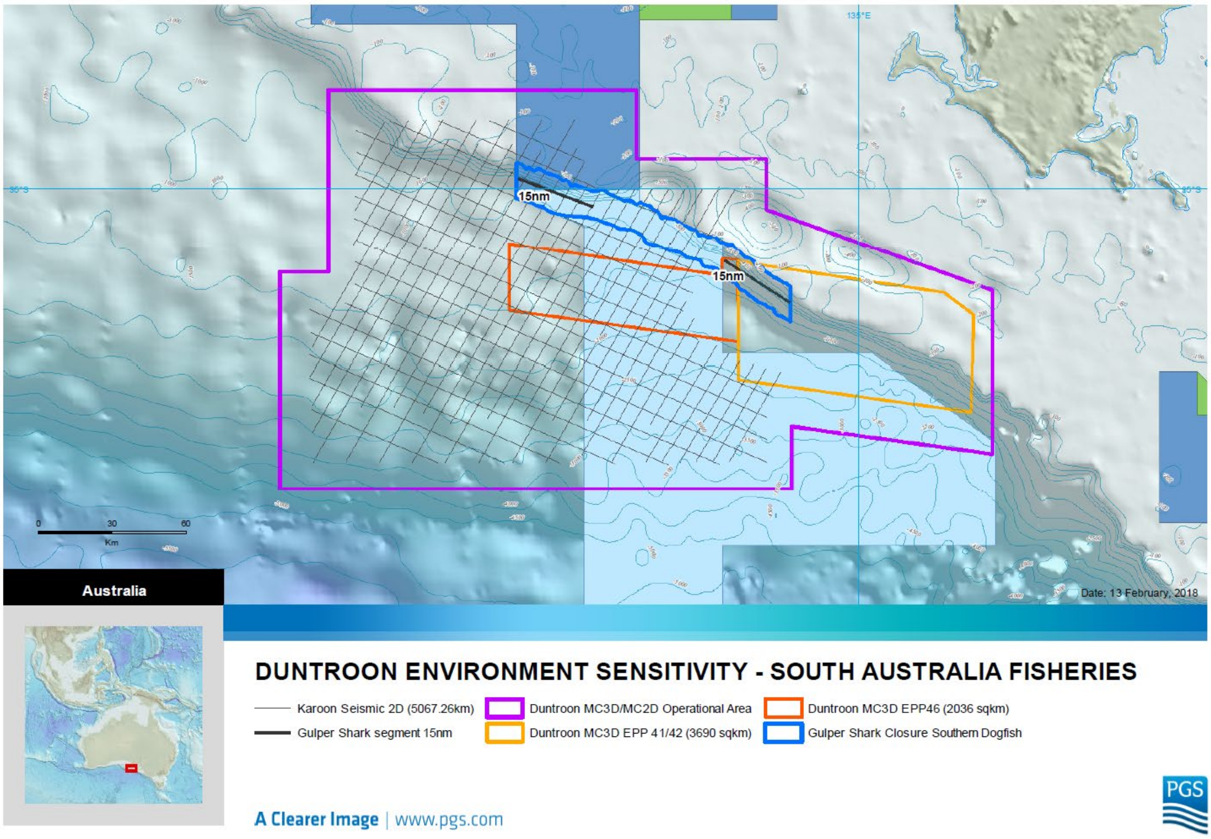
- *Other sharks:*

  Other elasmobranchs (migrating, demersal or pelagic) present in the Duntroon OA are wide-ranging within the bioregion with no critical areas are defined. Migratory sharks (shortfin mako, porbeagle) within the area are dispersed across the bioregion. As per the white shark assessment, any behavioural impacts to sharks are expected to be localised and temporary around the operational array (SLIGHT consequence).

- *Masking (Sharks):*

  Masking Impacts: In accordance with the Popper et al. (2014) risk criteria for masking in fish (particle motion detection only), a low risk of masking is expected at distances both near and far from the operating array. Accordingly, masking impacts to elasmobranchs are expected to be localised and temporary around the constantly moving survey vessel (SLIGHT consequence).

Figure 6-10: Modified MC2D seismic lines and MC3D polygon in EPP-46 to accommodate Gulper Shark Closure.



- *Tuna:*

  Migration: SBT juveniles migrate into the GAB in spring/summer with no evidence of specific or narrow migration pathways (i.e. juveniles are generally widespread in continental shelf waters (refer Section 3.7.4). SBT have a swim bladder however this is not involved in hearing (Type 2 fish - primarily particle motion detection).

  In accordance with the Popper at al (2014) guidelines, behavioural responses in Type 2 fish near the acoustic source is high with a low risk at far distance (thousands of meters). The Duntroon survey timing and OA does not overlap juvenile SBT presence in the eastern GAB. Any pelagic fish present has a low risk of behavioural disturbance ~kms from the operating array, and behavioural disturbance is very localised and temporary as the vessel is constantly moving and likely to affect only a small section of the free-ranging population at any one time.

  Evans et al (2017) identified that the timing of past geophysical surveys within the GAB had overlapped the spatial and temporal occurrence of juvenile SBT in the area. The direct measurement of spatial overlap had inherent errors estimating the position of juvenile SBT at exact times. The authors concluded that "*while some parameters could be identified as influencing the behaviour of juvenile SBT, which ones, and the strength and direction of the relationships, varied temporally and across individuals. This made identifying clear relationships between behaviour and environmental parameters difficult, suggesting that the drivers for behaviour of juvenile SBT are complex, and potentially interdependent and covarying in nature*". Further, the authors did observe that during geophysical surveys, at a broadscale, tagged juvenile SBT individuals remained in the broader vicinity of the GAB during survey periods and for individuals where observations are available across multiple years, the individuals continued to return to the GAB over the austral summer period.

On the basis of this evidence, this 'effects' distance of behavioural disturbance to SBT (if present), in the Duntroon OA during acquisition will be localised and temporary. Based upon the measured results of Evans et al (2017) the survey is not expected to create any barriers to migration or affect return migration to the eastern GAB fish (SLIGHT consequence).

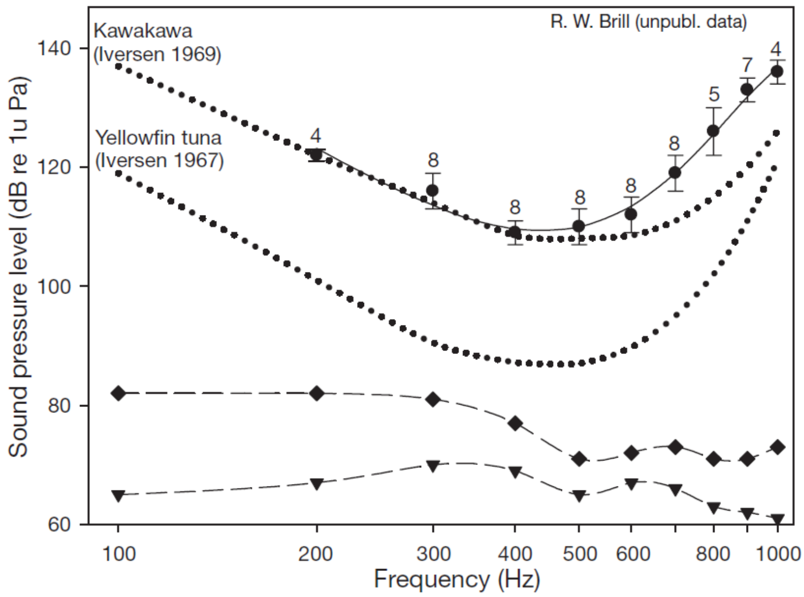
During consultation, ASBTIA [**Stakeholder Record 6**] raised concerns with a survey start time prior to April 1 due to potential conflict between SBT operations and survey activities. PGS initially committed to adopt the same conditions as agreed in the Bight Lightning EP by not commencing the survey prior to March 1 with a start location in the deeper water areas (well away from pontoon towing areas) during early March. PGS also increased the spatial buffer between towed pontoons and the operating array to 10 km from the agreed 3 km with Bight Petroleum to minimise disturbance to pontooned SBT. This distance was a conservative buffer and accommodated any potential behavioural effects to SBT. Further feedback from ASBTIA identified that any activity prior to April 1 was unacceptable as sound can create behavioural impacts in SBT for hundreds of kilometres and any seismic vessel operating closer than this to a pontoon under tow poses unacceptable risk (ASBTIA, 2017). ASBTIA also identified that the conditions negotiated with Bight Petroleum were now outdated and no longer relevant.

Feedback has been provided to ASBTIA of the altered survey timeframe (September 1 -November 30) to temporally separate survey activity with SBT presence, capture and pontooning on the continental shelf. ASBTIA has advised that the industry cannot support the seismic activity previously undertaken has created 'dead zones' within the GAB, has altered the traditional SBT fishing grounds at the HOB and compromises the ecosystem on which SBT are reliant. PGS considers the statement around 'creating dead zones' does not hold merit and has provided literature references to ASBTIA demonstrating SBT are foraging within its known geographic range (past and present). In addition, seismic activity has not physically modified the marine environment so as to alter conditions so biological resources, such as zooplankton and SBT, cannot be supported. The presence of zooplankton, a fundamental trophic level, is driven by metocean conditions and not influenced by intermittent sound which does not bioaccumulate. Instead of MSS activity, Eveson et al (2015) identified that the environmental varable which most influences SBT spatial distribution within the GAB is sea surface temperature. This information has been supplied to ASBTIA. PGS has not received a reply from PGS correspondence to ASBTIA dated 3rd October 2018 which conveyed this information.

Masking: Anatomical studies on the inner ear of several tuna species (Popper et al., 1981; Song et al., 2006) identified a lack of connection between the swim bladder and inner ear suggesting that tuna is primarily sensitive to the particle motion component of the sound field. Dale et al., (2015) identified in the Pacific bluefin tuna, the greatest sensitivity hearing was in the range 400-500 Hz in terms of particle motion (radial acceleration 88 dB re $1m/s^2$; vertical acceleration – 86 dB re $1m/s^2$) and sound pressure (83 dB re 1μPa) with sharp decreases in sensitvities at higher and lower frequencies (Dale et al, 2015). Compared to yellowfin tuna and kawakawa, Pacific bluefin tuna has a similar bandwidth of hearing and best frequency, but greater sensitivity overall, with the lowest sensitivity of the measured frequencies at 325 and 800 Hz (i.e. the frequency range tested[87]). This frequency range falls within the upper end of the spectrum for the species which lack a connection between the swim bladder and inner ear (Dale et al, 2015). Several species tested by Tavolga and Wodinsky (1963; cited in Dale et al, 2015) had best frequencies reported in the 400-600 Hz range. Inverson (1967, 1969) demonstrated that the yellowfin tina and kawakawa detect sounds in the range 50 – 1000Hz with the highest sensitivity within the range 300-500 Hz based upon behavioural responses (Southwood et al, 2008) (refer Figure 6-11).

[87] Results from this test method identifies that the results reported may reflect masked thresholds at some or all frequencies. The author reports that it is likely that there was little or no masking at 325 Hz as the variability of thresholds between individual measures compared to other frequencies was very small. Such small variability would not be found in an environment with fluctuating sound levels (Dale et al, 2015).

Figure 6-11: Hearing curve for yellowfin tuna recorded using auditory brainstem response (ABR) technique (solid line). Numbers above data points are numbers of yellowfin tuna from which data was obtained. The hearing curves from Iversen (1967; 1969) using behavioural means have been added for comparison. The dashed lines at the bottom of the graph show noise levels aboard the ship (diamond) and laboratory (triangles) where eht eexperinents were conducted (Southwood et al, 2008)



Movement of fish through water potentially has significant impacts on their ability to detect sound. As fish swim, water displacement caused by the fish produces a flow field around the body which can be either laminar or turbulent (Anderson et al 2001; in Dale et al, 2015). These boundary layer effects impact on the body both spatially and temporally fluctuating pressure and particle motion fields referred to as flow noise, which may mask important environmental sound stimuli to fish. Flow noise can be particularly problematic for fast swimming species such as tunas, as it increases rapidly with swimming speed (Urick, 1983; in Dale et al, 2015). Free swimming Pacific bluefin tuna swim at speeds that average 1 m/s or more (Blanke et al, 2007; in Dale et al, 2015) with maximum swimming speeds of 20 m/s (Wardle et al, 1989; Matcinek et al, 2001; in Dale et al, 2015).

Masking impairs an animal's hearing with respect to the relevant biological sounds normally detected within the environment. In effect, masking raises the threshold for detection by an animal. While the consequences of fish masking have not been fully examined, effects on survival, reproduction and population dynamics may result (Popper et al. 2014). Data on hearing for all vertebrates tested to date, including fish, show that the degree of masking relates both to the level of the masking noise and the frequencies it contains. In fish, pure tone sounds are masked most readily by noise at the same and immediate adjacent frequencies, falling within a critical band (Popper et al. 2014).

Masking may occur where a noise exceeds the absolute hearing thresholds of an animal and is likely to occur for most fish at some locations and times due to the varying level of background noise that occurs in all aquatic environments. Data on masking by seismic airguns are not available for any species, however masking is possible for the time that fish are exposed to airgun sound and may occur when animals are sufficiently far from the source where sounds merge and become more continuous (Nieukirk et al. 2004). Popper et al. (2014) surmised that "*It is likely that increments in background sound within the hearing bandwidth of fish may render the weakest sounds undetectable, render some sounds less detectable, and reduce the distance at which sound sources can be detected. Energetic and informational masking may increase as sound levels* *increase, so that the higher the sound level of the masker, the greater the masking".*[88] However, masking only occurs while the interfering sound is present, and therefore masking resulting from a single pulse of sound (such as an airgun shot) or widely separate pulses would be distinguishable and unlikely to significantly affect an individual's overall fitness and survival.

ASBTIA [**Stakeholder Record 6**] has identified a risk of the Duntroon survey masking navigational cues of the SBT based on the ambient acoustics of the region. This implies that SBT use acoustic cues for their migration, however this position is not scientifically supported, simply because it is extremely difficult to study and prove how tuna navigate. As previously identified, tuna do not have a high hearing sensitivity with their best hearing sensitivity in the range of 300-600 Hz (Dale et al, 2015; Southwood et al, 2008). The fish would have to rely on clearly audible acoustic cues in this frequency range for navigational purposes. The only known oceanographical feature producing sounds in this frequency range is wind and waves. If SBT had migratory routes which followed the coastline closely this assumption might support their use of 'navigational cues' but as a pelagic offshore species, the reliance on navigational cues shows little relevance. As determined by Eveson et al. (2015)[89], it's more likely that sea surface temperature (SST) is the key factor influencing their migration into the GAB.

This information has been supplied to ASBTIA. PGS has not received a reply from PGS correspondence to ASBTIA dated 3rd October 2018.

Note also, Ward et al (2006) support that largest catches of juvenile SBT are taken where SST are relatively high. Ward et al (2006) also suggest that juvenile SBT may migrate from the Western Wind Drift into the warm waters of the GAB during each summer-autumn to access the large quantities of lipid-rich sardines that are present in the region during the upwelling period. Nutritional analyses show that South Australian sardines have a reatively high lipid content (up to 6.8%) during summer-autumn, but that during the remainder of the year when productivity levels are low and comparable with other parts of Australia, the lipid content of local sardines is low, typically around 3% (D. Ellis, Australian Tuna Boat Owners Assocition, Adelaide, unpublished data; cited in Ward et al, 2006). This is not to suggest that sardines which have a dynamic sound spectrum between 400-550 Hz and 100-1400 Hz (Kuznetsov, 2009)[90] could be detected by tuna at long ranges as the source level of sardines wouldn't be strong enough to propagate over large distances. Moreover, these calls would not have any directionality to it and even at close range tuna would only be able to home in on pry by following a gradient (i.e. sound is getting louder).

In accordance with Popper et al (2014), a Type II fish has a *very low risk of masking* impact at any distance from the operational array given their anatomical makeup. If masking did occur mechanisms have been found in terrestrial animals and marine mammals which reduce the masking effect (i.e. 'masking-release' mechanisms) including: spatial or temporal release from masking, within-valley ('dip' – i.e. quieter gaps) listening or comodulation masking release (Erbe et al., 2016).

Masking impacts to SBT (or similar fish types) are expected to be localised and temporary given the constant movement of the vessel and the fish in the environmental setting (SLIGHT consequence).

- *Other Fish Species (pelagic):*

Behavioural Impacts: Pelagic Type 3 fish (swim bladder connected to hearing – sardines, herring) have a higher risk of behavioural response to sound at near/intermediate distances from the acoustic source with a moderate risk at far distances (thousands of meters). Based upon the

[88] Popper et al (2014) p18

[89] Eveson, J.P., Patterson, T.A., Hartog, J.R., Evans, K., 2018. Modelling surfacing behaviour of Southern Bluefin Tuna in the Great Australian Bight. Deep-Sea Research; DOI.org/10.1016/j.dsr2.2018.03.007

[90] Kuznetsov, M.Y (2009) – Traits of acoustic signalisation and generation of sound by some schoolong physostomius fish, Acoustic Physics, November 2009.

Popper et al (2014) criteria, these sound sensitive species (i.e. small pelagic fish) are expected to move away from the survey operations. However available studies on small pelagics identify that that seismic operations had an insignificant short-term scaring effects on herring (Slotte et al, 2004) and for feeding herring schools the approach of a seismic vessel to 2 km found no change in school size, swimming speed or direction (Pena et al, 2013). Given the presence of the small pelagic fishery/KEF in the area, if fish are consuming prey (plankton) for example during high-productivity upwellings, little behavioural change might be observed. If not consuming prey, more short-term scaring might occur. In both instances the behavioural changes are localised, temporary and recoverable (SLIGHT consequence).

- *Other Fish Species (demersal):*

  Behavioural Impacts: Przeslawski et al (2016) found little evidence of behavioural change across the demersal species studied during a seismic survey in Bass Strait, except flathead which exhibited an increase in swimming speed during the survey and a change in diel movement patterns after the survey. There was no significant difference in displacement (travel) across the monitored array. This is also supported by Millar and Cripps (2013) who found no significant effect on abundance or species richness of pomacentrid fish (high site fidelity) or non-Pomacanthidae fish (large demersal species with ability to flee and return when the disturbance had passed). Based on these non-captive studies, behavioural change in demersal fish is not expected to result in significant lateral displacement, however temporary behavioural modifications may occur during the survey (short-term and recoverable) (SLIGHT Consequence).

Masking: Popper et al. (2014) risk criteria identifies a low risk of masking in Type III fish at near and intermediate distances from the operating array, however at greater distances (~kms) there is a moderate risk of masking in these species. Given the oceanic nature of the Duntroon OA, the widespread area occupied by fish, the temporary nature of the activity and the constant movement of the survey vessel, only localised and temporary impacts would be present at any one location. Masking impacts given the movement of the survey vessel are expected to recover rapidly on this basis (SLIGHT consequence).

Summary:

- *Behaviour (Elasmobranchs):* Impacts to sharks are expected to be localised and temporary around the operational array (SLIGHT consequence).
- *Masking (Elasmobranchs – All):* Masking impacts are assessed as low risk for all ranges from an operating array. This may lead to incident effects in individual animals on a temporary and localised basis but is fully recoverable (SLIGHT consequence).
- *Behaviour (Tuna – Migrating):* Behavioural effects to migrating SBT are not expected due to the timeframe of the Duntroon survey. No barriers to migration are expected and any impacts, if present, would be incidental to the species (SLIGHT Consequence).
- *Behaviour (Tuna – Commercial Fishing Pontoons):* Pontooning activities on the continental shelf are not expected to coincide with the Duntroon survey timeframe.
- *Masking(Tuna):*Masking impacts are assessed as low at all ranges from an operating array. Impacts are expected to be localised and temporary [SLIGHTconsequence].
- *Behaviour (Other fish – Demersal & Pelagic):* Fish displacement or behaviour modification will be localised, temporary and recoverable within the OA. The OA is not present in an aggregation area nor does it overlap with identified spawning locations (SLIGHT Consequence).
- *Masking (Other fish):* Masking impacts are assessed as low risk for near and intermediate distances from the operating array and medium risk for far distances (~kms) for the most sensitive fish species. This may lead to temporary, localised effects to fish species present in the surrounding environment, effects are recoverable (SLIGHT consequence).

***Stock assessments (Indirect Impact)*:**

CSIRO SBT Stock Assessment Survey: A CSIRO SBT stock assessment is undertaken during the period January to March in selected years. As the Duntroon survey does not coincide with this timeframe, no impact to the CSIRO survey and associated stock assessments is predicted.

CSIRO **[Stakeholder Record 13]** expressed concerns with the potential risk of seismic survey operations affecting SBT behaviours in turn affecting CSIRO survey program outcomes (independent aerial surveys, gene-tagging abundance estimates, ability to find/tag fish); and disrupting purse seine fishing operations affecting the 'fishery dependent' index of abundance from commercial spotters and sampling operations for gene-tagging study. PGS has advised the CSIRO that the Duntroon survey will not be undertaken between January and March and the new timeframe of September 1 to November 30 will be adopted. PGS has not received a reply from PGS correspondence to CSIRO dated 17th July 2018 which conveyed this information.

GABTS Fishery Independent Survey: For proposed Duntroon survey activities in 2018, GABIA expressed concerns about interference with the 2018 FIS. The FIS area is located at least 86 km from the nearest Duntroon OA survey boundary. GABIA **[Stakeholder Record 3]** expressed concern relating Duntroon survey activities proceeding at the same time as the FIS. Previous experience associated with another MC3D survey in 2015 located closer and adjacent to the FIS area showed low stock levels in the FIS at that time and fishing catch declined after the survey. PGS has advised the GABIA that the Duntroon survey will not be undertaken between January and March and the new timeframe of September 1 to November 30 will be adopted. GABIA have not raised any issues or concerns with this revised timeframe. .

Commercial Fishing (Catch and Abundance Effects)

The potential impacts of seismic survey activities on commercial/recreational fisheries are:

- Localised and temporary exclusion of fishing operators from fishing grounds due to survey activities with the potential for decreases in catch/income (*refer to Section 6.9 – Disruption to Commercial Fisheries*); and
- Physiological or behavioural changes in target species resulting in altered catch in the short-term with impacts to associated income.

Commercial and recreational fisheries which operate within the Duntroon OA, their overlap area, target bathymetry within the overlap, number of licencees present and seasonality of fishing (where available) are detailed in Table 6-29.

The Charter Boat Fishery acts as the commercial platform for recreational fishing in the Duntroon OA. PGS has confirmed with local recreational fishing organisations that recreational fishing competitions do not extend into the OA area (refer GFCSA – **Stakeholder Record 71**].

Table 6-29: Commercial and Recreational Fisheries with Activity in the Duntroon OA (September to November)

Fishery	No Fishers	Species	Demersal / Pelagic	Fished Area overlap with Duntroon OA (km^2)	Target Bathymetry for Species (AFMA, 2018)	Area of Overlap on Bathymetry km^2	Peak Fishing Period
GAB Trawl Sector	<5 Licencees	Bight Redfish (T) Deepwater Flathead (T) Ocean Jacket (I)	Demersal Demersal Demersal	12,183 (lies to the west of the gulper shark closure)	Continental Shelf & Outer Margin (0-500 m) Continental Shelf & Outer Margin (70-490 m) Continental Shelf (0-200 m)	Rocky Reefs and mud substrates of upper slope [6] Area: 1,433	February to April October to December
Gillnet Hook and Trap Fishery (Shark)	< 5 Licencees	Elephant fish (I) Gummy Shark (T) Sawshark (I) School shark (I)	Demersal Demersal Demersal Demersal	648 (Gillnet) (<183m) 14,847 (Hook)	Continental Shelf (0-200 m) Continental Shelf & Outer Margin (80-350 m) Continental Shelf & Outer Margin (0-300 m) Continental Shelf & Outer Margin (0-300 m)	Shelf/slope environment (100-350m) Area (Gillnet 100-183m): 648 km^2 Area (Hook 100-350m): 7055 km^2	Fishing activity is centred around the lunar cycle (full moon) (pers.com S. Boag, 2018)
Gillnet Hook and Trap Fishery (Scalefish Hook)	< 5 Licencees	Blue-eye trevalla (T) Blue grenadier (T) Flathead (T) Gemfish (I) Jackass morwong (T) Ocean perch(T) Pink ling (T) Ribaldo (T)	Demersal/Pelagic Demersal/Pelagic Demersal Demersal/Pelagic Demersal Demersal Demersal Demersal	14,847	Continental Slope (200-900m) [6] Continental shelf/slope (200-700m) [6] Continental shelf/slope (100-490m) [6] Continental shelf/slope (100-700m) [6] Continental shelf/slope (100-400m) [6] Continental shelf/slope (100-750m) [6] Continental shelf/slope (100-800m) [6] Continental shelf/slope (500-1000m) [6]	Area (200-900): 1979 km^2 This area of overlap is assumed for all other depth ranges.	No information on the seasonal variation in scalefish hook fishery could be obtained. Assumed to be year-round
Westen Tuna and Billfish Fishery	<5 Licencees	Striper Marlin (T) Albacore Tuna (T)	Pelagic Pelagic	14,468	Continental slope/deepwater Continental slope/deep water	Deepwater areas (> 200 m): 10,699 km^2	No information on the seasonal variation in scalefish hook fishery could be obtained. Assumed to be year-round
Giant Crab Fishery	2 Miscellaneous Licences; 5 NRLZF Licences with allocations	Giant Crab (T)	Demersal	3703	Continental Shelf at (140 to 270 m)	Within MFA38 (140-270 m): 1,150	November 1 to May 31
Marine ScaleFish Fishery	< 5 Licencees	King George Whiting (T)	Demersal	3703	Range: Continental Shelf (0-200 m) [3]. Substrate: Coastal Reef, sand and weed bank substrates [2]	Within MFA38 (100-200m): 1,610	Season Feb-Oct; Higher fishing level May to Sept [1]
	< 5 Licencees	Snapper (T)	Demersal	3703	Continental Shelf (0-200 m) Substrate: Seabed features - Reef, oysters [4]	Within MFA38 (100-200m): 1,610	Season Jan – Oct; Higher Fishing Level Jan to July [1]
Sardine Fishery	5 (Est)	Sardine (T)	Pelagic	4940	Continental Shelf (0-200 m)	Within MFA38/26 (100-200m): 2,700	Nov/Dec - Starts Peak – March to June
Charter Boat Fishery	< 5 Licencees	Snapper (T)	Demersal		Continental Shelf (0-200 m)	Within MFA38/26 (100-200m): 2,700	All year

Fishery	No Fishers	Species	Demersal / Pelagic	Fished Area overlap with Duntroon OA (km^2)	Target Bathymetry for Species (AFMA, 2018)	Area of Overlap on Bathymetry km^2	Peak Fishing Period
		King George Whiting (T)	Demersal	4940	Continental Shelf (0 - 200 m)	Within MFA38/26 (100-200m): 2,700	Peak – December to April
		Bight Redfish (T)	Demersal		Continental Shelf & Outer Margin (0-500 m)	Within MFA38/26 (100-500m): 3,030	
		Silver Trevally (T)	Pelagic		Continental Shelf (10-230 m)	Within MFA38/26 (100-230m): 2,700	
		Southern Bluefin Tuna	Pelagic		Continental Shelf & Outer Margin (0-500 m)	Within MFA38/26 (100-500m): 3,030	

References:

1. Steer et al, 2018 2. Brown et al, 2013 3.Hyndes et al., 1998 4.M. Steer (SARDI) (pers com, February 2018) 5. AFMA, 2018 6. Kailola et al, 1994

Relevant Research:

Some effort to relate fishing catch data to seismic survey effort has been undertaken, but to date no Australian studies undertaken to relate catch data with seismic survey activity have yielded results of any meaning. Elsewhere, the potential effects of seismic operations on fish distribution, local abundance or catch has been examined for some teleost species with varying results (Carroll et al., 2017).

A range of response behaviours has been observed on the behaviour of wild fish in the presence of anthropogenic sound. Studies suggest that fish will generally move away from a loud sound source to minimise their exposure, but this response may depend upon the animal's motivational state. Anthropogenic sound (including seismic surveys) has been shown to cause changes in schooling patterns and distribution (Engas et al., 1996; Engas and Lokkeborg, 2002; Slotte et al., 2004; Lokkeborg et al., 2012a, 2012b; Popper at al., 2014; Streever et al, 2016). This can potentially reduce the availability of commercially valuable species or recreationally targeted species.

The following studies have relevance to behavioural impacts on fish species with respect to their catchability:

- The effects of seismic activity on demersal long-line and trawl catch rates of Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) in Norway in an area exposed to seismic were shown to fall by 45% and 70% respectively five days after survey completion (Engas et al., 1996). Based upon this decline Engas et al. (1996) hypothesised a reduction in catch rates due to fish avoidance behaviour, but this was not quantified. Similar reductions in catch rates (52% decrease in catch per unit effort (CPUE)) relative to controls) has been observed in the hook-and-line fishery for rockfish during controlled discharges of a single airgun (Skalaski et al. 1992). The authors suggest that the CPUE decline may not be dispersal but a decreased responsiveness to baited hooks from alarm response behaviour. A companion behavioural study showed the alarm and startle responses were not sustained following the removal of the sound source (Pearson et al., 1992; Skalski et al, 1992) suggested fishing effects may be transitory, primarily occurring during the sound exposure.
- Lokkeborg et al. (2012) observed following airgun exposure, gillnet catches increased substantially for redfish (*Sebates norvegicus*) and Greenland halibut (*Reinharditius hippoglossoides*) by 86% and 132% respectively compared with preshooting levels, while longline catches of Greenland halibut and haddock decreased by 16% and 25% respectively compared with pre-survey catch. These contradictory results were explained by greater swimming activity versus lowered food search behaviour in fish exposed to air-gun emissions. Changes in catch rates of all species studied including saithe and ling found all species responded to air-gun sounds. Except for saithe (a pelagic more hearing sensitive fish), acoustic mapping of fish abundance did not suggest displacement from fishing grounds.
- Sonar observations by Pena et al. (2013) observing real-time behaviours of herring schools, a pelagic fish, exposed to an acoustic source approaching from 27 km to 2 km over a two-hour period found no changes observed in school size, swimming speed or direction. The lack of response was interpreted as a combination of a strong motivation for feeding, a lack of suddenness of the airgun stimulus and an increased tolerance to seismic shooting.
- Przeslawski et al. (2016) in catch studies undertaken as part of a seismic survey in the Gippsland Basin found no clear evidence of adverse effects on scallops, fish or commercial catch rates. The study followed 15 species caught by Danish seine and demersal gillnet and identified in the six months which followed the survey, six species showed increased catch (Danish Seine: tiger flathead, goatfish, elephantfish; Demersal Gillnet: boarfish, broadnose shark and school shark) and three species showed decreased catch (Danish Seine: gummy shark, red gurnard, sawshark). No change was observed in the remainder of species. No change to gummy shark catch was observed for demersal gillnet catches. These results support previous studies in which the effects of seismic surveys on catch seem transitory and vary among species and gear types.

Accordingly, the effect of seismic on catch and abundance varies by fish type and capture method. Most studies identify that the effects of the survey are transitory, if the effects are measured at all.

Extent and Duration of Exposure and Identified Potential Impact:

Predicted Impacts:

Table 6-27 provides an impact assessment for each active fishery within the Duntroon OA with respect to possible exclusion impacts (lost catch due to access) and for the target species within the fishery and possible effects on the species catchability.

From available fish catchability studies, the effects of seismic surveys on catch vary among studies, species, and gear types. Engås et al. (1996) hypothesised that the reduction in Atlantic cod and haddock catch rates from commercial longlines and trawls was most likely the result of fish moving away from the seismic area due to avoidance behaviour, but this may instead be due to decreased responsiveness to baited hooks associated with an alarm behavioural response (Skalski et al. 1992) or impacts related to fishing the same area for over two weeks. Most other studies on fish have found positive, inconsistent, or no effects of seismic surveys on catch rates or abundance (Løkkeborg et al. 2012, Miller and Cripps 2013, Peña et al. 2013, Thomson et al. 2014; Przeslawski et al. 2016). It appears likely that the effects on fishing may be transitory, primarily occurring during the sound exposure itself (Skalski et al. 1992; Przeslawski et al. 2016; Woodside, 2008; Pena et al, 2013).

Given the low level of fishing within the Duntroon OA, and as assessed in Table 6-30, abundance impacts to fish within the OA are expected to be localised, temporary and recoverable soon after acquisition is complete. Landed catch and catchability will vary according to capture method and target species. The low catch taken within the Duntroon OA for the fisheries active in the area does not contribute significant amounts to the overall catch within the fishery (i.e. other areas within the fishery are more productive). Fishing areas within the OA do not contain unique features for fish habitat, fishermen have access to other areas within the fishery (i.e. OA is not limiting and non-exclusive fishing rights), the Duntroon OA does not block access to other fishing areas and other more productive areas are generally closer to port. Catchability impacts to this small portion of the total catch, while considered temporary, localised and recoverable, is not expected to be significant given the other catch areas the fishermen can access. Impacts associated with catchability within the OA is assessed as having a slight to negligible effect on commercial and recreational fishing values in the OA (SLIGHT consequence).

Consultation Feedback:

Consultation feedback from the SPFIA **[Consultation Record 60]** has advised that due to the limited vessels (1) now operating in the fishery, fishing effort will be concentrated in southern NSW waters (based at Bermagui). The Duntroon survey activity is not expected to impact on catch within this fishery.

The SSIA **[Consultation Record 61]** has advised that GH&T (hook) fishermen may be present. Information was provided to SSIA on the known GH&T activity in the area as requested. No response has been made to the information provided.

Industry associations SASIA **[Consultation Record 8]** and Charter Boat Fishery **[Consultation Record 55]** have been consulted on the proposed survey activities. No feedback has been provided by the Charter Boat Fishery Industry Association. SASIA has advised of concerns associated with spatial overlap of stock assessment surveys which occur if the survey proceeded in mid-March and with concerns on possible impact of seismic in spawning areas (refer to *plankton impacts*). SASIA has also noted the limited likely impact on actual fishing activity within the fishery. SASIA has been advised of the altered timeframe for the survey between September 1 and November 30. PGS has not received a reply from the PGS correspondence to SASIA dated 20th July 2018 which conveyed this information

Table 6-30: Impacts Assessment to Commercial and Recreational Fisheries which overlap the Duntroon OA

Fishery	Fishery Exclusion Potential – Assessment (see Section 6.9 – Spatial Conflict)	Fishery target species catchability - Assessment.
GAB Trawl Sector	Level of Catch affected by survey: 9.5% catch (Target: Flathead. Total catch affected by survey – 52 t (flathead)). Target catch taken Oct-Dec or 17 t/mth. For October-November period: 35 t (total) Number of Licencees: 5 Highly Productive Area: No. Productive area is on shelf/slope at HOB (> 86 km from OA). Period of Fishing: Operates year-round; Deepwater Flathead target (October to December) Target Bathymetry: Demersal between 70-490 m (use of shelf-break west of gulper shark closure with the OA only). Marginal overlaps with MC2D survey lines only. Potential Fishing Overlap with Duntroon Survey: Predominantly **October/November** (western MC2D shelf areas) Consultation Outcomes: Contact with GABIA has not identified any issues or concerns with the altered survey timeframes (**Stakeholder Record 3**).	Target Species: Flathead (during survey period) Method: Demersal Trawl: Available research: • Following exposure to seismic, tiger flathead catches increased (Przeslawsk et al (2016)). • Demersal trawl catches rates of Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) in Norway in an area exposed to seismic were shown to fall by 45% and 70% respectively five days after survey completion Engas et al. (1996). • Companion behavioural studies to a fish catch study into the demersal rockfish (Skalski et al, 1992) identified that alarm and startle responses were not sustained following the removal of the sound source (Pearson et al, 1992) suggesting that the effects on fishing may be transitory. Potential for localised, short-term increases/decrease to catch post-seismic. IMPACT: Localised, temporary catch increase impact (SLIGHT consequence).
	SUMMARY IMPACT: Duntroon OA has low fishing effort (< 5 licencees) with more productive grounds located at the HOB. October-November is within the capture season for flathead, however the level of catch affected within the Duntroon OA is small (9.5% catch). Fishery met 48% of the TAC in previous season. Fishery unlikely to be significantly impacted given presence of MC2D survey. If fishermen are temporarily excluded from fishing in the OA, displacement will be to more productive areas. OA is not located close to shore (does not block access). Fish abundance may not decrease given the demersal nature of target species. Catchability may alter on a temporary and localised basis given the equipment used by the GAB trawl sector and available research. However, catch and abundance impacts are likely to be localised, temporary and recoverable in a low productivity area of rthe fishery (SLIGHT consequence).	

<table>
<tr><th>Fishery</th><th>Fishery Exclusion Potential – Assessment (see Section 6.9 – Spatial Conflict)</th><th>Fishery target species catchability - Assessment.</th></tr>
<tr><td rowspan="2">Gillnet Hook and Trap Fishery (Shark)</td><td><u>Level of Catch affected by survey:</u> 3.8% catch (Target: Gummy Shark. Total Catch affected: 61 t over 12-month period or 5 tonnes per month).
<u>Number of Licencees</u>: Assume 5 (area is nominated confidential).
<u>Highly Productive Area</u>: No – productive area is Bass Strait (Gillnet) and Robe (Hook)
<u>Period of Fishing</u>: No seasonal distribution (Fishing around lunar cycle – full moon)
<u>Target Bathymetry</u>: Demersal between 80-350 m. Overlaps with MC3D and MC2D survey area.
<u>Potential Fishing Overlap with Duntroon Survey</u>: September/October/November on shelf, shelf break and slope
<u>Consultation Outcomes</u>: Contact with SSF (Stakeholder Record 20) and SSIA (Stakeholder Record 61) has not raised any key issues with the survey or the location with respect to fishing catch. SSIA identified that hook fishermen may be present in the OA. Information gas been sent to hook fishermen (Stakeholder Record 77, 78 and 79) with no response to date. No response has been forthcoming from SSF.
Note: Gillnet fishermen cannot fish in water depths greater than 183 m and a closure to protect sea lions in the shelf area west of a line directly south of Port Lincoln to the shelf-break and east of a south-westerly line from Elliston to the shelf break will prevent gillnet fishermen fishing in the OA until at least 9 March 2019.</td><td><u>Target Species</u>: Gummy shark (during survey period)
<u>Method</u>: Demersal gillnet and hook:
<u>Available research</u>:
• Following exposure to seismic, gillnet catches increased substantially for demersal species by 86-132% and longline catches decreased by 16-25% compared with pre-survey Lokkeborg et al (2012).
• Przeslawski et al, 2017 observed that gummy shark catches decreased by Danish seine capture and no impact to catch from demersal gillnet in six months following a seismic survey in Bass Strait. In a review of historic catch rates and seismic surveys in Bass Strait, no effect could be found on catch rates or abundance of gummy shark with seismic activity however the long-term nature of the study may have masked immediate or short-term effects (Thompson et al, 2014; cited in Carroll et al, 2017).
Potential for short-term decrease by hook fishermen based upon long-line results.
<u>IMPACT</u>: Possible localised, temporary catch decrease by hook fishermen (SLIGHT consequence).</td></tr>
<tr><td colspan="2"><u>SUMMARY IMPACT:</u>
Duntroon OA has low GH&T (Gillnet and Hook) (shark) fishing effort (< 5 licencees) with other more productive fishing areas (Robe – Hook; Bass Strait – gillnet) available. Advice is that the fishery is non-seasonal, instead around the lunar cycle. There are substantial closures for gillnet fisheries within the Duntroon OA to protect endangered species (sea lion) and fishing has moved to the south-east where closures do not exist. If fishermen are temporarily excluded from the Duntroon OA, effort is likely to displace to more productive areas, closer to port facilities. TACs in fishery are not usually met.
Fish abundance/catchability may decrease on a temporary and localised basis in a non-productive area of the fishery (SLIGHT consequence).</td></tr>
</table>

Fishery	Fishery Exclusion Potential – Assessment (see Section 6.9 – Spatial Conflict)	Fishery target species catchability - Assessment.
Gillnet Hook and Trap Fishery (Scalefish Hook)	<u>Level of Catch affected by survey:</u> 4.3% catch (Target, based on largest catch in area): • Blue-eye trevalla. Total Catch affected: 11.8 t over 12 months (1 t/mth). • Pink Ling. Total Catch affected: 12.8 t over 12 months (1.1 t/mth) <u>Number of Licencees</u>: Assume 5 (area is nominated confidential). <u>Highly Productive Area</u>: No – productive area is eastern Tasmania <u>Period of Fishing</u>: No seasonal distribution identified <u>Target Bathymetry</u>: Demersal between 200-900 m. Overlaps with MC3D and MC2D survey area. <u>Potential Fishing Overlap with Duntroon Survey</u>: **September/October/November** on shelf break and slope <u>Consultation Outcomes</u>: Contact with SSF (**Stakeholder Record 20**) and SSIA (**Stakeholder Record 61**) has not raised any key issues with the survey or the location with respect to fishing catch. No response has been forthcoming from SSF.	<u>Target Species</u>: Blue-eye trevalla, pink ling <u>Method</u>: Demersal hook: <u>Available research</u>: • Demersal long-line in Norway in an area exposed to seismic were shown to fall by 45%-70% respectively five days after survey completion (Engas et al., 1996). • Similar reductions in catch rates (52% decrease in catch per unit effort (CPUE)) relative to controls) has been observed in the hook-and-line fishery for rockfish during controlled discharges of a single airgun (Skalaski et al. 1992). The authors suggest that the CPUE decline may not be dispersal but a decreased responsiveness to baited hooks from alarm response behaviour. A companion behavioural study showed the alarm and startle responses were not sustained following the removal of the sound source (Pearson et al., 1992; Skalski et al, 1992) suggested fishing effects may be transitory, primarily occurring during the sound exposure. Potential for short-term decrease by hook fishermen based upon long-line results. <u>IMPACT</u>: Possible localised, temporary catch decrease by hook fishermen (SLIGHT consequence).
	<u>SUMMARY IMPACT:</u> Duntroon OA has low GH&T (scalefish hook) fishing effort (< 5 licencees) with other more productive fishing areas (eastern Tasmania) available. Advice is that the fishery is non-seasonal. If fishermen are temporarily excluded from the Duntroon OA, effort is likely to displace to more productive areas, closer to port facilities. TACs in fishery are usually met for blue-eye trevalla. Fish abundance/catchability may decrease on a temporary and localised basis in a non-productive area of the fishery (SLIGHT consequence).	
Giant Crab Fishery	<u>Level of Catch affected by survey:</u> ~1.85 t based upon 7-month season or 0.26 t/mth (Note overlap is at end of season where catches are lower) <u>Number of Licencees</u>: 2 dedicated fishermen for giant crab. Five other NZRLF licences with giant crab entitlements (fish closer to shore). <u>Highly Productive Area</u>: No – productive area is south of Kangaroo Island. Catch is confidential in Duntroon OA <u>Period of Fishing</u>: 1 November to 31 May <u>Target Bathymetry</u>: Demersal between 140-270 m. Overlap with MC3D survey area. <u>Potential Fishing Overlap with Duntroon Survey</u>: **November** on shelf, shelf break and slope <u>Consultation Outcomes</u>: Contact with individual crab fishermen has indicated no key issues with the survey or the location with respect to fishing catch (only sustainability of the fishery). Spatial conflict has been raised by one fisherman who fishes within the OA during April. The revised Duntroon survey timeframe has been provided to the fishermen and no issues have been raised for the November timeframe.	<u>Target Species</u>: Giant Crab <u>Method</u>: Demersal crab pots <u>Available research</u>: • Studies undertaken into the effects of MSS activity on the catchability of snow crab species (Morris et al, 2017; refer Table 6-18) found MSS activity did not negatively affect catch rates in the short term (within days) or longer timeframes (weeks). Significant differences were found in catch across study areas and study years. These results suggest that if seismic effects on snow crab harvests do exist, their magnitude is smaller than changes related to natural spatial and temporal variation (Morris et al, 2017). • Christian et al (2003) observed that CPUE was greater post-MSS survey and field animals did not leave the study area after exposure to seismic sound. No expected change in catch (within seasonal variances) within the Duntroon OA from seismic activity predicted. <u>IMPACT</u>: No measurable change in catch (SLIGHT consequence).

Fishery	Fishery Exclusion Potential – Assessment (see Section 6.9 – Spatial Conflict)	Fishery target species catchability - Assessment.
	SUMMARY: Duntroon OA has low Giant crab fishing effort (MFA-38 < 5 licencees) due to the small nature of the fishery. November is within the fishing season with catch rates high between November and Januray, declining thereafter. If fishermen are temporarily excluded from fishing in OA, displacement will be to more productive areas, OA is not located close to shore (does not block access). No expected catch effects are predicted, based upon available research for giant crab (SLIGHT consequence)	
Marine ScaleFish Fishery	**Whiting**: Level of Catch affected by survey: ~0.32 t based upon 9-month season or 0.036 t/mth Number of Licencees: Assume 5 (area is nominated confidential). Highly Productive Area: No – productive area is within Gulfs and in coastal areas on West Coast. Catch is confidential in Duntroon OA Period of Fishing: February to October. Higher fishing levels – May to September Target Bathymetry: Demersal between 100-200 m. Overlap with MC3D survey area. Potential Fishing Overlap with Duntroon Survey: **September/October** on shelf Consultation Outcomes: Contact with MSF has not yielded any key issues with the survey or the location with respect to fishing catch.	Target Species: King George Whiting (demersal) Method: Demersal Handline Available research: • Following exposure to seismic to demersal species longline catches decreased by 16-25% compared with pre-survey Lokkeborg et al (2012). • Companion behavioural studies to a fish catch study into the demersal rockfish (Skalski et al, 1992) identified that alarm and startle responses were not sustained following the removal of the sound source (Pearson et al, 1992) suggesting that the effects on fishing may be transitory. Potential for short-term decrease to line capture of whiting. IMPACT: Localised, temporary catch decrease impact (SLIGHT consequence).
	SUMMARY IMPACT: Duntroon OA has low King George whiting fishing effort (MFA38 < 5 licencees). September is within the higher capture season, however the level of catch affected within the Duntroon OA is very small (0.01% catch) with fishing areas within the gulf areas and along the west coast more productive. If fishermen are excluded from MFA-38, fishermen will be displaced to more productive areas, closer to port facilities and the Duntroon OA does not prevent a barrier to accessing those areas, hence a negligible impact to catch. Fish abundance may decrease on a temporary and localised basis. Reduced CPUEs are likely to be associated with behavioural impacts interacting with fishing equipment (SLIGHT consequence).	
	Snapper: Level of Catch affected by survey: ~0.38 t based upon 10-month season or 0.038 t/mth Number of Licencees: Assume 5 (area is nominated confidential). Highly Productive Area: No – productive area within Gulfs. Catch is confidential in Duntroon OA. Period of Fishing: January to October. Higher fishing levels – January to July Target Bathymetry: Demersal between 100-200 m. Overlap with MC3D survey area. Potential Fishing Overlap with Duntroon Survey**: September/October** on shelf Consultation Outcomes: Contact with MSF has not yielded any key issues with the survey or the location with respect to fishing catch.	Target Species: Snapper (demersal) Method: Demersal Handline/longline Available research: • Following exposure to seismic to demersal species longline catches decreased by 16-25% compared with pre-survey Lokkeborg et al (2012). • Companion behavioural studies to a fish catch study into the demersal rockfish (Skalski et al, 1992) identified that alarm and startle responses were not sustained following the removal of the sound source (Pearson et al, 1992) suggesting that the effects on fishing may be transitory. Potential for short-term decrease to line capture of snapper. IMPACT: Localised, temporary catch decrease impact (SLIGHT consequence).

<table>
<tr><th>Fishery</th><th>Fishery Exclusion Potential – Assessment (see Section 6.9 – Spatial Conflict)</th><th>Fishery target species catchability - Assessment.</th></tr>
<tr><td>Marine ScaleFish Fishery</td><td colspan="2">SUMMARY IMPACT:
Duntroon OA has low snapper fishing effort (MFA38 < 5 licencees). September & October are not within the higher capture season and the level of catch affected within the Duntroon OA is very small (0.1% catch) with fishing areas within gulf areas more productive. If fishermen are excluded from MFA-38, fishermen will be displaced to more productive areas, closer to port facilities and the Duntroon OA does not prevent a barrier to accessing those areas, hence a negligible impact to catch.
Fish abundance may decrease on a temporary and localised basis, however reduced CPUEs are likely to be associated with localised behavioural impacts interacting with fishing equipment (SLIGHT consequence).</td></tr>
<tr><td rowspan="2">Sardine Fishery</td><td>Sardine:
Level of Catch affected by survey: ~342 t/mth (spatial) or 5 t/mth based upon actual catch data within Duntroon survey area (all distributed over a 10-month season)
Number of Licencees: Assume 5
Highly Productive Area: No – productive area within Spencer Gulf and West Coast. Catch is confidential in Duntroon OA (MFA-36) and low catch in MFA-26.
Period of Fishing: October to June (9 months). Higher fishing levels – March to June
Target Bathymetry: Pelagic between 100-200 m. MFA-38: Overlap with MC3D survey area. MFA-26: Marginal overlap with MC2D lines (predominantly in vessel turning area).
Potential Fishing Overlap with Duntroon Survey: October/November on shelf
Consultation Outcomes: Contact with SASIA has not yielded any key issues with the survey, or the location with respect to fishing catch. Key concerns have been expressed over interference with spawning grounds and egg survey in March (now resolved).</td><td>Target Species: Small pelagic fish (sardine, mackerel, redbait)
Method: Purse seine
Available research:
• No evidence of short-term scaring on migrating pelagic fish a horizontal scale but some evidence of vertical displacement during line acquisition (Slotte et al, 2004). No changes to behaviour of feeding herring at 2-25 km from an operating array over a six-hour period (Pena et al, 2013). Migrating pelagic fish densities higher at about 20nm from the centre of the shooting area (Slotte et al, 2004).
• Habituation to sound has been observed within these species (Olsen et al, 1976; Dalen, 1973, Platch and Popper, 2003: cited in Pena et al, 2013).
• Lokkeborg et al (2012) observed meso-pelagic fish during acquisition and identified lower abundance during acquisition than before or after shooting (25 days after acquisition ceased). Herring catch displayed a falling trend throughout the survey.
Potential for displacement of pelagic species during acquisition depending upon context (feeding, migration) however evidence of limited horizontal displacement and habituation to sound. Impacts within the OA is expected to be temporary.
IMPACT: Localised, temporary catch reduction impact (SLIGHT consequence).</td></tr>
<tr><td colspan="2">SUMMARY IMPACT:
Duntroon OA has low sardine fishing effort (MFA38 < 5 licencees; MFA28 – marginal overlap with MC2D acquisition). September is not fished within the fishery and October/ November are not within the peak sardine capture season, however the level of catch affected within the Duntroon OA is very small (1% catch (spatial); 0.02% actual) with fishing areas closer to ports more productive. If fishermen are excluded from MFA38 and MFA28 (overlap), fishermen will be displaced to more productive areas, closer to port facilities and the Duntroon OA does not prevent a barrier to accessing those areas, hence a negligible impact to catch.
Fish abundance may decrease on a temporary and localised basis. If this occurs, displacement of fish, given the OA lies at the outer limit of the fishery would only lead to displacement of fish inshore into more productive fishing areas. Therefore, while abundance effects within the OA may decrease on a temporary basis, this may assist catch in other areas. Catch and abundance impacts will have only a SLIGHT consequence.</td></tr>
</table>

<table>
<tr><th>Fishery</th><th>Fishery Exclusion Potential – Assessment (see Section 6.9 – Spatial Conflict)</th><th>Fishery target species catchability - Assessment.</th></tr>
<tr><td rowspan="2">Charter Boat Fishery</td><td><u>Level of Catch affected by survey (Monthly Basis: Catch taken Dec-Apr (peak season)):</u>
- Snapper ~0.16t (103 Fish) (total season); Monthly catch 0.032 t (21 Fish);
- King George whiting ~0.06t (225 Fish) (total season); Monthly catch 0.012 t (45 Fish);
- Bight redfish ~0.28t (451 Fish) (total season); Monthly catch 0.056 t (90 Fish);
- Silver Trevally ~0.007t (26 Fish) (total season); Monthly catch 0.0014 t (5 Fish);
- SBT ~1.64t (113 Fish) (total season); Monthly catch 0.033 t (23 Fish);
<u>Number of Licencees</u>: 5 (Fishing is confidential within OA)
<u>Highly Productive Area</u>: No – productive area is within Gulfs and around Kangaroo island. Catch is confidential in Duntroon OA (MFA-36 [overlaps MC3D survey]) & low catch in MFA-26 ([little MC2D survey acquisition in MFA, overlap largely within vessel turning area].
<u>Period of Fishing</u>: Fishery active all year (peaks December to April)
<u>Target Bathymetry</u>: Primarily shelf area to 200m.
<u>Potential Fishing Overlap with Duntroon Survey</u>: September/October/November on shelf
<u>Consultation Outcomes</u>: Contact with Charter Boat Fishery Industry Association has not resulted in any feedback. No concerns with location or timeframe of survey expressed.</td><td><u>Target Species</u>: Demersal (Snapper, King George whiting, Bight redfish) and Pelagic (Silver Trevally, SBT)
<u>Method:</u> Within OA – Rod and Reel
Refer to MSF – King George whiting and snapper assessment for impacts to these target recreational species
<u>Available research</u>:
• Refer to pelagic studies contained within the small pelagic fishery assessment for silver trevally and SBT;
• Lokkeborg et al (2012) observed a decrease in longline catches of demersal species after seismic compared with pre-shooting.
• Companion behavioural studies to a fish catch study into the demersal rockfish (Skalski et al, 1992) identified that alarm and startle responses were not sustained following the removal of the sound source (Pearson et al, 1992) suggesting that the effects on fishing may be transitory.
Potential for displacement of pelagic species during acquisition is possible however evidence of limited horizontal displacement and habituation to sound. Given pelagic species are not site attached displacement from survey area is expected to be temporary.
Potential for short-term decrease to line capture of demersal snapper, King George whiting and Bight redfish.
<u>IMPACT</u>: Localised, temporary catch reduction impact (SLIGHT consequence).</td></tr>
<tr><td colspan="2"><u>SUMMARY IMPACT:</u>
Duntroon OA has low CBF fishing effort (< 5 licencees) and has an estimated 1.1% of the fish caught in the CBF. The OA does not contain any bathymetric features which would attract target species (aggregations over islands), is a long distance from ports with other more productive grounds located closer to port and more productive (e.g. barrier islands, etc.) (as evidenced by game fishing competitions not entering open seas but remaining around barrier islands – GFASA Stakeholder Record 71). In reality, if fishermen are excluded from the OA during seismic activities, they will move to the more productive grounds. CBF activity is decreasing in the April/May period.
In the unlikely situation that CHF fishermen fish within the survey area after acquisition the fishermen may experience localised temporary reduction in fish species in the short-term (SLIGHT consequence).</td></tr>
</table>

Consultation feedback from GABIA **[Consultation Record 3]** identified that target demersal species took a downturn after the Ceduna MC3D survey during 2015. GABIA, when the Duntroon survey was planned for March to May, requested that no survey activity occurs in the period November 2017-April 2018 to manage potential impacts and risks to the fishery to ALARP and acceptable levels; to ensure operational timeframes do not impact on the activities of the GAB trawl fishery (refer Section 6.9); and opposed any MSS work in the GAB before 1 April in FIS years to protect TACs.

PGS notes that the 2015 MSS activity was located close to or overlapped the primary HOB fishing zones for this fishery located between 126ºE and 133ºE where fish catch was affected. PGS has discussed this issue with GABIA and has risk assessed possible impacts to the productive fishing grounds at the HOB fishery location. The Duntroon OA is located at least 86 km from these key fishing grounds and effects to fish catchability and abundance from the survey activity at the HOB fishing area is considered extremely low based on available science (Popper et al, 2014; Przeslawsk et al (2016); Engas et al. (1996; Skalski et al, 1992, Pearson et al, 1992). PGS has provided information to the GABTS associated with the revised timeframes of acquisition which avoids temporal conflicts with FIS activities.

GABIA, based upon the revised September 1 to November 30 timeframe for the Duntroon survey, which does not temporally or spatially overlap the FIS, has not expressed any issues or concerns with the proposed survey (**Stakeholder Record 3**).

Summary:

<u>Consequence</u>: Refer to Table 6-28 for an assessment of abundance and catchability impacts to each fishery present in the OA. Catchability impacts to this small portion of the catch, while considered temporary, localised and recoverable, are assessed as having a slight to negligible effect on the total catch of fishermen and to commercial and recreational fishing values in the OA (SLIGHT consequence).

Table 6-31: Assessment of possible controls to reduce impacts to fish and stock assessment surveys

Control Measure	Practicable?	Will it be Implemented?	Justification
EPBC Policy Statement 2.1 (Part A): Implement soft-start procedures to alert fish species of pending survey activities and allow displacement.	YES	YES	Control measure adopted to limit impacts to all sensitive sound species.
Spatial Separation: Do not undertake seismic acquisition activities within gulper shark closure area.	Partial	Yes	MC2D survey lines are required within this closure area to provide full coverage of the permit area. Seismic lines in this area have been eliminated to the extent practicable while still allowing for acquisition objectives to be achieved. MC3D survey operations within the gulper shark area in EPP-46 has been eliminated to prevent repeated sound exposure to gulper sharks and the potential for disruption to breeding.
Spatial Separation: Do not undertake survey activities in the northern OA which overlaps the Ancient Coastline KEF.	Yes	Yes	While the area impacted from 2D survey activities is not substantial within this KEF, a review of MC2D lines in this area has determined that they can be eliminated without compromising survey objectives. This eliminates injury impacts to demersal fish in this KEF.
Spatial Separation: Do not undertake survey activities in the northern OA which overlaps the White Shark BIA	No	No	MC2D survey lines have been eliminated within the KEF to protect demersal fish, however extension to the BIA overlaps starts to compromise survey objectives. Given the potential to injure sharks species is low, plus the low encounter rate of the species expected at the edge of this BIA, elimination of survey lines within the BIA would not result in a significant environmental impact reduction.
Temporal Separation: No survey activities between January and April to prevent disruption to CSIRO SBT surveys; GABTS FIS surveys and SASIA egg count surveys.	Yes	Yes	The Duntroon is programmed to commence in September to November 2019/20. This timeframe eliminates impacts to fishery surveys.
Temporal Separation: Given the giant crab fishing activities present in April/May on the shelf environment, exclude these areas from the survey.	No	No	The shelf break and slope area is a key target for the MC3D survey and cannot be removed from the survey plans. Not practicable.

Control Measure	Practicable?	Will it be Implemented?	Justification
Access Arrangements for Fisheries: Communicate pending survey activities to fisheries affected by survey activities to allow for harvest in Duntroon OA prior to acquistion activities (if allowed by fishing season closures).	Yes	Yes	Adoption of management protocols to allow for fishermen to access stock in the Duntroon OA is considered a suitable method to maintain CPUE and total catch from the area. As no issues have been raised by fisheries/fishermen who actively fish in the survey area associated with the proposed timeframe September – November, PGS is uncertain whether this proposed measure offers benefit. PGS will notify fishermen at least one month prior to survey mobilisation to allow for pre-fishing area prior to survey commencement. While consultation with giant crab fishermen agreed to this arrangement for the March/April timeframe, the earlier notification will not provide benefit as this will occur in the closure season.
Alternate Technology: Use of quieter technologies (air gun bubble curtains, marine vibrators, DTAGS)	No	No	PGS has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Duntrron survey. Other than eSource (a technolology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration.
Streamers: Utilise a larger number of streamers to reduce the potential for cumulative TTS impacts to site-attached species.	No	No	Survey vessel uses the maximum feasible within the capability of the vessel while maintaining geophysical objectives. Maximum utilisation of vessel capability is used in all survey activities.
MC3D Adjacent Lines: Maintain adjacent line time intervals within the MC3D areas to a minimum of 18 hours.	Yes	Yes	Assessment of the MC3D survey design confirms that adjacent lines are not acquired within 18 hours of the previous line to prevent TTS impacts to demersal fish species.
Source Size: Use smallest source size to meet survey objectives (3260 in^3)	Yes	Yes	Good Industry Practice. Due to the sub seabed depths of geophysical targets, a smaller energy source would be unable to meet the geophysical objectives of the survey. PGS would be unable to meet seismic data delivery requirements of clients. This source size is smaller than other sources used in GAB survey activities.

Acceptability of Impact:

Impacts to fish stock detailed in this assessment for the Duntroon OA are acceptable, with controls adopted as outlined in Table 6-21, based upon the following acceptance criteria:

- Mortality of fish (both immediate and delayed) is considered highly unlikely. No mortality impacts have been observed in fish exposed to airgun sounds (Popper et al, 2014; 2016; Carroll et al, 2016; McCauley et al, 2003, Boeger et al, 2006; Wardle et al, 2001; Popper et al, 2005; Song et al, 2008; Santulli et al, 1999; Woodside, 2008) however some temporary physiological (TTS, hearing hair cell damage, serum stress analytes) (Song et al, 2008; Woodside, 2008; Santulli et al, 1999; Popper et al, 2005) and behavioural impacts (e.g. vertical/lateral displacement, schooling behaviour, startle behaviour) (Woodside, 2008; Przeslawski et al. 2016; Slotte et al, 2004) have been observed. All physiological and behavioural impacts are temporary and recoverable;
- Injury impacts in sharks are considered remote given this biology (i.e. no swim bladder) and their observed response to sound intensity increases close to sound sources (Myrberg et al, 2001; Casper et al, 2010; Klimley and Myrberg, 1979). There are no documented cases of mortality in the more 'sound-sensitive fish' types (i.e. with swim bladders) from seismic exposure under experimental or field conditions (Carroll et al, 2017) which supports this conclusion.
- No physical injury to demersal fish will occur in water depths less than 120 m within the Ancient Coastline KEF (South-west Marine Parks Network Management Plan 2018 - IUCN Reserve Management Principles (IUCN VI));
- The cumulative sound exposure to demersal fish within the Ancient Coastline KEF boundary will not exceed TTS hearing for fish (South-west Marine Parks Network Management Plan 2018 - IUCN Reserve Management Principles (IUCN VI);

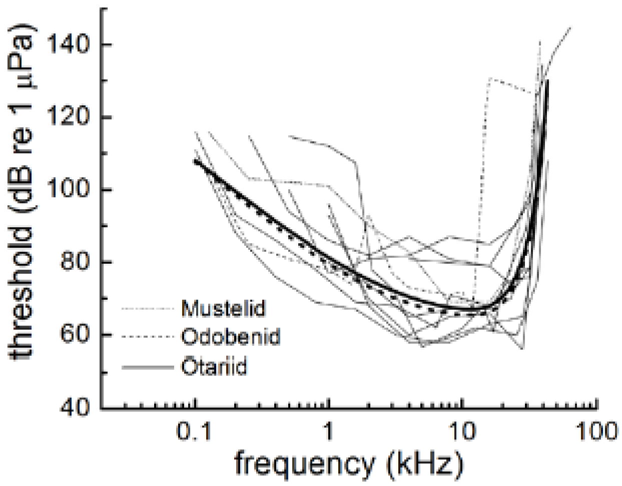
- Mortality and recoverable injury impact to the white shark and behavioural disturbance to foraging in the white shark foraging BIA is remote (South-west Marine Parks Network Management Plan 2018 - IUCN Reserve Management Principles (IUCN VI));
- Disturbances within the non-spatially defined small pelagic fish KEF are localised, temporary and recoverable. No ecosystem disturbance to the small pelagic fishery KEF is expected (South-west Marine Parks Network Management Plan 2018 - IUCN Reserve Management Principles (IUCN VI));
- No fish or shark mortality impacts (*indirect from physiological impacts*) which affects the sustainability of fish resources in the OA from survey activities (ABARES, 2016; McCleay, 2016; Steer et al, 2018; Fowler et al, 2015; Steer et al (2016); Ward et al, 2015; Rogers et al, 2017; Giri & Hall, 2015; TSSC, 2013);
- The September to November survey timeframe ensures that there is no disturbance to SBT fishing activities and spatial overlap with SBT presence in the eastern GAB. This fulfils the requirement for no behavioural disturbances to SBT on the continental shelf from acoustic sound before April 1, 2019 [**ASBTIA Stakeholder Record 6**];
- Acquisition is expected to have temporary and localised impacts to commercial fish abundance within the OA (Skalski et al. 1992; Przeslawski et al. 2016; Woodside, 2008; Pena et al, 2013, **GABIA Stakeholder Record 3**] with catchability impacts to target species within the OA short-term and recoverable;
- No impacts to SBT during CSIRO SBT surveys result in 2019 (if CSIRO survey is held) (**CSIRO Stakeholder Record 13**);
- No impacts to GAB Trawl Sector Fishery Independent Study (FIS) activities **GABIA Stakeholder Record 3].**

Acceptability Statement: Impacts from the Duntroon survey to fish species (including commercial abundance/ catchability and fishery surveys) are localised, temporary and recoverable with no impacts on the sustainability of biomass (fish stock); disturbance to ecological processes within the demersal fish or small pelagic fish KEFs; or foraging disturbance in BIAs.

6.2.3.5 Pinnipeds

Pinniped species present within the Duntroon OA include the Australian sea lion, the Australian fur seal and the New Zealand fur seal, all otariids species. NMFS (2016) defines the functional hearing of otariid pinnipeds under water between 60 Hz and 39 kHz. Figure 6-11 provides the audiogram of otariids compared with mustelids (sea otters) and odobenids (walruses). This functional hearing frequency of otariids overlaps the frequencies emitted by an operational acoustic array.

Figure 6-12: Psychophysical hearing thresholds measured underwater of otariids, mustelid and odobenid species (NMFS, 2016)



Biologically Important Areas: The Duntroon OA spatially overlaps a BIA for the Australian sea lion (foraging) (male) and a small portion of the Australian sea lion (foraging) (male and female) (refer to Section 3.7.6). The male and female Australian sea lion BIA has a spatial buffer of 10 km[92] between the operating acoustic array and its boundary to prevent behavioural disturbance to foraging female sea lions (refer *behavioural assessment*). The Australian sea lion normally forages between depths of 20 -100 m, so the presence of sea lions in the OA is expected to be low (Shaughnessy, 1999).

The Duntroon OA is also coincident with both the Australian and New Zealand fur seal foraging areas (refer Section 3.7.6), however no BIAs, according to the NCVA, are present within or adjacent to Duntroon OA.

Threatened Pinniped Species: The Australian sea lion is listed as a vulnerable species under the EPBC Act 1999. Review of the Recovery Plan for the Australian sea lion (SEWPC, 2013) does not list marine sound as a threat to this species.

Temporary and Permanent Hearing Loss

Receptor Sensitivity:

Studies of impact of acoustic sound on pinnipeds are limited. Underwater sound exposures that elicit TTS in pinnipeds have been measured for harbour and northern elephant seals (both phocid pinnipeds) and Californian sea lions (otariid pinniped). Kastak et al. (2005; cited in Southall et al. 2007) identified that, under continuous, TTS occurred in harbour seals at 183 dB re 1μPa^2.s (SEL), in Californian sea lions at 199 dB re 1μPa^2.s (SEL) and the northern elephant seal at 204 dB re 1μPa^2.s (SEL). All animals showed full recovery in 24 hours after exposure.

Further studies involving phocid pinnipeds (harbour seals) when exposed to a continuous source of 180 dB re 1μPa^2.s (SEL), animals experienced TTS (Kastelin et al., 2012); and when two spotted and two ringed seals were exposed to single pulses from a 10 in^3 airgun there was no measurable TTS (maximum unweighted SEL 181 dB re 1μPa^2.s, SPL ~ 203 dB re 1μPa PK) (Reichmuth et al., 2016).

Underwater TTS-onset data in pinnipeds exposed to pulses is limited to a single study. Finneran et al. (2003: cited in Southall et al. 2007) identified that there was no measurable TTS following exposure of two Californian sea lions to single impulses at received sound levels of 183 dB re 1μPa PK-PK or maximum unweighted SEL of 163dB re 1μPa^2.s however the two test animals showed avoidance responses at these levels. Based on the Kastak et al. (2005) results using nonpulse sounds, the absence of TTS for the sea lions following such exposures was not unexpected.

[92] Acoustic modelling identifies a spatial buffer of 9.1 km between the operational array and male and female foraging BIA boundary is required to achieve 160 dB re 1μPa (SPL) at that boundary (Wladichuk et al, 2018).

Southall et al. (2007) in a synthesis of scientific information on sound impacts to pinnipeds identified that harbour seals experienced TTS at lower exposure levels than the Californian sea lion or northern elephant seal.

Adopted Thresholds:

As no measured PTS data exists for pinnipeds (in water), TTS onset thresholds and known pinniped-to-cetacean differences in TTS-onset have been used to extrapolate PTS onset acoustic thresholds for pinnipeds (Southall et al. 2007). For groups such as octariid pinnipeds where impulsive TTS onset data does not exist, Finneran (2015) derived impulsive TTS onset thresholds using the relationship between non-impulsive TTS onset thresholds and impulsive TTS onset thresholds for MF and HF cetaceans.

Southall et al. (2007) recommended dual acoustic injury criteria for impulsive sound including a peak pressure level (PK) and SEL_{24hr} threshold (i.e. an accumulated SEL over 24 hrs). The peak pressure criterion is not frequency weighted whereas the SEL_{24hr} is frequency weighted for pinnipeds in water. In 2016, after substantial public and expert input, NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing. This guidance describes injury criteria with new thresholds and frequency weighted functions for pinnipeds (phocid and otariid) described by Finneran and Jenkins (2012).

Based upon the sensitivity studies identified, PGS considers these thresholds are suitable for assessing impacts to pinnipeds from acoustic sound produced during the Duntroon survey. A summary of these thresholds is provided in Table 6-32.

Table 6-32: Marine mammal injury (PTS onset) and TTS onset thresholds for pinnipeds (NMFS, 2016).

Hearing Group	NMFS (2016)			
	Injury (PTS)		Temporary Threshold Shift (TTS)	
	Weighted SEL24h (dB re 1µPa².s)	PK (dB re 1µPa)	Weighted SEL24h (dB re 1µPa².s)	PK (dB re 1µPa)
Phocid Pinnipeds in water	185	218	170	212
Otariid Pinnipeds in water	203	232	188	226

Extent and Duration of Exposure and Identified Potential Impact:

Acoustic Modelling Results: Table 6-33 provides the modelling results for PTS (PK) thresholds for pinnipeds at differing locations/water depths across the Duntroon OA. These values provide the horizontal distance from the operational array where peak pressure thresholds may result in pinniped injury based upon NOAA guidance (NMFS, 2016) for a single pulse. For all locations, PTS may occur within 40 m of the operating array for phocid pinnipeds and at distances less than 20 m from the operating array for otariid pinnipeds.

Modelling results for the PTS and TTS frequency-weighted SEL_{24hr} thresholds based on NOAA Technical Guidance (NMFS, 2016) also including the maximum ensonified area if thresholds are reached, is provided in Table 6-34. No PTS impacts to either phocid or otariid pinnipeds are predicted using the SEL_{24hr} metric. No TTS is predicted in otariid pinnipeds (i.e. Australian sea lion and Australian/New Zealand fur seals).

Given these results, based upon the PK metric (only), pinnipeds may be exposed to sound levels sufficient to cause physical damage if the acoustic source starts suddenly with pinnipeds in proximity. In circumstances where arrays are already operating (i.e. during survey line acquisition) it is expected that individual animals would implement avoidance measures before entering ranges at which physical damage might occur. Standard protective measures for sound sensitive species adopted during seismic operations (e.g. soft-starts) will allow individual pinnipeds to move away and minimise potential exposure to sound levels which might result in physical damage.

Table 6-33: Maximum (R_{max}) horizontal distances (km) from the 3260in^3 array to the modelled maximum-over-depth PTS and TTS peak pressure level (PK) threshold based on the NOAA Technical guidance (2016) (Wladichuk et al., 2018)

Hearing Group (in water)	PK Threshold (dB re 1µPa)	Site 1, Line 2	Site 3, Line 2	Site 4, Line 2	Site A	Site B
		127 m	348 m	747m	496m	950 m
		Shelf	Slope	Slope	Slope	Deep water
		R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
Phocid pinnipeds in water (PTS)	218	0.04	0.04	0.04	0.04	0.04
Phocid pinnipeds in water (TTS)	212	0.07	0.07	0.07	0.07	0.07
Otariid pinnipeds in water (PTS)	232	<0.02	<0.02	<0.02	<0.02	<0.02
Otariid pinnipeds in water (TTS)	226	<0.02	<0.02	<0.02	<0.02	<0.02

Table 6-34: Maximum over depth result for frequency-weighted SEL_{24h} for acoustic effects (PTS & TTS) on pinnipeds (NMFS, 2016). A dash indicates that the threshold was not reached. (Wladichuk et al., 2018)

Hearing Group	NMFS (2016)					
	Injury (PTS)			Temporary Threshold Shift (TTS)		
	Weighted SEL24h (dB re 1µPa^2.s)	R_{max} (km)	Area (km^2)	Weighted SEL24h (dB re 1µPa^2.s)	R_{max} (km)	Area (km^2)
Phocid Pinnipeds in water	185	-	-	170	0.27	54.9
Otariid Pinnipeds in water	203	-	-	188	-	-

Biologically Important Areas: Modelling predicts no PTS or TTS impacts to otariid pinnipeds except in very close proximity to the operational array based upon PTS (PK) metrics. On a precautionary basis, pre-start observations will include pinniped surveillance prior to soft-start commencement adopting an observation zone of 1000 m. Start-up will be delayed until a MFO confirms the pinniped has move to a point more than 1000 m from the source; or despite continuous observation, 10 minutes has passed since the last detection of a pinniped within 1000 m of the source. . Source shutdown will also be initiated if the pinniped is sighted within 500 m of an operating array consistent with the shutdown distance adopted for whales under the EPBC Policy Statement 2.1. No power-down zone is proposed for pinnipeds.

Spatial buffers adopted to the male and female foraging BIA boundary to prevent behavioural (foraging) impacts to sea lions in that BIA area willprevent pinniped PTS or TTS impacts (*refer behavioural impacts*).

The Duntroon OA overlaps the male sea lion foraging BIA by 7135 km^2 (i.e. area coincident with continental shelf) which represents 2.4% of the BIA area available to foraging male sea lions. The area ensonified to a PTS level of 232 dB re 1µPa PK lies < 20 m horizontal distance from the operating array (or an estimated ensonified area of ~ 0.0013 km^2). This means that the sea lions would need to be within the aperture of the array to receive such a level. As per the general pinniped assessment, male sea lions are expected to avoid high sound levels which may cause physical damage and with pre-start up observation, soft-start procedures and shutdown zones implemented, PGS does not expect PTS/TTS impacts to the species to occur.

The Duntroon OA does not contain habitat or topographical features leading to sea lion aggregation within the OA noting sea lions are commonly encountered in water depths of 20-100 m (Duntroon OA minimum water depth is 100 m). Areas affected by ensonification at PTS levels are localised, transient and not expected to have a significant impact at a population level to this species.

During a seismic survey, a new portion of sound energy is introduced with each pulse of the airgun array. Acoustic modelling also considered the total acoustic energy which the Australian sea lion was subjected to over 24 hrs from MC3D seismic operations in EPP-41/42. This consisted of two representative survey lines in the northern section of the EPP-41/42 MC3D polygon in proximity to the sea lion BIAs. The EPP-41/42 survey area has the greatest spatial overlap and proximity to foraging BIA of all three Duntroon surveys. Five fixed locations were identified either at the nearest boundary of, or within, the adjacent male and female foraging BIA to assess the maximum weighted SEL_{24hr} for the species (refer Figure 6-2 for locations 1-5).

Modelling predicted that the maximum weighted SEL_{24hr} to sea lions in this BIA of 151.6 dB re 1µPa^2. s. This field sampling location was on the boundary of the male and female Australian sea lion BIA and exposed to the broadside aspect to the array while the seismic vessel traversed Lines 1 and 2 as shown in Figure 6-2. The received levels at both sampling locations on the 100 m isobath is identical (SEL_{24hr} of 145.5dB re 1µPa^2.s) well below both PTS and TTS criterion. The maximum level at the sampling location on the BIA boundary in the direction of Kangaroo Island was 144.6dB re 1µPa^2. s. Results for all locations are provided in Table 6-8.

It is to be noted that modelling is conservative and assumes the animal is stationary for 24 hrs to accumulate this exposure. More realistically a marine mammal does not stay in the same location for 24 hours and these results represent an unlikely worst-case scenario.

Table 6-35: Received frequency-weighted SEL 24hr (dB re 1µPa^2.s) at five sampling locations (Wladichuk et al., 2018)

Location		THRESHOLD Weighted SEL24h (dB re 1µPa^2.s)	MODELLED RESULT SEL_{24hr} (Phocid Pinnipeds)	THRESHOLD Weighted SEL24h (dB re 1µPa^2.s)	MODELLED RESULT SEL_{24hr} (Otariid Pinnipeds)
1	Closest point between the array the Sea Lion BIA	Phocid: PTS – 185 dB re 1µPa^2.s TTS – 170 dB re 1µPa^2.s	152.5	Otariid: PTS – 203 dB re 1µPa^2.s TTS – 188 dB re 1µPa^2.s	150.9
2	Closest point between the broadside of the array and the Sea Lion BIA		154.6		151.6
3	Closest point between the end-fire of the array and the Sea Lion BIA		145.6		144.6
4	Closest point between the array and 100 m isobath		146.0		145.5
5	Closest point between the broadside and the array and the 10 m isobath		147.2		145.5

Summary:

Consequence Level (PTS/TTS): No population level impacts are predicted. With controls implemented any areas of impact are localised and transient possibly affecting individual animals only in areas outside the male sea lion foraging BIA. No impacts predicted to pinnipeds within the male/male and female foraging BIAs (SLIGHT consequence).

Behavioural Disturbance

Receptor Sensitivity:

Southall et al. (2007) extensively reviewed marine mammal behavioural responses to sound and identified behaviours as variable, context-dependent, and less predictable than effects of noise exposure on hearing or physiology. Studies varied in their lack of control groups, imprecise measurements, inconsistent metrics and the animal's study context including the animal's activity state. Southall et al. (2007) identified that the context-specificity of behavioural responses in animals generally made extrapolation of behavioural data inappropriate and assessment of the severity of behavioural disturbance should consequently rely more on empirical studies with carefully controlled acoustic, contextual, and response variables than on extrapolation based on shared phylogeny or morphology.

Few studies have been undertaken which document the reaction of pinnipeds to seismic sound however pinnipeds have been observed during seismic monitoring studies. Within these studies some pinnipeds showed avoidance to airguns, but their observed avoidance reactions are generally not as strong or consistent as cetaceans (LGL, 2009). Monitoring studies (Harris et al. 2001) undertaken on the behaviour of phocid seals during a near-shore seismic program in Alaska observed that:

- During daylight hours seals were seen at nearly identical rates during periods where there were no airguns firing, one airgun firing and the full array operational;
- Seals tended to be further away during full array seismic. Swimming away was more common during full array operation than no airgun periods, but relative behaviours (looked, approached, swam parallel to boat's track, dive or swam away when full array was firing) did not differ significantly among the distance categories;
- Approximately 79% of seal sightings were within 250 m of the seismic vessel. There was partial avoidance of the zone less than 150 m from the vessel during full array seismic, but seals did not move much beyond 250 m at any time.

Received levels of noise pulses from the full array were ≥ 180 dB re 1µPa SPL out to a radius of 1 km. Despite this, many seals showed little or no obvious avoidance and no obvious tendency to avoid diving (Harris et al. 2001).

Thompson et al. (1998; cited in Gordon et al., 2003) conducted controlled exposure experiments with small airguns (215 – 224 dB re 1 µPa PK-PK) over 1 hr observing harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) fitted with telemetry devices. The telemetry packages allowed the movement, dive behaviour, and swim speeds of the seals to be monitored and thus provided detailed data on their responses to seismic pulses. Two harbor seals equipped with heart rate tags showed evidence of a fright responses when playbacks started: their heart rates dropped dramatically from 35-45 beats/min to 5-10 beats/min. However, these responses were short-lived and following a typical surfacing tachycardia; there were no further dramatic drops in heart rate. In six out of eight trials with harbor seals, the animals exhibited strong avoidance behaviour, swimming rapidly away from the source. Stomach temperature tags revealed that they ceased feeding during this time. Only one seal showed no detectable response to the guns and approached to within 300 m of them. The behaviour of harbor seals seemed to return to normal soon after the end of each trial. Similar avoidance responses were documented during all trials with grey seals: they changed from making foraging dives to v-shaped transiting dives and moved away from the source. Some seals hauled out (possibly to avoid the noise); those that remained in the water seemed to have returned to pre-trial behaviour within two hours of the guns falling silent.

Studies undertaken on the reaction of pinnipeds to other pulsed sources (i.e. pile-driving) have included:

- A study on the effects of pile driving on the ringed seal (*Phoca hispida*) in Alaska did not show dramatic reactions to underwater impulses with mean levels of at least 151-157 dB re 1µPa (SPL) (145 dB re 1µPa^2.s SEL) at 63m. Underwater SPLs were <180 dB re 1µPa at all distances. Ringed seals swam in open water throughout construction activities and as close as 46 m from the pile-driving operation (Blackwell et al. 2004);
- Observations of pile driving in connection with wind farms in the western Baltic found a significant effect on the haul-out behaviour of harbour seals (Edren et al. 2004; cited in Masden et al. 2006). This study conducted over a period of three months showed a 10% to 60% reduction in the number of seals hauled out on a sandbank approximately 10 km away during pile driving compared with periods of no pile driving. Sound levels in the water were not measured and no observations were made of seals in the water. It is therefore not known whether the seals reacted to

underwater noise by leaving the area or reacted to airborne noise by remaining in the water, but the reaction seemed short-term as a concurrent aerial survey did not show any decrease in the general abundance of seals during the construction period as a whole (Teilmann et al. 2004; cited in Masden et al. 2006).

Adopted thresholds:

Southall et al. (2007) found that most marine mammals exhibited varying behavioural responses between 140 and 180 dB re 1µPa SPL but inconsistent results between studies made choosing a single behavioural threshold difficult. NMFS has historically used a relatively simple sound level criterion for potentially disturbing a marine mammal. For impulsive sounds this threshold is 160 dB re 1µPa SPL.

Based on the limited studies available, PGS considers the current NMFS sound level criterion for behavioural disturbance to mammals from impulsive sounds is a very conservative, but suitable threshold to adopt for pinnipeds which are transiting or foraging within and adjacent to the Duntroon OA.

Extent and Duration of Exposure and Identified Potential Impact:

Acoustic Modelling Results:

Table 6-36 provides a summary of the maximum horizontal distance from the operational array where the ensonified area exceeds 160 dB re 1µPa SPL together with the maximum-over depth ≤ 600 m ensonified area for this isopleth. The table is segmented according to relevant topographical features within the Duntroon OA. As otariid pinnipeds generally forage to water depths of approximately 200 m, this impact assessment has adopted SPL modelling results for maximum over depth ≤ 600 m radii for the topographical feature (refer modelling interpretation).

Table 6-36: Depths ≤ 600 m: R_{max} horizontal distance (in km) from the 32600 in^3 array to modelled maximum over depth ≤ 600m for the 160 dB re 1µPa SPL (Wladichuk et al. 2018)

Topographical Feature	Relevant Depth Range	$R_{95\%}$ (km) (max)	Ensonified Area (km^2) (≤ 600m water depth)
Continental Shelf	<600m	9.09	124
Continental Slope	< 600 m	13.05	103
Deep Water	< 600 m	6.68	24.3

Potential Impacts (foraging): Modelling predicts for continental shelf environments (i.e. Line 1, Site 4/5 and Line 2, Site 1/2) ensonification above 160 dB re 1µPa SPL might occur to out to 9.09 km (horizontal distance) from the operating array. On this basis, to prevent behavioural impacts to foraging sea lions in the male and female BIA, PGS will implement a spatial buffer of 10 km between the operating acoustic array and boundary of the female and male sea lion BIA. On this basis, any behavioural impacts to female sea lions are expected to be incidental.

The continental shelf portion of the Duntroon OA (7135 km^2) overlaps the male Australian sea lion foraging BIA which equates to 2.4% BIA area available to foraging male sea lions adjacent to the SA/WA coastline. During survey operations a maximum ensonified area of 124 km^2 above the 160 dB re 1µPa SPL isopleth may occur at any one time potentially leading to possible avoidance and displacement in those areas[93]. This area represents 0.042% of the BIA area available to foraging male sea lions. Acquisition across the continental shelf area is currently estimated at no more than 20 days[94] based upon the current Duntroon MC2D and MC3D survey scope. Given the localised and transient nature of the area affected; the low numbers of sea

[93] The ensonified area of 124 km^2 has been selected given it is the maximum area. Other areas of the OA will have smaller ensonification areas, hence calculation is conservative.

[94] Basis of the calculation is approximately 27% of MC3D survey areas (17 days of 60 days) and 6% of MC2D survey lines (2.7 days of 45 days) are located on the continental shelf.

lions present in these water depths and the small observed reaction of phocid pinnipeds (more sensitive to sound than otariids) to seismic activities (Harris et al, 2001); and foraging responses to prey (cephalopod, pelagic fish) availability, behavioural impacts to foraging male sea lions would be incidental (*i.e. no observed foraging-related behaviour displacement*).

Table 6-37 provides details of foraging areas of other pinnipeds listed as present in the Duntroon OA together with the proportion of their foraging area which might be affected by ensonification above 160 dB re 1µPa SPL at any one time. Given the diversity of target prey species available, the lack of topographical features which would lead to aggregation within the Duntroon OA and the small areas affected, impacts are predicted to be incidental and transient in any one location with no population level impacts expected.

Table 6-37: Percentage of foraging area ensonified above 160 dB re 1µPa SPL

Species	Sex	Total Foraging Area (km^2)	Percentage of area ensonified (based upon maximum area of 124 km^2)
Australian Sea Lion	Male	297,272	0.042%
	Male & Female	132,992	NA – No overlap
New Zealand Fur Seal	Male	197,396	0.063%
	Female	954,065	0.013%
Australian Fur Seal	Male and Female	70,639	0.176%

Potential Impacts (Coastal Colonies): Table 6-38 provides the distances of pinniped colonies (Shaughnessy & Page, 2009) from the nearest planned MC2D acquisition line or MC3D area boundary, together with the predicted SPL at the coastal colony location. The SPL has been determined from the per-pulse distance of modelled location Line 2, Site 1 on the continental shelf which provides the maximum modelled SPL exposure to these coastal areas. The distance is based on the nearest boundary of the MC3D survey polygon or MC2D seismic line and reference to the acoustic modelling plot for this location (refer Figure 6-12).

Figure 6-13: Site 1, Line 2 – Sound level contour map showing maximum-over-depth SPL results for the 3260 in^3 array (Wludichuk et al. 2018)

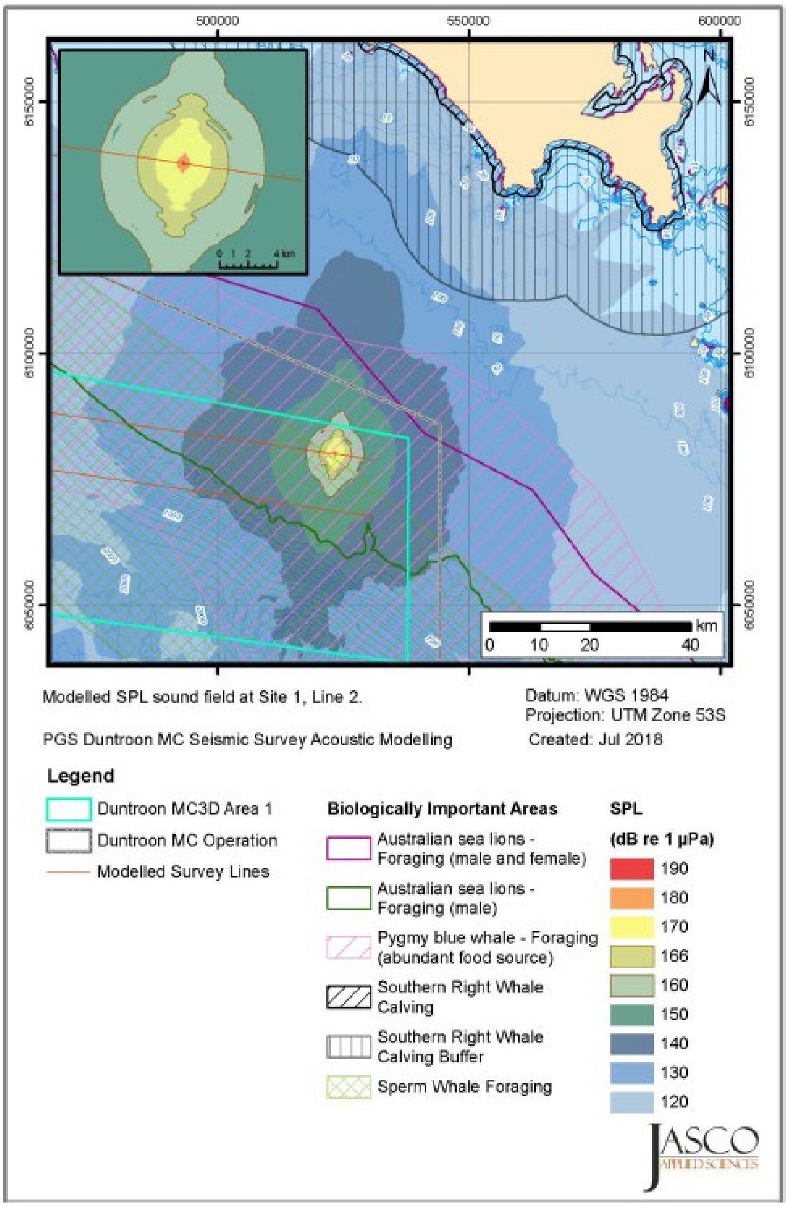


Table 6-38: Pinniped colonies adjacent to the Duntroon OA and predicted SPLs

Location	Pinniped Type	Distance from Nearest Survey Line	Predicted SPL (dB re 1µPa)
Cap Island	Australian Sea Lion	127 km	< 130
Rocky North Island	Australian Sea Lion	104 km	<130
Rocky South Island	Australian Sea Lion New Zealand Fur Seal	25 km	<150
Four Hummock Island	Australian Sea Lion New Zealand Fur Seal	50 km	< 140
Little Hummock Island	Australian Sea Lion New Zealand Fur Seal	64 km	< 140
Price Island	Australian Sea Lion	75 km	< 140
Liguanea Island	Australian Sea Lion New Zealand Fur Seal	50 km	<140

Location	Pinniped Type	Distance from Nearest Survey Line	Predicted SPL (dB re 1µPa)
Curta Rocks	Australian Sea Lion	69 km	<140
Williams Island	Australian Sea Lion	68 km	<140
Lewis Island	Australian Sea Lion	78 km	<140
North Neptune Island	Australian Sea Lion New Zealand Fur Seal	63 km	120
South Neptune Island	Australian Sea Lion New Zealand Fur Seal	64 km	120
Albatross Island	Australian Sea Lion	81 km	<140
North Casuarina Island	Australian Sea Lion New Zealand Fur Seal Australian Fur Seal	121 km	< 130

Based on this assessment, SPLs at colonies are predicted to be less than 160 dB re 1µPa SPL, the threshold for behavioural impacts in pinnipeds (i.e. avoidance). It is to be noted that the predicted SPL values in Table 6-38 are only present during data acquisition on the continental shelf (intermittent basis during the survey period (approx. 20 days)) and while the operational array is located at the closest point to the colony. Any behavioural impacts at colony locations are expected to be localised, incidental and transient.

Potential Impacts (Prey Displacement): An assessment of the acoustic impact to pinniped prey from an operating array (i.e. fish, invertebrates, cephalopods) has been undertaken in Section 6.2.3.3 and Section 6.2.3.40). These sections identified:

- *Pelagic fish*: Behavioural effects in pelagic fish vary according to the presence or absence of a swim bladder and its function in the animal's hearing. The most sensitive fish type present in the area (swim bladder connected to hearing) has a moderate risk of displacement kilometres from the operating array based upon thresholds adopted by Popper at al. (2014). Based upon this criterion fish displacement around the operating array is localised and not expected to cause significant impacts to foraging pinnipeds.

- *Cephalopods:* Cephalopods, a sound sensitive species, is expected to respond to acoustic sound by displacing from areas of high ensonification. The cephalopod threshold utilised for avoidance behaviours is 161-166 dB re 1µPa SPL based upon the work of McCauley (2012) which, again is greater than the adopted threshold for pinniped behavioural impacts. On this basis, cephalopods would be expected to displace to a lesser extent than pinnipeds when exposed to an equivalent level of acoustic sound.

- *Invertebrates:* Benthic invertebrates cannot move large distances in response to acoustic sound. Based upon scientific literature, sound exposure to invertebrates such as lobsters are not predicted to cause mortality impacts, however sub-lethal physiological impacts may be observed (e.g. righting times, etc.). On this basis, Duntroon survey activities are not expected to have a significant impact on prey (lobster) availability to foraging pinnipeds.

Behavioural impacts to key (mobile) prey species of the pinniped are expected to avoid areas immediately around the operating acoustic array however are also expected to displace to similar distances as pinniped species from the operating array which is constantly moving. On this basis, impact to the availability of prey species for pinnipeds is localised, transient and recoverable and not expected to have significant impacts to pinniped foraging.

Summary:

Consequence Level (foraging): No population level impacts are expected from behavioural disturbance. Impacts are predicted to be localised, transient and recoverable (SLIGHT Consequence).

Acoustic Masking:

Species Sensitivity:

Auditory Masking:

Auditory masking is possible in pinnipeds. Pinnipeds use underwater sound (whines, roars, grunts, chirps) for socialisation. Studies performed on the elephant seal, harbour seal and Californian sea lion for frequencies between 200-2500 Hz to obtain "masked thresholds" identified the critical ratio (CR) for these pinnipeds increased with frequency except for very low frequencies. Additionally, the CRs were lower in average magnitude than most other mammals tested at similar frequencies. This may indicate signal processing adaption in pinnipeds which facilitates detection in naturally noisy marine environments (Southall et al. 2000).

Sensory Masking:

Wild Migration Limited (**Stakeholder 35 Records**) has identified the potential of sensory masking from introduced marine sound in pinniped vibrissae (whiskers) used for detecting vortex fields from wakes of prey. This may affect the animal's ability to forage.

In reviews undertaken on pinniped sensory ecology, hearing has been assumed to be of paramount importance to underwater foraging and navigation given light is absorbed rapidly in the water column and is often assumed that complete or near complete darkness is present in benthic foraging environments (Schusterman et al., 2000). However, a few authors have attempted to reinforce the idea that pinnipeds forage visually based upon studies of anatomy and behaviour (Schusterman, 1981; Levensen and Schusterman, 1997, 1999) supporting the idea that the pinniped eye possesses adaption allowing function in water and in dark conditions. In fact, it is likely that pinnipeds may use a combination of sight, hearing and vibrissal tactile reception to find, track and capture prey (Grinter, 2011).

Pinnipeds foraging on muddy seafloors utilise vibrissae (whiskers) and facial structures to extract prey from the seabed (Reidman, 1990). Vibrissae are used to explore items of interest by direct contact using small head movements, particularly during benthic feeding; and within the pelagic environment to sense water displacement caused, for example, by moving organisms or prey species such as fish (Miersch et al., 2011). Vibrissae differ in number, arrangement and shape among the three groups of pinnipeds: phocids (true seals), otariids (fur seals and sea lions) and odobenids (walruses). Physical contact or exposure to air or water currents is necessary to activate the receptors in the vibrissae follicle (Dykes 1975). Pinnipeds have either smooth, ellipsoidal vibrissae (otariid) or vibrissae with a sinusoidal beaded profile (phocid), showing a regularly repeating sequence of crests and troughs (Dehnhardt and Kaminski 1995; Ginter et al. 2010; Ling 1977; Watkins and Wartzok 1985; Yablokov and Klevezal 1964).

It has been demonstrated that swimming fish create complex three-dimensional hydrodynamic vortex trails (Bleckmann et al. 1991; Blickhan et al. 1992; Drucker and Lauder 1999). These trails induce a change in water velocity that is above the threshold of hydrodynamic reception by most marine organisms for several minutes, which suggests that fish can be pursued by predators by detecting and following hydrodynamic signals in the fish wake (Hanke et al. 2000). Studies have shown that harbor seals were able to use vibrissae to follow the course of a hydrodynamic trail similar to a swimming trail of a 30 cm fish, as well as a trail created by another swimming seal, even if blindfolded and auditory cues eliminated (Dehnhardt et al. 2001; Schulte-Pelkum et al. 2007; Wieskotten et al. 2010b). 'Control' experiments where the whiskers were impeded by placing a stocking mask over the muzzle; were also undertaken and the seal was never able to detect the trail. California sea lions, possessing smooth vibrissae, were also able to follow a hydrodynamic trail, but had only a 50% success rate with a trail with a directional change (Gläser et al. 2011). Additionally, a sea lion showed a drastic decrease in successful tracking when there was a delay of more than a few seconds between trail generation and the start of tracking behaviour (Gläser et al. 2011). These results, combined with studies of visual capability, suggest that sea lions likely rely primarily on vision while foraging and therefore may have not developed either the needed bumpy profile of the vibrissal hair shafts and/or the investment of mechanoreceptors and dense innervation to the degree that phocids have (Grinter, 2011).

Otariids generally do not dive to the depths that phocids do in search of prey. The greater amount of ambient light present in shallower water may allow otariids to rely more heavily upon vision for prey detection and capture or a combination of visual, auditory and tactile cues (Gläser et al. 2011). Both California sea lions and harbor seals can detect water velocities below those that would be generated by a swimming fish using their vibrissae (Dehnhardt and Amuck 2008; Dehnhardt et al. 1998). However, given the reduced ability of the California sea lion to successfully track a non-linear hydrodynamic trail using their vibrissae and decreased tracking ability with a delay of more than a few seconds between trail generation and search commencement (Gläser et al. 2011), this data suggests that vibrissae are an important sensory mode in this species, but not the only sensory system involved in prey tracking as fish rarely swim in a straight line (Grinter, 2011).

In contrast, harbor seals can follow a complex hydrodynamic trail as long as 40 m with high accuracy, even with glide phases in the trail, and can determine the direction of a trail after delays up to 35 s (Dehnhardt et al. 2001; Wieskotten et al. 2010a, 2010b). Additionally, these seals can follow a trail, even when they contact it at an obtuse angle, by repeatedly crossing the trail and gradually narrowing the angle. Such a search method would be more successful in tracking fleeing fish (SchultePelkum et al. 2007).

Extent and Duration of Exposure and Identified Potential Impact:

Auditory Masking:

There are no published recordings of vocalisations from Australian sea lions underwater. Based on in-air recordings, most of the call energy of the Australian sea lion is concentrated between 400 and 2100 Hz (Charrier and Harcourt, 2006). Frequencies over 500 Hz typically attenuate at distances beyond 1 km of the array in Australian waters (McCauley et al. 2016).

Figure 6-13 (a) provides the sound spectrum of a typical operating array in Australian southern margin waters at a range of 1.5 km from the array. The presence of higher frequency components occurs in conjunction with each seismic pulse. The same signal is also shown at 40 km from the operating array (Figure 6-13 (b)) where it is apparent the impulses only have frequencies only below the recognised 60 Hz functional hearing of otariid pinnipeds. It is expected that for pinnipeds at locations close to the operating array, masking may be significant for the duration of the pulse, however a sizable portion of pinniped calls will remain unmasked and it is not expected to significantly affect communication. Masking is not expected to occur at distances beyond 1 km of the acoustic source due to the attenuation of relevant frequency components therefore, pinniped species are not expected to be significantly impacted.

Sensory Masking:

Otariid pinniped species are listed as present in the Duntroon OA with foraging areas across the continental shelf (all species) and in deeper water (female New Zealand fur seal). Species information identifies that most otariid species forage to water depths of less than ~200 m which lie in the euphotic zone (i.e. sunlight penetration zone).

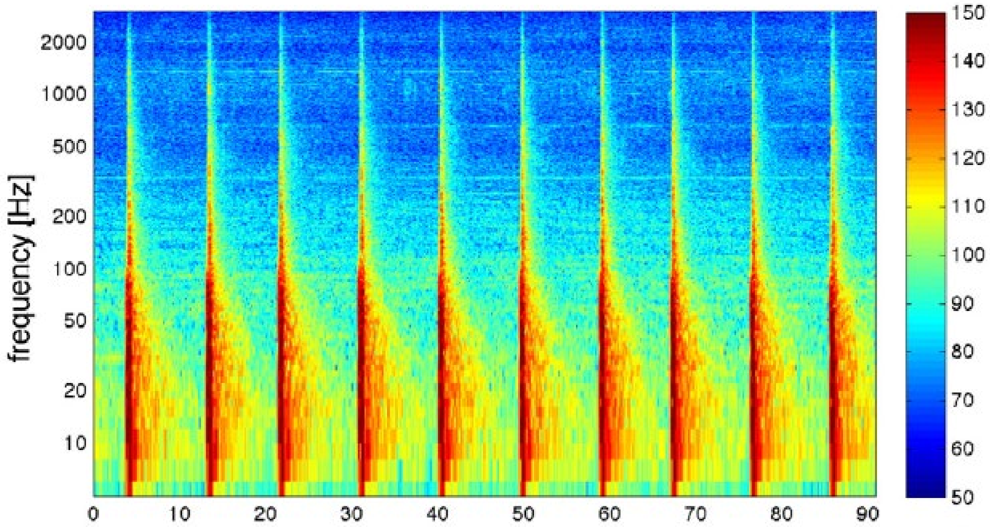
Vibrissae sense water displacement in proximal locations to pinnipeds to aid in the capture of mobile prey such as fish. The water displacement footprint of fish is usually a complex three-dimensional structure (vortices) which have the potential to be distorted by water movement created from refracted sound from the operating acoustic array. However, based upon available studies, otariid pinnipeds appear to primarily rely on visual cues for prey detection. While some sensing interference of vibrissae is possible, foraging impacts are not expected to be significant.

Acoustic modelling for survey location in deep water (i.e. off the continental shelf) shows little sound ingress over the continental shelf. Based upon this, interference effects might be expected in source operation on the continental shelf. Acquisition across the continental shelf area is currently estimated at 28 days[95] based upon the current survey definition and on an intermittent basis according to the location of seismic line.

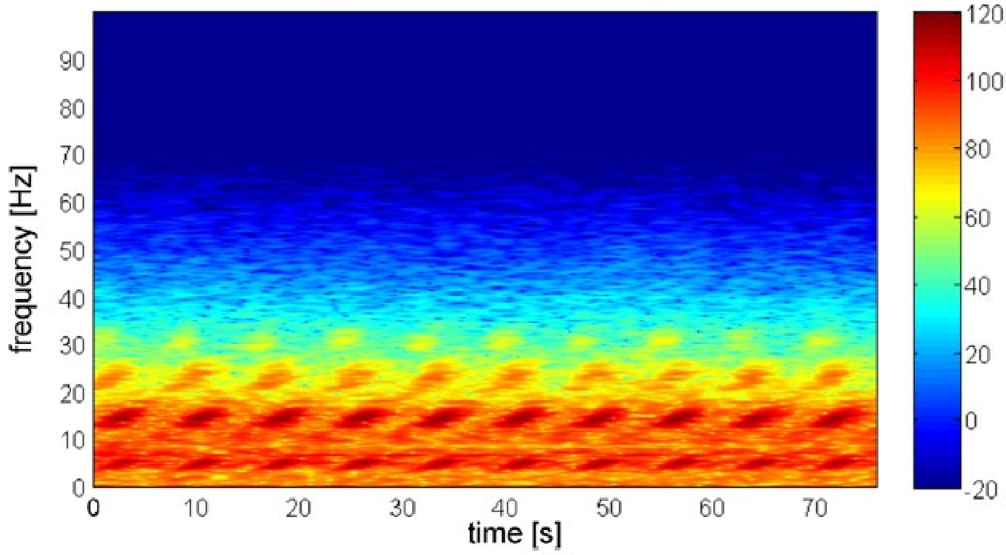
Figure 6-14: Spectrograms of seismic airgun signals at a range of a) 1.5 km from an operating array and b) 40 km from the same operating array over a hard seabed in shallow water (Erbe et al. 2015).

(a)

[95] Basis of the calculation is 27% of MC3D survey areas and 6% of MC2D survey lines are located on the continental shelf.



(b)



Summary:

Consequence Level:

- Acoustic masking to otariid pinniped present within, and adjacent to, the Duntroon OA during survey operations are expected to be temporary, localised and given that beyond 1 km the frequency components of the source are not expected to overlap with the estimated vocalisation frequency ranges of otariid pinnipeds, the source is not expected to have significant masking impacts to pinniped species (SLIGHT consequence).

- Sensory masking to otariid pinnipeds is not expected to lead to significant impacts to foraging activity (SLIGHT consequence)

Stakeholder Feedback:

Wild Migration Limited (WML) (**Stakeholder 35 Records**) requested that PGS undertake acoustic modelling to provide accurate information to assess survey activities against NOAA criteria, namely the SEL_{24hr} value and also a complete bandwidth profile to provide an accurate assessment of behavioural impacts to the Australian sea lion. Original modelling and revised modelling has been provided to WML together with the proposed mitigative actions to prevent impacts to foraging areas. This has included adoption of a spatial buffer to the female sea lion foraging BIA (i.e. alteration to line transects in proximity to the foraging area) and adoption of EPBC Policy Guideline 2.1 requirements for pre-survey observation, soft–start procedures and shutdown zones to prevent impacts to sound sensitive species. WML have advised that the assessment meets their requirements.

The Wilderness Society (TWS) (**Stakeholder 42 Records**) also was concerned that:

- There was no shutdown provided for pinnipeds to control sound impacts during acquisition. This control has now been adopted and a shutdown zone will be implemented for pinnipeds of 500 m. This is consistent with the shut-down distance (zone) adopted for cetaceans. Prior to soft-start, PGS will monitor pinniped interactions and apply a 10-minute observation period for pinnipeds within 1000 m of the array as part of pre-survey observation to prevent the acoustic array starting up adjacent to a pinniped;
- Sound ingress into the male and female foraging BIA would disturb foraging female sea lions. PGS agrees this is an issue and has implemented a 10 km spatial buffer between any acquisition activities and this BIA boundary to prevent behavioural displacement impacts.
- TWS requested habitat sound propagation monitoring in the adjacent male and female foraging BIA area. Predictive modelling has identified that at the closest line to the BIA, TTS thresholds are not met. PGS has previously undertaken sound source verification (SSV) for the 3260 in^3 array during operations within New Zealand to assess for compliance with the mitigation zones outlined in the New Zealand Code of Conduct (short-range modelling). The verification process utilised recorded seismic data from the survey to confirm that actual emitted sound levels were as per predicted levels (G. Bennett, 2017). The analysis found that the received levels were less than the levels modelled in the sound transmission loss modelling report. The sound modelling was performed by SLR Consulting Australia Pty Ltd, and the sound verification was performed by Talis Consultants (G. Bennett, 2017). Given the conservative nature of the buffer distance applied between the operating array and the male and female foraging BIA boundary, PGS does not believe habitat monitoring has merit in this case. PGS will however verify the accuracy of the medium to long-range sound modelling via sound loggers to confirm modelling accuracy for future modelling events.

Controls Assessment:

Table 6-39 provides an assessment of possible controls to reduce impacts to pinnipeds from the Duntroon survey activity.

Table 6-39: Assessment of possible controls to reduce impacts to pinnipeds

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part A) procedures (*pre-startup visual observation*)	Yes (at close range)	Yes (at close range)	Visual observation of pinniped species to distances of 3 km from the seismic vessel cannot be achieved given the characteristics of pinnipeds in the marine environment (i.e. no visual breathing spout, small surface presence/size). However, based upon seismic survey monitoring studies (Harris et al., 2001) detection of pinnipeds at close distances are possible. At these distances PTS/TTS impacts are not predicted. As pinnipeds do not remain beneath water for extended time (~ 8 minutes (Taronga Zoo, 2017)), pinniped surveillance prior to array start-up is a practicable measure in close proximity to the sesimic vessel as the array starts-up. PGS will adopt the following control to protect pinnipeds from high sound levels during start-up. If, during pre-start observations prior to initiation of source soft start, a qualified observer detects a pinniped within 1000 m of the source, start up will be delayed until: • A MFO confirms the pinniped has moved to a point that is more than 1000 m from the source, or • Despite continuous observation, 10 minutes has passed since the last detection of a pinniped within 1000 m of the source and the mitigation zone remains clear.
Implement EPBC Policy Statement 2.1 (Part A) procedures (*soft start procedures*)	Yes	Yes	Soft-start procedures will assist in displacing sound sensitive species from areas where ensonification may be damaging.

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part A) procedures (*Implementation of precaution and shutdown zones*) Implement EPBC Policy Statement 2.1 (Part A) procedures (*night-time and low visibility procedures*)	Yes	Yes	Visual observation of pinniped species to 3 km is not possible given the size of the pinniped and its lack of noticeable surface presence (i.e. no spout), however observation in closer proximity to the source is possible (refer above). Modelling identifies that potential PTS/TTS impacts to pinnipeds is restricted to very close ranges to the operating array (i.e. within the appature of the source). Pinnipeds present in the area are expected to displace to areas of non-damaging sound during operation and soft-starts. On a precautionary basis, to prevent injury to pinnipeds, PGS will implement a source shutdown zone of 500m in the event that a pinniped is detected in water depths < 200 m. No power-down zones are proposed for pinnipeds.
Implement at spatial buffer between the operating acoustic array and the female sea lion foraging area to prevent behavioural (foraging) impacts	Yes	Yes	Survey polygons have been amended to include this spatial buffer without significantly compromising data acquisition objectives.
Eliminate spatial overlap with male sea lion foraging area	No	No	Elimination of all seismic lines across the continental shelf plus an additional spatial buffer to prevent behavioural disturbance would eliminate substantial area from the survey polygon and data acquisition objectives cannot be achieved. Spatial overlap of the Duntroon OA on the continental shelf is less than 2.4% of the male foraging BIA and acqusition activities at any one time would affect 0.04% of the BIA. Additionally most sea lion foraging is recorded in water depth less than 100 m and sea lion encounter is expected to be low. Based on the observed responses of pinnipeds to acoustic sound and displacement of prey species, foraging impacts are not predicted.
Use of smallest source size to meet survey objectives (3260 in^3)	Yes	Yes	Good Industry Practice. Due to the sub seabed depths of geophysical targets, a smaller energy source would be unable to meet the geophysical objectives of the survey. PGS would be unable to meet seismic data delivery requirements of clients. The acoustic source used for this survey is less than the 4130 in^3 source array used in previous PGS surveys within the region.
In addition to whale management, MFOs and crew will monitor for pinnipeds and other marine fauna.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds and seabirds. There is a limitation on the practicability of sighting of some species (e.g. shark, fish) and increasing visual observation to these species may serve to compromise implementation of EPBC 2.1 control provisions for key sensitive species (whales).
Use of quieter technologies (silenced (air bubble curtain) air guns, marine vibrators, DTAGS)	No	No	PGS has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Duntrron survey. Other than eSource (a technolology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration.

Control Measure	Practicable?	Will it be Implemented?	Justification
Verify acoustic modelling output to protect sea lion foraging area.	Yes (SSV only)	Yes (SSV only)	PGS has undertaken site specific 2D/3D modelling, in conjunction with known sensitivities within and around the Duntroon OA to understand the potential sound impacts from survey activities. Given the nature of the environment, this level of modelling was considered necessary. This modelling has been undertaken independently by third party subject matter experts (JASCO). An assessment of the accuracy of this model is provided below. As per this assessment, PGS considers that the model output for the Duntroon area is accurate particularly at distances close to the operational array (pers.com C. McPherson, 2018). Duntroon survey design includes a spatial buffer of 10 km between the acoustic source and the BIA foraging boundary (male and female sea lion) utilising a threshold value of 160 dB re 1µPa (SPL) for behavioural impacts to marine mammals. Given the ranges for the 160 dB re 1µPa (SPL) isopleth are close to the source, predicted sound levels have a higher level of accuracy (pers.com C. McPherson, 2018). This spatial buffer has adopted an Rmax value and applied an addition 10% in distance to be conservative. On this basis deployment of a sound logger at the boundary of the male and female sea lion foraging BIA to verify far-field propagation modelling is not considered to be warranted. PGS has previously verified the 3260 in^3 sound source output levels using recorded data compared to modelled data. The analysis found that the received levels were less than the levels modelled in the sound transmission loss modelling report. The sound modelling was performed by SLR Consulting Australia Pty Ltd, and the sound verification was performed by Talis Consultants (G. Bennett, 2017). PGS will undertake SSV via multi-channel streamer (MCS) assessment for the Duntroon survey. This information will be assessed at the completion of the survey for use in future modelling activities.

Accuracy of acoustic modelling:

JASCO's peer-reviewed, acoustic models have been verified with in-field data measured from more than 20 underwater acoustic programs around the world verifying that JASCO models are accurate and reliable (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Martin et al, 2017, Matthews and MacGillivray (2013)).

JASCO's peer-reviewed AASM (MacGillivray 2006 updated 2014), has been used to predict the pressure signatures and directional source levels of airgun arrays. This model has been benchmarked against datasets from the Svein Vaage Broadband Airgun Study (Mattsson 2010) and accurately model seismic arrays to 25 kHz. Studies comparing AASM predictions with seismic array measurements have been carried out at different sites including the Chukchi Sea (McPherson et al., 2005), the Beaufort Sea (Matthews and MacGillivray, 2013) and offshore British Columbia (Austin et al., 2012). These studies have shown that the modelled SELs are typically within 3dB of the measured values.

In addition, PGS has had the 3260 in^3 sound source output levels verified using recorded data as part of the environmental permitting requirements in New Zealand. The evaluation was carried out by Talis Consultants Pty Ltd (G. Bennett, 2017), and concluded that the recorded sound levels were less than the results modelled by SLR Consulting Australia Pty Ltd.

A recent Report of the Acoustic Ground-truthing Technical Working Group (DOC, 2016) identified that most models are typically highly conservative. In addition, any disparities in some input parameters, such as seabed reflectivity, is more significant in long-range received levels (a few tens of kilometres) and not in the near-field propagation zones (< 2 km).

PGS considers the modelling undertaken for the Duntroon survey is accurate particularly close to the acoustic array where adopted thresholds for fauna disturbance (e.g. 160 dB re 1µPa SPL - a lower level effect) lies within 10 km of the source (i.e. reasonably close to the acoustic source).

Acceptability of Impact:

Impacts to pinnipeds detailed in this assessment for the Duntroon OA are acceptable, with controls adopted as outlined in Table 6-39, based upon the following acceptance criteria:

- No injury to Australian sea lions is predicted (TWS (**Stakeholder 42 Record**), WML (**Stakeholder 35 Record**));
- No disturbance to foraging behaviours predicted within the male and female foraging BIA (WML (**Stakeholder 35 Record**), TWS (**Stakeholder 42 Record**));
- Noise levels within the female Australian foraging BIA are maintained to a level which does not result in site avoidance or other physiological or behavioural responses (Marine Bioregional Plan – Southwest region (SEWPC, 2012), WML (**Stakeholder 35 Record**), TWS (**Stakeholder 42 Record**)).

Acceptability Statement: Impacts from the Duntroon survey to pinnipeds are expected to be localised, temporary and recoverable, with no injury or behavioural disturbance leading to foraging related impacts.

6.2.3.6 Marine Reptiles

Species Sensitivity:

Marine turtles may potentially use sound for navigation, locating prey and avoiding predators (CoA, 2017). Acute noise, or temporary exposure to loud noise, may result in avoidance of important habitats and in some situations physical damage to turtles. Morphological studies of green and loggerhead turtles (Ridgway et al. 1969; Wever 1978; Lenhardt et al. 1985) found that the sea turtle ear is similar to other reptile ears but has some adaptations for underwater hearing. A thick layer of fat may conduct sound to the ear in a similar manner as the fat in jawbones of odontocetes (Ketten et al. 1999), but sea turtles also retain an air cavity that presumably increases sensitivity to sound pressure. Sea turtles have lower underwater hearing thresholds than those in air, owing to resonance of the middle ear cavity, and hence hear best underwater (Willis 2016).

Underwater audiograms are only available for three species. Two of these species, the red-eared slider (Christensen-Dalsgaard et al. 2012), the loggerhead turtle (Martin et al. 2012), both demonstrated sensitivity at around 500 Hz (Willis 2016). Recent work on green turtles has refined their maximum underwater sensitivity to be between 200 and 400 Hz (Piniak et al. 2016). Yudhana et al. (2010) measured auditory brainstem responses from two hawksbill turtles in Malaysia and found that peak frequency sensitivity occurred at 457 Hz in one turtle and at 508 Hz in the other. Studies using auditory brainstem responses of juvenile green and Ridley's turtles and sub-adult green turtles showed that juvenile turtles have a 100 to 800 Hz bandwidth, with best sensitivity between 600 and 700 Hz, while adults have a bandwidth of 100 to 500 Hz, with the greatest sensitivity between 200 and 400 Hz (Bartol & Ketten 2006). Piniak et al. (2012) found that leatherback turtle hatchlings detected sounds between 50 – 1000Hz, with maximum sensitivity between 100-400 Hz. Like other species of marine turtle, they have a relatively narrow, low-frequency range of hearing sensitivity; however, these frequencies overlap the frequency range of the maximum energy from an operating acoustic array.

It is possible that seismic airgun exposure may damage turtles very close to the acoustic source, although preliminary data suggest that sea turtles are highly resistant to high intensity explosives (Ketten et al. 2005), making it likely they would also be resistant to damage from seismic airguns. It is also likely the turtles may suffer recoverable injury or TTS.

There is a paucity of data regarding responses of turtles to acoustic exposure and no studies of hearing loss due to exposure to loud sounds. Nelms et al. (2016) conducted a review of seismic surveys and turtles which considers the studies detailed below. A common theme was the complex nature of the studies (i.e. behavioural response interpretation due to airguns or vessel noise/presence) through to difficulties in visually detecting animals. Most studies assessing the effect of seismic noise on marine turtles have focused on behavioural responses as physiological impacts are more difficult to observe in living animals. Relevant studies include:

- Caged green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles increased their swimming the absence of definitive data activity in response to an approaching seismic array in 100 m water depth at received SPLs of approximately 166 dB re 1µPa SPL (SEL - 155 dB re 1µPa^2.s) and behaved erratically (agitated state) above 175 dB re 1µPa SPL (SEL - 164 dB re 1µPa^2.s). This corresponded to behavioural changes at ~2 km, and avoidance from ~1 km (McCauley et al., 2003).

- Moein et al. (1994) found caged loggerhead turtles showed an initial response to an operating air gun at a mean range of 24 m however further trials several days afterwards did not elicit any significant behaviour change. Physiological measures recorded during the study did show evidence of increased stress, but the effects of handling turtles for sampling were not accounted for and therefore the stress increase could not be attributed to the air gun operations. A temporary reduction in hearing capability was evident from the neurophysiological measurements but this effect was temporary, and the turtles hearing returned to pre-test levels at the end of two weeks. The study quotes three air gun levels received by the turtles, 175, 177 and 179 dB @ 1m (units not defined).

- Weir (2007) observed 240 turtle responses to a seismic survey during a 10-month seismic survey off the coast of Angola concluding that *"there was indication that turtles occurred closer to the source during guns-off than full array, with double the sighting rate during guns-off in all distance bands within 1000 m of the array*". This reduction in numbers of turtles is reasonable consistent with McCauley et al. (2003). However, there was no significant difference in the median distance of turtle sightings from the airguns during full-array or guns-off. While this result apparently indicates a lack of movement away from active airguns, it is possible that turtles only detect airguns at close range or are not sufficiently mobile to move away from approaching airgun arrays (particularly if basking for metabolic purposes when they may be slow to react). Apparent responsive dives were noted for 20 turtles, six during full-array seismic and 14 during guns-off. Thirteen turtles dived in apparent response to the vessel, nine of which startle dived at the bow (full-array=2; guns-off=7). Seven turtles startle dived in apparent response to seismic equipment, including six in response to towed surface floats (full-array=1; guns-off=5) and one in apparent response to the inactive airgun array. An assessment of turtle behaviour in relation to seismic status was therefore hindered by apparent reaction of individuals to the ship and towed equipment rather than specifically to airgun sound. These reactions occurred at close range (usually <10 m) to approaching objects and appeared to be based principally on visual detection.

- Eckart *et al.* (2004) used GPS and Time Depth Recorders (TDR) to track movement and behaviour of two leatherback turtles exposed to seismic source noise. They found no change in behaviour or movement from previous turtles that were not exposed to seismic survey noise.

- DeRuiter and Doukara (2010) observed turtles during active operation of an airgun array and found a startle response (rapid dive) to the airgun. However, again, the authors could not distinguish the stimulus source of the startle response as they did not perform a control with the airguns off (DeRuiter and Doukara, 2010).

Adopted Thresholds:

In the Arctic Programmatic Environment Impact Statement (PEIS) (NSF, 2011) in the absence of definitive injury data for turtles, TTS or PTS onset were considered possible at an SPL of 180 dB re 1µPa (NSF, 2011). Popper et al. (2014) after consideration of available scientific literature and the way animals detect sound established sound exposure guidelines for sea turtles. These levels have been developed based on impulsive sounds (i.e. pile driving or explosives) given there is no quantified data for seismic airguns. It is noted that these levels are based on pile drive studies, a static source and seismic with a moving vessel and receptor and hence are considered conservative. The material used to inform the guidelines is limited to publications that provide full background information including measured sound exposure levels, received levels, controls, and appropriate experimental design. These guidelines suggest injury to turtles at 207 dB re 1µPa (PK) or above 210 re 1µPa^2.s (SEL_{24hr}). The Popper et al. (2014) threshold criteria are used in this assessment given it is based upon the latest available information.

Behavioural guidelines defined by Popper et al (2014) show that animals are likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of meters) and a low response if they are far (thousands of meters) from the airgun. McCauley et al. (2003) identified a behavioural threshold of 166 dB re 1µPa SPL for caged turtles and is the criteria adopted within this assessment to identify the level of potential displacement (avoidance) from the array. The SPL of 166 dB re 1µPa has been used as the behavioural disturbance response for sea turtles by the NFMS and applied to the Arctic Programmatic Environment Impact Statement (PEIS) (NSF, 2011). However, given behavioural observations which have been made during seismic survey operations (Weir, 2007), this behavioural threshold is considered highly conservative. Table 6-40 summarises these threshold criteria.

Extent and Duration of Exposure and Identified Potential Impact:

Habitats:

The Duntroon OA is not located in a BIA for marine turtles (refer Section 3.7.7). While the EPBC protected matters database identifies three species of turtle as “likely to have habitat present” only the leatherback turtle, given its ability to endure cold-water, might be encountered and is more likely to be present during periods of upwelling . The species presence is expected to be transitory only during the survey timeframe.

The Recovery Plan for Marine Turtles 2017-2027 identifies noise interference as a general threat to sea turtles within Australian waters with a requirement for, in accordance with the *EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines*, all seismic survey vessels operating in Australian waters to undertake soft start procedures during surveys irrespective of location and time of year of the survey.

Table 6-40: Sound exposure guidelines for mortality, impairment and behavioural change in turtles (Popper et al. 2014)

Species	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Turtles	210 dB SEL_{cum} or > 207 dB PK	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
					166 dB SPL (McCauley et al. 2003)
Definitions:					
Mortal and mortal injury	Immediate or delayed death.				
Recoverable injury	Injuries including hair cell damage, minor internal or external haematoma, etc. None of these injuries are likely to result in mortality.				
Temporary Threshold Shifts	Short or long-term change in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6 dB or greater that persists and has been selected as the working group considers that anything less than 6 dB will not have a significant effect from a hearing standpoint.				
Masking	Impairment of hearing sensitivity by greater than 6 dB in the presence of noise.				
Behavioural effects	Substantial change in behaviour for the animals exposed to sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction or alteration in migration patterns. This criterion does not include effects on single animals or where animals have become habituated to the stimulus or small changes in behaviour such as a startle response or small movements.				
Note: Peak and rms pressure levels are dB re 1µPa; SEL dB re 1µPa^2.s. All criteria are presented as sound pressure since no data on particle motion exists. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) (tens of metres), intermediate (I) (hundreds of metres) and far (F) (thousands of metres) (Popper et al. 2014).					

Physical Injury: Results of the Duntroon acoustic modelling for mortality level thresholds in marine turtles in PK metrics is provided in Table 6-41. The SEL_{24hr} from Popper at al. (2014) for turtles was not reached. These results identify, based upon Popper et al, (2014) criteria, that marine turtles may possibly be exposed to sound levels sufficient to cause physical damage within 150 m of an operating array.

Injury may occur if the seismic source started suddenly with turtles nearby. In circumstances where the acoustic arrays are already operational, individual animals would be expected to avoid (behavioural impact) areas where physical damage might take place. With soft state procedures implemented, injury impacts to individual turtles exposed to these sound levels is not expected.

For this assessment, the estimated area ensonified by the PK levels which could cause physical impacts to turtles transiting the area (MC3D and MC2D areas)[96] is 9080 km^2 over the survey period The Duntroon OA is not located within, or adjacent to, areas which have known narrow, restricted migratory pathways; near areas important for feeding, breeding or nesting to turtles or during key upwelling timeframes when turtles may be present. Any marine turtle presence in the survey area would be expected to be representative of their wider distribution in southern Australian waters.

Apportioning this possible impact area to the respective bioregions it overlays, approximately 2075 km^2 overlays the Spencer Gulf Shelf bioregion and 7005 km^2 overlays the Southern Province Bioregion which consists of 1.56% and 0.9% of the bioregions respectively. This area receives ensonification over a period of 91 days (max per season) as the seismic vessel moves through the area. Given the small bioregion area affected on a transitory basis, any impact is not considered significant to marine turtle population.

Table 6-41: Maximum (R_{max}) and 95% (R95%) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth peak pressure levels (PK) thresholds based upon Popper et al., (2014) for turtles at four modelling sites. (Wladichuk et al. 2018)

Hearing Group (in water)	PK Threshold (dB re 1µPa)	Site C	Site D	Site E	Site F
		200 m Depth	1099 m Depth	649 m Depth	160 m Depth
		$R_{max\ (m)}$	$R_{max\ (m)}$	$R_{max\ (m)}$	$R_{max\ (m)}$
Turtles	207	123	-	-	150

Summary:

Consequence Levels: Localised, temporary impacts may occur to a small number of animals if present near array on start-up without soft-start procedure implementation. No population level impacts are expected (SLIGHT consequence).

Behavioural Disturbance:

Scientific literature has identified that turtles exposed to sound levels can lead to behavioural changes (e.g. increased swimming, avoidance). Duntroon acoustic modelling identifies that sound source levels which exceed the turtle behavioural threshold (SPL 166 dB re 1µPa) lies in a maximum horizontal distance range from the operating array of 5.38 km[97] when the array is operating at full power.

The estimated area ensonified above behavioural sound thresholds (considered conservative based upon observed behaviours in the field), based upon a horizontal distance of 5.38 km from the operational array during survey activities (MC3D and MC2D areas) is 64,890 km^2. As previously discussed, this area does not represent key foraging, breeding, migration or aggregation areas for marine turtles and is representative of the broad southern Australian distribution area for turtle species. Apportioning this impact area to the respective bioregions it overlays, approximately 6,230 km^2 overlays the Spencer Gulf Shelf bioregion and 58,660 km^2 overlays the Southern Province Bioregion which consists of 4.6% and 7.6% of the bioregions respectively. It is noted that this area will receive the stated sound level over a maximum period of 91 days (per season) as the seismic vessel moves through the area. On a daily basis, the estimated area of ensonification above behavioural thresholds for the MC3D survey areas (most intensive) is approximately 2293 km^2. This equates to 0.7% of the Spencer Gulf Shelf Bioregion and 0.2% of the Southern Province Bioregion on a daily basis.[98]

[96] This assumes polygon dimensions and acquisition lines as described in Table 2.2 with a 5 km lead-in/lead-out distances. A 150 m horizontal radius around polygons and survey lines has been included.

[97] R_{max} figure utilising maximum-over-depth as leatherback turtles can forage to 1200 m.

[98] Assume seismic lines are acquired across shelf and non-shelf areas in proportion to those areas for the MC3D surveys (most intensive surveys).

Summary:

Consequence Levels: Localised, temporary and transient impacts may occur to individual animals if present in the Duntroon OA. No population level impacts expected or impacts on critical habitats (SLIGHT consequence).

Controls Assessment:

Table 6-46 provides an assessment of possible controls to reduce impacts to turtles from the Duntroon survey activity.

Table 6-42: Assessment of possible controls to reduce impacts to marine turtles

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part A) procedures (*pre-startup visual observation to 3 km*)	Partially	Yes	Visual observation of turtles species to distances of 3 km from the seismic vessel cannot be achieved given the characteristics of turtles in the marine environment (i.e. no visual breathing spout, small surface presence/size). However, visual detection within 500 m is possible based upon observation studies (Weir, 2007). Given injury impacts are predicted close to sound source (i.e. 150 m), observation within 500 m during the 30 min visual observation period will prevent acoustic arrays starting up when turtles are in close proximity. Control will be adopted.
Implement EPBC Policy Statement 2.1 (Part A) procedures (*soft start procedures*)	Yes	Yes	Soft-start procedures will assist in displacing sound sensitive species from areas where ensonification may be damaging. The Recovery Plan for Marine Turtles 2017-2027 identifies noise interference as a general threat to sea turtles within Australian waters with a requirement for, in accordance with the EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines, all seismic survey vessels operating in Australian waters must undertake a soft start during surveys irrespective of location and time of year of the survey.
Implement EPBC Policy Statement 2.1 (Part A) procedures (*Implementation of precaution and shutdown zones*) Implement EPBC Policy Statement 2.1 (Part A) procedures (*night-time and low visibility procedures*)	Yes	Yes	Visual observation of turtle species at distance is difficult given the size of the turtles and its lack of noticeable surface presence (i.e. no spout). However, visual detection of a turtle within 500 m of the operational array will result in a shut-down of the array to prevent turtles from being exposed to PTS levels. Modelling identifies that potential PTS/TTS impacts to turtles is high in a very close range to the operating array. Turtles present in the area will be expected to displace to areas of non-damaging sound during operation and soft-starts.
Use of smallest source size to meet survey objectives.	Yes	Yes	Good Industry Practice. Due to the sub seabed depths of geophysical targets, a smaller energy source than 3260 in^3 would be unable to meet the geophysical objectives of the survey and the seismic data delivery requirements of clients. During all surveys, the minimum size array will be utilised for acquisition.
In addition to whale management, MFOs and crew will monitor for pinnipeds, turtle and other marine fauna.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds, turtles and seabirds. There is a limitation on the practicability of sighting of some species (e.g. shark, fish) and increasing visual observation to these species may serve to compromise implementation of EPBC 2.1 control provisions for key sensitive species (whales).
Use of quieter technologies (air guns with bubble curtains, marine vibrators, DTAGS)	No	No	PGS has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Duntron survey. Other than eSource (a technolology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration.

Acceptability of Impact:

Impacts to turtles detailed in this assessment for the Duntroon OA are acceptable, with controls adopted as outlined in Table 6-42, based upon the following acceptance criteria:

  - No injury to marine turtles (Recovery Plan for Marine Turtles in Australia, (DoEE, 2017)).

Acceptability Statement: Impacts from the Duntroon survey to turtles are expected to be localised, temporary and recoverable, with no injury to turtle species present in the survey area.

6.2.3.7 Avifauna

Species Sensitivity:

Bird species within the Duntroon OA during survey activities are unlikely to be directly affected by acoustic sound unless plunge diving underwater for prey. Although ear anatomy in aquatic birds is not well investigated, adaptations for diving have been found in a number of penguin species. Current available evidence suggests that hearing in seabirds is less vulnerable to damage from underwater sound than in marine mammals based on adaptations to protect the tympanum and middle ear from large, rapid changes in pressure which occur when diving (Dooling and Therrien 2012). The only published field study assessing the impact of seismic activities on diving birds (Long-tailed Ducks *Clangula hyemalis*) found no difference in indices of site fidelity or diving intensity between the seismic area and two control areas (Lacroix *et al.* 2003).

Conservation advices/recovery plans for threatened species which may occur within the Duntroon OA do not identify threats related to acoustic noise.

The Duntroon OA overlaps or lies adjacent to BIAs (foraging) for some listed avifauna (refer Section 3.7.8). This includes the:

- Short-tailed shearwater which is present from September to April. The Duntroon OA and MC3D survey areas represents 5.9% and 1.1% of the BIA respectively. *Foraging patterns are dependent on presence of upwelling*;
- Pacific gull present and foraging throughout the year. The Duntroon OA spatially overlaps 1.6% of the foraging BIA;
- Caspian tern present in adjacent waters to the Duntroon OA and foraging throughout the year;
- Little penguin present in adjacent waters to the Duntroon OA, and foraging throughout the year except for a 17-day moulting period between February and April; and
- Australian fairy tern present in adjacent waters to the Duntroon OA and foraging throughout the year.

The area also has a diverse array of seabirds (predominantly albatross and petrels which are widespread and highly mobile in Australian waters) and some shoreline birds which may also be present in the coastal waters provisioning for young. In the event that individual birds or flocks are present in the survey area during operations, vessel movement is expected to temporarily deter them from foraging in the immediate vicinity of the vessel.

Extent and Duration of Exposure and Identified Potential Impact:

Survey activities may lead to:

- avifauna mortality, if bird diving pattern is close to the operational array;
- localised, temporary displacement of birds due to physical presence of vessel and equipment;
- altered prey abundance; or
- if close to colonies, disturbance to breeding birds.

Vessel/Streamer Displacement:

If individual birds or flocks are present in the survey area during operations, vessel movement is expected to temporarily deter them from foraging in the immediate vicinity of the vessel. As this area of disruption is localised to immediate areas around the vessel and trailing equipment, displacement impacts are incidental only, temporary and will not create impacts at a population level.

Injury/mortality (Seabirds):

The MC3D and MC2D acquisition area contains foraging habitat for a diverse array of seabirds (petrels, albatross, shearwaters). For individual birds present in the acquisition area during operations, vessel movement is expected to temporarily deter foraging in the immediate vicinity of the vessel (refer *vessel/streamer displacement*). Most seabird species are highly mobile and would be expected to flee from approaching seismic noise sources at distance, well beyond those that could cause physiological injury, but initiation of a sound source at full power if diving seabirds are present might result in injury or mortality where foraging behaviour overrides a flight response to seismic survey sounds.

The threshold for physiological damage on the auditory system for marine birds is unknown, however most marine bird species are generally shallow divers and utilise surface waters where the acoustic signals 'destructively interfere' resulting in much lower sound exposure compared with deeper waters (Marine Technology Directorate, 1996: cited in SCAR, 2002) and the time of exposure underwater is short. In addition, the potential for physiological impacts to diving birds would be limited to the immediate area around the acoustic source for the duration of the survey (short-term) and the associated risk of underwater sound significantly impacting a population of any given seabird species or even individual animals (during plunge/dive feeding) is extremely low.

Injury/mortality (Little penguin):

The little penguin, a flightless bird with observed diving to 60m, is known to forage 15 km from their colonies during breeding season. The nearest colony identified is 30 km from the nearest Duntroon OA boundary and 45 km for the nearest seismic acquisition line (MC2D). On this basis, encounter rates with little penguins in the Duntroon acquisition area during the survey period is predicted to be very low and the associated potential for injury/mortality impacts to individual animals is also low outside the immediate area around the acoustic source.

Disturbance to breeding birds:

A vessel (seismic or otherwise) that approaches too close to a breeding colony could disturb adult birds from nests in response to acoustic or visual stimuli. There is little potential for this during the proposed surveys, as the nearest breeding colony is Greenly Island is ~ 30 km from the nearest Duntroon OA boundary and ~45 km from the nearest planned MC2D survey line. No significant impacts to breeding populations are expected on this basis.

Behavioural Disturbance (Seabird Foraging):

An indirect impact to seabirds present in the area may occur if air gun discharges alter the abundance or behaviour of prey species. However, the extent to which a temporary 'descending' or 'tightening' or displacement effect (if it occurs) affects prey availability either positively or negatively, is not known. Seabirds occurring in the acquisition area have considerable foraging habitat present throughout the region and the size of the acquisition area and area ensonified at any one time is not significant compared with this normal foraging range. In addition, the Duntroon OA does not contain any topographical features (e.g. offshore islands) where species aggregate. Any temporary dispersal of prey species (e.g. fish, cephalopods) is not expected to result in a significant impact on prey species availability which is of biological significance to foraging birds or a net reduction in feeding opportunities. With the survey vessel constantly moving, sound impacts are localised and temporary.

The seasonal upwelling period (December to March) within the Kangaroo Island Pool KEF gives rise to high productivity surface aggregations of fish and associated high levels of foraging in some bird species (i.e. short-tailed shearwater). While the September-October period is down-welling favourable, the potential for environmental/oceanic conditions which lead to upwellings increases in November. PGS will monitor for upwelling favourable conditions during November and if blue whale presence is detected in proximity to the survey area, PGS will assume upwelling conditions exist and will halt the survey for the season. This also eliminates disturbance to seabirds such as the short-tailed shearwater who have foraging patterns dependent on the presence of upwellings. Any impacts to seabirds are therefore localised and temporary (SLIGHT consequence).

Behavioural Disturbance (Little penguin foraging):

Penguins communicate via calls (vocalisations) for mate and chick recognition. The hearing capabilities of birds are complex and poorly understood. Although some information is available on underwater hearing capabilities of cormorants, virtually no research has been undertaken on hearing in penguins (Pichegru et al, 2017). The hearing range of most birds lies between 0.1-8 kHz (McCauley, 1994). Inferences from taxonomically related birds and the frequency range of their vocalisations suggest the little penguin has its best hearing at frequency ranges above 1 kHz and below this range hearing becomes poor with a decrease in frequency (McCauley, 1994). This implies that the thresholds of perception for the low frequency sounds of seismic (10-300 Hz) will be high (McCauley et al, 1994). Joutventin (1982; cited in McCauley, 1994) observed that the spectral character of little penguin songs had a main frequency range of 200-1950 Hz with a mean spectral frequency peak at 601 Hz and a highest frequency between 700-6000 Hz. Joutventin (1982; cited in McCauley, 1994) found filtering out the low frequency portion of the song (< 500 Hz) had no effect on the penguin response, an observation which supports the notion that penguins have poor low frequency sensitivity (at least in air).

No record of little penguins producing underwater sound is documented (McCauley, 1994). While knowledge of vocalisation at sea remains very limited, contact calls have been recorded for penguins at the surface when at sea (Pichegru et al, 2017).

Penguin colonies are present in proximity to the Duntroon OA (refer **Section 3.7.8**). Table 6-43 provides the spatial separation between the closest MC3D and MC2D survey lines and these locations.

Table 6-43: Penguin Colony proximity to nearest MC3D and MC2D survey lines

Location	Population	MC2D Distance (nearest survey line proximity)	MC3D Distance (nearest survey line proximity)
Pearson Island	12,000	90 km (north)	140 km (north)
Troubridge Island	3,000	300 km (east) (& protected by Yorke Peninsula)	215 km (east) (& protected by Yorke Peninsula)
Waldegrave Island	> 500	150 km (north)	180 km (north)
Dorothee Island	~ 200	85 km (north)	135 km (north)
Flinders Island	< 20	120 km (north)	160 km (north)
Greenly Island	1,500	45 km (north)	70 km (north)
Lewis Island	< 100	135 km (east) (& protected by Lincoln National Park Peninsula from sound)	75 km (north-east) (& protected from Lincoln National Park Peninsula from sound)
Althorpe Island	132	210 km (east)	125 km (east)

Pichegru et al (2017) investigated the foraging behaviours of endangered African Penguins (*Spheniscus demersus*) before, during and after seismic operations conducted within 100 km of the two largest breeding populations in South Africa over the period March to May 2009-2013. The study identified that when seismic activity took place in March 2013, the closest breeding population switched foraging direction and foraged significantly futher away from the centroid of the seismic activity during that period (i.e. 77 km, compared with ca 65 km on average in the absence of seismic activity). By contrast the second colony, travelled consistently due east to SSW of their colonies regardless of seismic activity with no significant change in direction or foraging effort. Penguins foraging < 100 km from the active seismic operations showed a clear change of foraging direction, increasing their distance between feeding area and the location of the seismic. The 2D seismic survey utilised a 4230 in^3 source array at a shot point interval of 25 m over a 35-day period. Survey data was acquired at water depths between 50 – 3000m. No received sound levels by the penguins were documented in the study.

Acoustic modelling performed for the Duntroon survey, for shot points located on the continental shelf (i.e. Line 1, Site 4 (Depth 164 m); Line 1, Site 5 (Depth 135m) Line 2, Site 1 (127 m) and Line 2, Site 2 (141 m) identify that sound attenuates to a level < 150 dB re 1µPa within 45 km of the acquisition location. Note, for shot points at locations off the shelf (i.e. along the slope and deep water) representing 76% of the Duntroon OA, there is very little sound encroachment onto the shelf environment and no behavioural impacts at Greenly Island would be expected.

Based upon the Pichegru et al (2017) study (i.e. colonies within 100 km of an operating Duntroon survey array), seismic sound may affect the foraging behaviours of penguins located on Greenly Island (for MC3D and MC2D survey lines) and Dorathee Island (for MC2D survey lines). Within a radius of 100 km of Greenly Island in waters < 200m[99] there is ~350 km of MC2D survey lines (42 hrs of acquisition over a possible 91-day period) are planned on the continental shelf with the longest line length approximately 76 km (or 9 hrs of acquisition before moving beyond 100 km of the colony). On this basis, seismic sound exposure during MC2D activities affecting penguin foraging behaviours will be intermittent, temporary and immediately recoverable.

Foraging disturbance at Greenly Island from MC3D survey activity is also possible on the near-shore racetrack which lies on the continental shelf within 100 km radius of Greenly Island based upon the findings of Pichegru et al (2017). Acquisition over the MC3D near-shore racetrack is expected to take ~ 24 days. Approximately 1.1% of this racetrack lies within a 100 km radius of Greenly Island in water depths < 200m with the longest sail line 68 km (8 hrs). Given the distance between sequential lines (~10 km) which translate south over continental slope/ deep water environments as the MC3D survey progresses, any sound impacts at Greenly Island will be intermittent and temporary with levels of sound exposure decreasing as the survey progresses into deeper water.

Pichegru et al (2017) identified that the African penguins quickly reverted to normal foraging behaviour after the cessation of seismic activities, suggesting a relatively short-term influence of seismic activity on these bird's behaviour and/or their prey. The study also noted that most bird and fish species have the capacity to regenerate lost or damaged sensory cells of the ear, although the study could not rule out potential longer-term impacts on hearing ability as the biological significance of altered behaviours during seismic surveys is difficult to measure. African penguins are known to respond to underwater vocalisation of predators (Frost et al, 1975; cited in Pichegru et al, 2017) and noise pollution may affect their capacity to detect the presence of a predator with potential negative consequences for survival. Increasing energy expenditure at sea to located food can also negatively affect penguins' reproductive output (Boersma & Rebstock, 2009; cited in Pichegru et al, 2017).

Based upon available scientific literature, it is possible that the penguin colony at Greenly Island may be exposed to sound levels causing behavioural change and foraging impacts. The colony at this location is estimated at 3-7.5% of the SA little penguin population. Based upon this assessment any behavioural impacts (foraging displacement) associated with noise exposure are expected to be temporary, intermittent and recoverable (SLIGHT consequence).

Summary:

Consequence Levels (Injury): Injury to seabirds present in proximity to the operational array may affect individual birds, however impacts are localised and temporary and not expected to impact upon bird populations (SLIGHT consequence).

Consequence Levels (Foraging - Seabirds): Seabird foraging displacement within the OA will not affect the foraging success or reduce net feeding opportunities. Impacts are expected to be incidental to affected bird populations (SLIGHT consequence).

Consequence Levels (Foraging - Penguins): The behavioural impacts (foraging displacement) associated with this noise exposure are temporary, short-term and recoverable (SLIGHT consequence).

Controls Assessment:

Table 6-44 provides an assessment of possible controls to reduce impacts to avifauna from the Duntroon survey activity.

Table 6-44: Assessment of possible controls to reduce impacts to avifauna

Control Measure	Practicable?	Will it be implemented?	Justification

[99] Sound ingress onto shelf environments from deeper water acquisition is not predicted in modelling (Wladichuk et al, 2018)

Control Measure	Practicable?	Will it be implemented?	Justification
Temporal Exclusion: No seismic acquisition undertaken in the Duntroon OA during the primary upwelling period (December to March) to prevent impacts to up-welling related bird aggregations.	Yes	Yes	PGS has positioned its acquisition timeframe to the period September 1 to November 30 . This avoids the key upwelling period December to April. Forecasting tools adopted in the survey to avoid upwellings and impacts to high productivity watersprevents impacts to upwelling areas and bird aggregations with upwelling-related foraging patterns (refer below).
Spatial Buffers: Adopt spatial controls to prevent overlap with Kangaroo Island Pool KEF and upwelling related foraging BIAs during primary upwelling period	No	No	PGS has adopted temporal buffers to prevent impacts during periods of upwelling. Temporal controls are reliable to prevent foraging impacts to upwelling-related foraging events.
Control: Implement EPBC Policy Statement 2.1 (Part A) procedures (*pre-start-up visual observation*)	No	No	Visual observation protects marine mammals in proximity to the acoustic source from being exposed to high levels of sound in the water. Birds present on the water surface are not significantly impacted by sound in the water Diving species such as the little penguin which may be diving at depths is not expected to be present in proximity of the survey given the timeframe overlaps the breeding period for the species. Control will not be adopted as it does not offer any environmental benefit.
Control: Implement EPBC Policy Statement 2.1 (Part A) procedures (*soft start procedures*)	Yes	Yes	Soft-start procedures will assist in displacing sound sensitive prey species from areas where ensonification may be damaging. This will asssit in displacing prey species (fish, celphalopods) from the survey area which will inturn displace foraging bird species.
Control: Implement EPBC Policy Statement 2.1 (Part A) procedures (*Implementation of precaution and shut-down zones*)	No	No	Visual observation and implementation of precaution and shut-down zones protect marine mammals in proximity to the acoustic source from being exposed to high levels of sound in the water. Seabirds present on the water surface are not affected by sound in the water and have minimal exposure to underwater sound, and the little penguin is not expected to be present within the survey area due to the survey timeframe overlapping the breeding period.
Source Size: Use of smallest source size to meet survey objectives	Yes	Yes	Good industry practice to limit sound in the marine environment and assist with limiting displacement impacts of prey.
Monitoring: In addition to whale management, MFOs and crew will monitor for other marine fauna including seabirds.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds, turtles and seabirds (including seabirds).
Alternate Technologies: Use of quieter technologies (silenced air guns, marine vibrators, DTAGS)	No	No	PGS has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Duntrron survey. Other than eSource (a technolology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration.

Acceptability of Impact:

Impacts to avifauna detailed in this assessment for the Duntroon OA are acceptable, with controls adopted as outlined in Table 6-44, based upon the following acceptance criteria:

- No disturbance to seabird (aggregations) foraging in upwelling related BIAs during upwelling events given the survey controls adopted (South-west Marine Parks Network Management Plan 2018 - IUCN Reserve Management Principles (IUCN VI)).
- No substantial adverse effect on a marine species including its lifecycle (for example breeding, feeding, migration behaviour, life expectancy) and spatial distribution.

Acceptability Statement: The Duntroon survey does not disturb foraging behaviour of seabird aggregations responding to upwelling events within upwelling related BIAs during the survey period and does not have a substantial adverse effect on seabird lifecycle or spatial distribution.

6.2.3.8 Cetaceans

Cetaceans use sound for foraging, orientation, communication, navigation, location of prey and predator avoidance and are therefore sensitive to underwater sound. High levels of anthropogenic sound can cause loss of hearing sensitivity, deafness, behavioural change, displacement from important habitat, induced stress responses and individuals' ability to detect, recognise and /or discriminate sounds used for foraging, conspecific communications, navigation and predator/hazard avoidance (Gomez et al., 2016).

The effect of sound on cetaceans depends on factors including the hearing sensitivity of the species, the sound exposure level, the location of the animal in relation to the sound, exposure history, repetition frequency and the ambient sound level. The context of the exposure plays a critical and complex role in the way in which the animal might respond (Gomez et al., 2016). High levels of anthropogenic underwater noise can have potential effects on cetaceans ranging from changes in their acoustic communication, behavioural disturbances and in more severe cases physical injury or mortality (Richardson et al, 1999).

Hearing sensitivity in cetaceans is based upon the frequency range of hearing and their thresholds of hearing (i.e. level at which they perceived noise). Based upon the current knowledge of functional hearing, Southall et al. (2007) defined three functional hearing groups in cetaceans based upon the frequency range at which their hearing is sensitive: a) low frequency cetaceans (7 Hz to 35 kHz); b) mid-frequency cetaceans (150 Hz to 160 kHz); and c) high frequency cetaceans (275 Hz to 160 kHz) (NFMS, 2016). The cetacean species listed in the EPBC Protected Matters Database as possibly having habitat present in the Duntroon OA together with their functional hearing group are listed below.

Table 6-45: EPBC-listed cetaceans within Duntroon OA (DoEE, 2017a)

Scientific Name	Common Name	EPBC Act Status	Functional Hearing Group
Balaenoptera acutorostrata	Minke Whale	L	Low
Balaenoptera bonaerensis	Antarctic Minke Whale	M	Low
Balaenoptera borealis	Sei Whale	V,M	Low
Balaenoptera edeni	Bryde's Whale	M	Low
Balaenoptera musculus	Blue Whale*	E, M	Low
Balaenoptera physalus	Fin Whale	V, M	Low
Berardius arnuxii	Arnoux's Beaked Whale	L	Mid
Caperea marginata	Pygmy Right Whale	M	Low
Delphinus delphis	Common Dolphin	L	Mid
Eubalaena australis	Southern Right Whale	E, M	Low
Feresa attenuata	Pygmy Killer Whale	L	Mid
Globicephala macrorhynchus	Short-finned Pilot Whale	L	Mid

Scientific Name	Common Name	EPBC Act Status	Functional Hearing Group
Globicephala melas	Long-finned Pilot Whale	L	Mid
Grampus griseus	Risso's Dolphin	L	Mid
Hyperoodon planifrons	Southern Bottlenose Whale	L	Mid
Kogia breviceps	Pygmy Sperm Whale	L	High
Kogia simus	Dwarf Sperm Whale	L	High
Lagrnorhynchus obscurus	Dusky Dolphin	M	Mid
Lissodelphis peronii	Southern Right Whale Dolphin	L	Mid
Megaptera novaeangliae	Humpback Whale	V, M	Low
Mesoplodon bowdoini	Andrew's Beaked Whale	L	Mid
Mesoplodon densirostris	Blainville's Beaked Whale	L	Mid
Mesoplodon grayi	Gray's Beaked Whale	L	Mid
Mesoplodon hectori	Hector's Beaked Whale	L	Mid
Mesoplodon layardii	Strap-toothed Beaked Whale	L	Mid
Mesoplodon mirus	True's Beaked Whale	L	Mid
Mesoplodon ginkgodens	Ginkgo-toothed whale	L	Mid
Orcinus orca	Killer Whale	M	Mid
Peponocephala electra	Melon-headed whale	L	Mid
Physeter macrocephalus	Sperm Whale*	M	Mid
Pseudorca crassidens	False Killer Whale	L	Mid
Tasmacetus shepherdi	Sheperd's beaked whale	L	Mid
Tursiops aduncus	Indian Ocean Bottlenose Dolphin	L	Mid
Tursiops truncatus s. str.	Bottlenose Dolphin	L	Mid
Ziphius cavirostris	Cuvier's Beaked Whale	L	Mid

* BIA (foraging) present within Duntroon OA for these species.

Baleen whales (e.g. blue, humpback and southern right whales) are considered the most sensitive of the marine mammals to seismic arrays due to their use of low-frequency signals (Range: 12 Hz-8 kHz but predominantly less than 1 kHz) for communication (McCauley, 1994). Richardson et al. (1995) summarises published baleen call sound characteristics. Table 3-5 lists the estimated source levels, frequency ranges and dominant frequencies for the species which may be encountered in the Duntroon OA, reflecting that species produce sounds with high source levels. McCauley et al. (2003) reported humpback whale song components reaching 192 dB re 1µPa (PK-PK) as well as 180-190 dB re 1µPa (PK-PK) for humpback pectoral fin slapping and breachings sounds.

Odontocetes (i.e. toothed whales) produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The frequency range of toothed whale sounds excluding echo location clicks are mostly <20 kHz with most of the energy typically around 10kHz, although some sounds may be as low as 100-900 Hz. Sound levels of these calls range from 100 to 180 dB re 1µPa (Richardson et al., 1995). The sounds produced (other than echolocation clicks) are very complex and used for communication between members of a pod and coordinating feeding activity.

It is noted that the timeframe for undertaking the proposed MC2D and MC3D surveys has been aligned as far as practicable to minimise the likelihood of noise exposure to cetacean species present in the Duntroon OA during September to November.

Temporary and Permanent Hearing Loss

Species Sensitivity:

PTS occurs when an animal experiences a shift in their hearing threshold caused by prolonged or repeated exposure to high sound levels from which an animal does not recover (permanent hair cell or receptor damage). While the loss of hearing sensitivity is usually strongest in the frequency band of the emitted noise, it is not limited to frequency bands where the noise occurs but can affect a broader hearing range.

TTS occurs when an animal's hearing threshold is temporarily increased during and immediately after sound exposure whereas PTS is hearing loss from which an animal does not recover (Richardson et al., 1995). TTS severity is expressed as a magnitude and duration of hearing sensitivity shift relative to pre-exposure sensitivity. The relationship between these two thresholds is complex since PTS can either be induced from a single high-level noise exposure or by chronic (longer term) noise exposure at lower levels (Southall et al., 2007). The threshold for auditory injury is therefore taken as the level at which PTS starts to occur, based on the overall noise dose received over time. Given that PTS cannot be ethically or legally induced in animals to determine the threshold, Southall et al. (2007) proposed for PTS-onset sound criteria should be extrapolated from TTS-onset criteria and the relationship between the relative levels of noise likely to cause TTS and PTS.

It is noted that there are different mechanisms (e.g. anatomical, neurophysiological) associated with TTS versus PTS onset making the relationship between these types of thresholds not completely direct, however the only data available for marine mammals is from TTS studies (NMFS, 2016). This method also provides a conservative estimate of the noise levels likely to induce permanent injury.

TTS data from impulsive airgun sources on cetaceans has been measured in the following studies:

- Finneran et al. (2002) reported behaviourally-measured TTS of 6 and 7 dB in a beluga exposed to single pulses (186 dB re 1µPa^2.s (SEL), 224 dB re 1µPa (PK)); and
- Lucke et al. (2009) reported measured TTS of 7 to 20 dB in a harbour porpoise exposed to single impulses (162 dB re 1µPa^2.s (SEL), 195 dB re 1µPa (PK)).

Several impulsive noise studies have also been conducted without measurable (behavioural) TTS. Finneran et al. (2000) exposed belugas and dolphins to single pulses from an 'explosion simulator" (179 dB re 1µPa^2.s (SEL), 217 dB re 1µPa (PK)); and Finneran et al. (2015; in NOAA, 2016) exposed three dolphins to sequences of 10 impulses from a seismic airgun (193 dB re 1µPa^2.s (SEL), 196-210 dB re 1µPa (PK)) without measurable TTS (NFMS, 2016). While these TTS studies are on odontocetes exposed to impulsive sounds (Finneran, 2016) there is no data for mysticetes.

TTS impacts in cetaceans are thought to have very similar effects to masking: a reduction in foraging efficiency, reproductive potential, social cohesion and ability to detect predators (Weilgart, 2007).

Adopted Impact Thresholds for Injury:

In 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing and propose new noise exposure criteria. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included a peak pressure level threshold (PK) and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of three cetacean species hearing groups: Low-, Mid- and High-Frequency Cetaceans (LFC, MFC, and HFC respectively). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of TTS in belugas by the amount of TTS required to produce PTS in chinchillas.

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LFC and HFC while retaining the filter shapes. Revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HFC of 179 dB re 1 µPa^2·s. Because there was no data available for baleen whales, Wood et al. (2012) based their recommendations for LFC on results obtained from MFC studies. In particular the author's referenced Finneran and Schlundt

(2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed.

As of 2018, an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for cetacean injury. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2018). The guidance describes PTS injury criteria with new thresholds and frequency weighting functions for the three cetacean hearing groups described by Finneran and Jenkins (2012). The recommended PTS thresholds as defined by NFMS (2018) are provided in Table 6-46 and are adopted for injury assessment criterion.

For seismic surveys in Australian waters, the *EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales* determines exclusion zones based on an unweighted per-pulse SEL threshold of 160 dB re 1µPa^2.s (DEWHA, 2008). This threshold minimises the likelihood of hearing impairment (TTS) in mysticetes and large odontocetes (DEWHA, 2008) . The EPBC Policy Statement 2.1 does not apply to smaller dolphins and porpoises as DEWHA assessed these cetaceans as having peak hearing sensitivities occurring at higher frequency ranges than those that seismic arrays typically produce.

Table 6-46: The SPL, SEL, SEL_{24h} and PK Thresholds for acoustic effects on cetaceans. Injury is measured as permanent thresholds shift (NMFS, 2018)

Hearing Group	DEWHA (2008)	NMFS (2018)			
	Unweighted per-pulse SEL (dB re 1µPa^2.s)	Injury (PTS)		TTS	
		Weighted SEL24h (dB re 1µPa^2.s)	PK (dB re 1µPa)	Weighted SEL24h (dB re 1µPa^2.s)	PK (dB re 1µPa)
Low Frequency Cetaceans	160	183	219	168	213
Mid-Frequency Cetaceans		185	230	170	224
High Frequency Cetaceans		155	202	140	196

To supplement acoustic modelling, PGS also engaged JASCO Applied Sciences to undertake an Animal Movement Modelling Study for Assessing Marine Fauna Sound Exposures for a 3260 in^3 array (Lucke et al, 2018). This study estimated the number of SRWs potentially exposed to sound levels which could elicit behavioural responses or be potentially injurious during 24 hrs of survey. As explained by Lucke et al (2018), the exposure modelling was conducted using JASCO's Animal Simulation Model Including Noise Exposure (JASMINE) linked to the acoustic modelling results for 24 hrs of survey operations as presented in Wladichuk et al (2018). This model is based upon the open-source marine mammal movement and behaviour model, 3MB (Houser, 2006) and used to predict the exposure of animats (virtual marine mammals) to sound arising from the sound sources in simulated representative surveys. Inside the model, the sound source location mimics the movement off the source vessel through the proposed survey pattern and animats are programmed to behave like the marine mammals likely to be present in the survey area. The parameters used for forecasting realistic behaviours (e.g. diving, foraging, surface times, etc.) are determined and interpreted from marine species studies where available or reasonably extrapoloated from related species. An individual animat's modelled sound exposure levels are summed over the total simulation duration, such as 24 hours or the entire simulation, to determine its total received energy (accumulate SEL). The maximum PK and SPL exposure during the period is also determined from the exposure history and both total energy received (SEL) and maximum PK or SPL are compared with relevant criteria.

Given the selected timeframe of the Duntroon survey, animat modelling has been performed for the SRW in terms of PTS and TTS sound exposure according to the sound exposure criteria detailed in Table 6-46 for SRW located in coastal environments (nearshore) and SRWs during oceanic migrations (offshore SRWs). Modelling has been undertaken for the entire Australian SRW population and the south-eastern SRW population. These results are contained within Table 6-48.

Extent and Duration of Exposure and Identified Potential Impact (Injury):

Based upon the acoustic modelling undertaken for the Duntroon survey location, the R_{max} for the 160 dB re 1µPa^2.s single pulse SEL horizontal range is 1.75 – 4.47 km across the survey area. As this distance exceeds 1 km,a power-down zone of 2 km is adopted for the Duntroon survey in accordance with EBPC Policy Statement 2.1 requirements (refer Table 6-6).

Table 6-48: Predicted scaled number of animat exposed to sound exposure levels exceeding the TTS and PTS criteria from NMFS (2018) for entire and eastern SRW (sub-) population during 24 hr simulation (Lucke et al, 2018).

(Sub-) Population	Eastern		Entire	
	TTS (168 dB re 1µPa2.s) ($L_{E,\ LF,\ 24h}$)	PTS (183 dB re 1µPa2.s) ($L_{E,\ LF,\ 24h}$)	TTS (168 dB re 1µPa2.s) ($L_{E,\ LF,\ 24h}$)	PTS (183 dB re 1µPa2.s) ($L_{E,\ LF,\ 24h}$)
Offshore SRW	0.09	0.001	0.41	0.01
Nearshore SRW	0	0	0	0

Table 6-49 provides acoustic modelling results for cetacean PTS and TTS thresholds by cetacean hearing group for locations across the Duntroon OA. Modelling predicts:

- *PTS:* For LF cetaceans, unmitigated sound exposures exceed PTS thresholds at a maximum horizontal distance of 30 m (PK) and 760 m (SEL_{24h}). The SEL_{24hr} is a cumulative metric assuming an animal is consistently exposed to 'injury' noise levels at a fixed position relative to the vessel for 24 hrs and represents an unlikely worst-case scenario. More realistically, cetaceans do not stay in the same location or range for 24 hrs given the constant movement of the survey vessel and individual cetacean movement. Therefore a reported radius for 24 hr SEL criteria does not mean the marine fauna travelling within this radius will be injured, but rather that an animal could be exposed to a sound level associated with PTS if it remained in that range for 24 hours. The maximum area receiving the frequency-weighted SEL_{24hr} PTS threshold is 160 km^2 over a 24-hour period which is 0.65% of the high-abundance foraging blue whale BIA (24,560 km^2) or 0.12% of the SGS Bioregion.

- *TTS:* For LF cetaceans modelling predicts unmitigated sound exposures exceed TTS thresholds at a maximum horizontal distance of 70 m (PK) and 42.3 km (SEL_{24hr}) for water depths < 600m, appropriate to LF cetacean habitats and behaviours present in the Duntroon OA. The SEL_{24h} area ensonified over a 24-hr period is 4181 km^2 which is 17% of the high abundance blue whale foraging BIA and 3.1% of the SGS bioregion.

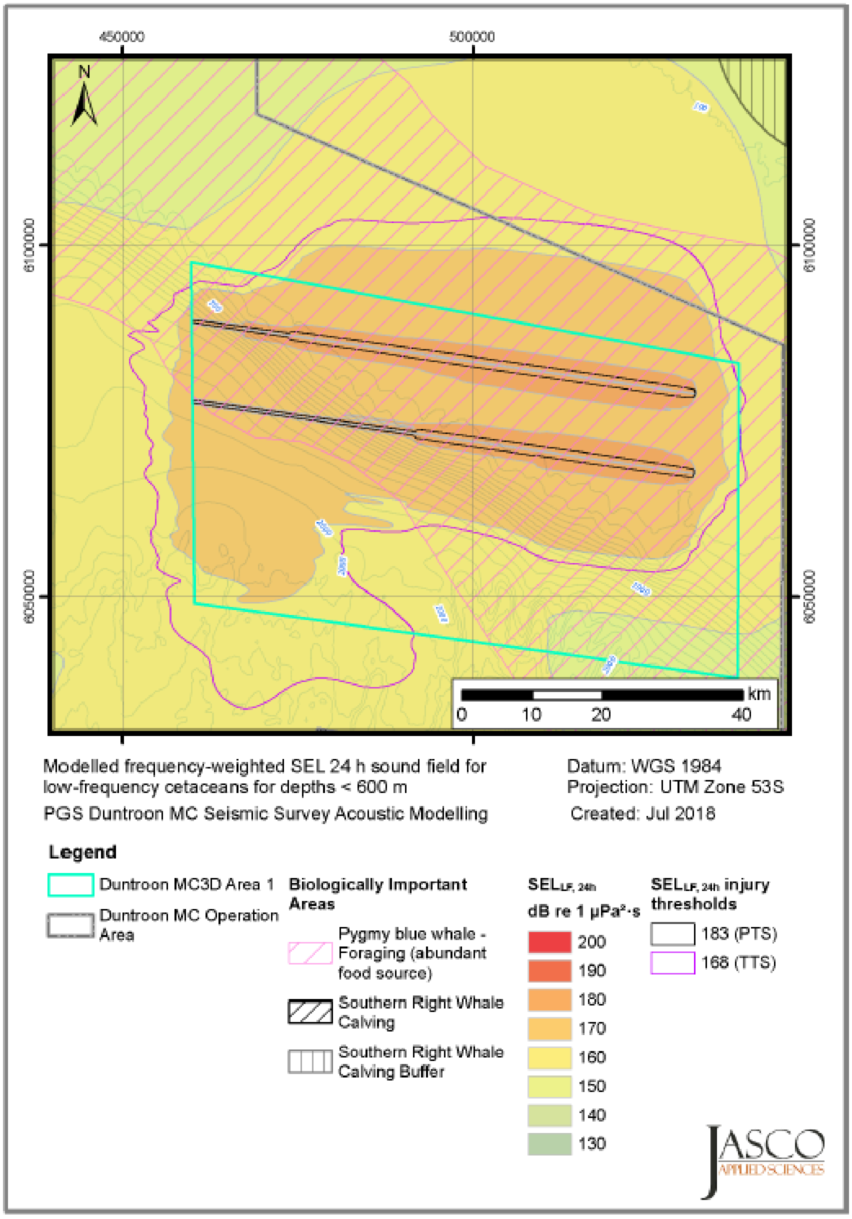
  This SEL_{24h} footprint is provided in Figure 6-14. Note that the SEL_{24h} TTS footprint, based upon the closest MC3D survey lines to shore, does not encroach on the SRW calving BIA or calving buffer BIA. Animat modelling as shown in Table 6-48, also predicts based on the estimated number of animals in those areas, no exposure to SRWs present in the BIAs.

  For migrating LF cetaceans transiting within a radius of 42.3 km of the operational array, individual animals may be exposed to TTS sound levels if the animal remains within that range for 24 hours. No recognised migration pathways or migration BIAs for LF cetaceans lie within this TTS SEL_{cum} footprint.

  For species seasonally present, the Duntroon survey timeframe and controls adopted to prevent blue whale (& associated fin and sei whale) foraging disturbance (refer *behavioural impact assessment*) if upwellings occur will prevent both foraging displacement and TTS exposure (SEL_{cum}) to these species. For migrating SRWs, a species with non-defined migratory pathways, animat modelling predicts TTS exposure to the eastern sub-population is 0.09 animals (0.04% eastern sub-population) and for the entire SRW population is 0.41 animals (0.02% entire SRW population).

  Other LF cetacean species present within the Duntroon survey area during the survey period are transiting through the area. Given no defined migration pathways, the low density of whales and the constant movement of the species, TTS impacts over a 24-hr period are very unlikely.

Figure 6-15: Depths ≤ 600m: Low frequency cetaceans - Sound level contour plot showing frequency weighted maximum over depth SEL results accumulated over 24 hrs (Wladichuk et al, 2018)



- For MF cetaceans (i.e. sperm and beaked whales, common dolphin), modelling predicts the SEL_{24hr} metric did not reach the PTS or TTS threshold, however on a PK threshold basis, PTS may impact if a whale is within a horizontal distance of < 20 m from the operational array.

- For HF cetaceans (i.e. pygmy and dwarf sperm whales), modelling predicts that unmitigated sound exposures exceed the:

    - PTS at a maximum horizontal distance from the operational array of 450 m (PK) (note SEL_{24hr} metric not reached); and

    - TTS at a maximum horizontal distance of 980 m (PK) and 140 m (SEL_{24h}) from the operational array.

The Duntroon survey will implement a shutdown zone of 500 m and a 2000 m low-power zone around the operational array to protect LF and HF cetaceans against PTS and TTS injury, compliant with EPBC Policy Guidelines 2.1 requirements.

For all cetaceans, injury may occur if the acoustic array is started suddenly with cetaceans nearby. In accordance with EPBC Policy Statement 2.1 requirements, with soft start procedures implemented, injury to cetaceans is not predicted as individual animals are expected to displace from areas where physical damage might occur. In circumstances where the acoustic array is operational, acoustic source shutdown and low-power zones protect all cetaceans from injury.

Table 6-47: Maximum over depth results for weighted SEL_{24hr} PTS thresholds based upon NOAA Technical Guidance (2018) for the entire water column and for depths ≤ 600m. A dash indicates the threshold was not reached (Wladichuk et al, 2018).

Hearing Group	PTS			TTS		
	Weighted SEL_{24h} (dB re 1µPa².s)	R_{max} (km)	Area (km²)	Weighted SEL_{24h} (dB re 1µPa².s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	183	0.76	160	168	88.1 42.3 (≤ 600m)	6470 4181 (≤ 600m)
Mid-frequency cetaceans	185	-	-	170	-	-
High-frequency cetaceans	155	-	-	140	0.14	38.5

Table 6-48: Predicted scaled number of animat exposed to sound exposure levels exceeding the TTS and PTS criteria from NMFS (2018) for entire and eastern SRW (sub-) population during 24 hr simulation (Lucke et al, 2018).

(Sub-) Population	Eastern		Entire	
	TTS (168 dB re 1µPa².s) ($L_{E,\ LF,\ 24h}$)	PTS (183 dB re 1µPa².s) ($L_{E,\ LF,\ 24h}$)	TTS (168 dB re 1µPa².s) ($L_{E,\ LF,\ 24h}$)	PTS (183 dB re 1µPa².s) ($L_{E,\ LF,\ 24h}$)
Offshore SRW	0.09	0.001	0.41	0.01
Nearshore SRW	0	0	0	0

Table 6-49: Maximum (R_{max}) horizontal distances (km) from the 3260in³ array to the modelled maximum-over-depth peak pressure level (PK) threshold based on the NOAA Technical guidance (2018) (Wladichuk et al., 2018)

Hearing Group	PK Threshold (dB re 1µPa)	Site 1, Line 2	Site 3, Line 2	Site 4, Line 2	Site A	Site B
		127 m	348 m	747m	496m	950 m
		R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
Low Frequency (PTS)	219	0.03	0.03	0.03	0.03	0.03
Low Frequency (TTS)	213	0.07	0.07	0.07	0.07	0.07
Mid Frequency (PTS)	230	<0.02	0.02	<0.02	<0.02	<0.02
Mid Frequency (TTS)	224	<0.02	<0.02	<0.02	<0.02	<0.02
High Frequency (PTS)	202	0.45	0.23	0.23	0.23	0.23
High Frequency (TTS)	196	0.98	0.60	0.60	0.60	0.60

Overlap with Critical Habitat and Periods of Activity:

The Duntroon OA overlaps the following cetacean BIAs as identified in the NCVA (2018b):

- Pygmy blue whales: Foraging BIAs (*abundant food source BIA* – use is high but variable between and within seasons. Season is nominated as November to May with data to date suggesting peak use in December with limited evidence of later use (NCVA, 2018b); *known foraging area BIA*; *foraging likely BIA* – 20 nm either site of 200 m depth contour in summer/autumn; upwelling driven productivity associated with the shelf break south and west of Kangaroo island. SARDI indicate that productivity is likely to be drifting north-west by prevailing south-easterly winds in summer and autumn (NCVA, 2018b)) and distribution BIAs; and

- Sperm whale: Foraging BIAs (*abundant food source BIA* Kangaroo Island canyons (west) (MC3D survey) and *foraging likely* on continental slope (MC2D survey), present year-round but most abundant in August and September).

Pygmy Blue Whale BIA (PTS/TTS impacts): The Conservation Management Plan for blue whales (CoA, 2015) and EPBC Policy Guidelines state surveys should be undertaken outside BIAs at biologically important times. The temporal placement of the Duntroon surveys has observed this requirement with the September to November period selected to limit temporal overlap. While there is the potential for upwelling-related foraging to occur during November, controls adopted (*refer to behavioural impacts*) will prevent spatial overlap and any possible PTS/TTS impacts to the species.

The Conservation Management Plan for the Blue Whale (CoA, 2015) also identifies the risk of physical impact is minimised by the implementation of the practical control measures outlined in the *EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*. This includes the implementation of a shutdown and low power zones for acoustic array operations, and soft-start procedures prior to full array operation. Control measures for reliably ensuring these shutdown/power down distances are activated are contained in Table 6-52.

Sperm whale BIA: The sperm whale, a mid-frequency cetacean, is a migratory species and does not carry a threatened status under the EPBC Act. Modelling predicts that PTS/TTS sound impacts may occur within a horizontal distance of < 20 m from the operational array. Implementation of EPBC Policy Statement 2.1 requirements for shutdown and low power zones together with soft-start procedures will prevent impacts to this species.

SRW Calving BIA: PTS and TTS sound impacts are not predicted to affect coastal BIAs for the SRW.

Summary:

Consequence Level (PTS/TTS Injury):

LF Cetaceans (PTS): Without EPBC Policy Statement 2.1 control measures implemented, low numbers of cetaceans present in proximity to the operating array may be injured (PTS) leading to disruption to a small portion of the population (MODERATE consequence). After adoption of controls in *EPBC Policy Statement 2.1* PTS impacts are not expected and effects are expected to be incidental to the species (SLIGHT consequence).

LF Cetaceans (TTS): LF cetaceans travelling within a radius of 42.3 km may be exposed to sound levels associated with temporary hearing impairment (TTS) if the animal remains in that range for 24 hours. The Duntroon survey area is not located within, and does not impact on, any recognised migratory corridors for cetaceans and avoids seasonal LF cetacean foraging activities. Any LF cetaceans transiting the area might be affected by TTS leading to a minor and temporary disruption to a small proportion of the population (MINOR consequence). TTS is temporary and recoverable.

MF/HF Cetaceans: Without EPBC Policy Statement 2.1 control measures implemented, low numbers of cetaceans present in proximity to the operating array may be injured (PTS) or temporarily impaired (TTS) leading to disruption to a small portion of the population (MODERATE consequence). After adoption of controls in *EPBC Policy Statement 2.1,* PTS and TTS impacts are not expected and effects are expected to be incidental to the species (SLIGHT consequence).

Behavioural Disturbance

Species Sensitivity: In considering behavioural responses in cetaceans, Southall et al. (2007) discussed a range of possible cetacean behavioural reactions including orientation or attraction to a sound source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat abandonment and in severe cases, panic and flight. An individual animal's response to a stimulus is influenced by the context in which the animal has received the stimulus and how relevant the stimulus is to the individual. A number of biological and environmental factors can affect the animal's response – behavioural state (e.g. foraging, travelling or socialising); reproductive state (e.g. female with or without calf, or single male), age (juvenile, sub-adult, adult), and motivational state (e.g. hunger, fear of predation, courtship) at the time of exposure as well as perceived proximity, motion, and biological meaning of the sound nature of the sound source.

Animals might temporarily avoid anthropogenic sounds, but could display other behaviours, such as approaching novel sound sources, increasing vigilance, hiding and/or retreating, that might decrease their foraging time (Purser and Radford, 2011). Marine mammals have also reduced their vocalisations in response to anthropogenic sounds, sometimes ceasing to call for weeks or months (IWC 2007). Some cetaceans might also compensate for masking, to a limited degree, either by increasing the amplitude of their calls or by changing their spectral or temporal vocalisation properties (Hotchkin and Parks 2013). Whales seem most reactive when the sound level is increasing, which they may perceive as an approaching sound. An animal may exhibit a startle effect at the onset of a sound. Although limited data is available, cetaceans respond less to stationary anthropogenic activities that produce continuous sounds (such as dredging, drilling, and oil-production-related activities) than they do to moving and/or transient sound sources, including seismic surveys and ships (Richardson et al. 1995). Some cetaceans may also partially habituate to continuous sounds (Richardson et al. 1995).

Mysticetes

There are limited behavioural studies on seismic sound impacts to mysticetes and more particularly to (southern) right whales, a species with a seasonal presence in the area coincident with the Duntroon survey timeframe. Most studies relate to northern right whales with respect to ship noise. Nowacek et al (2004) observed no avoidance behaviour in response to simulated ship noise; mild behavioural changes in response to playbacks on con-specific sounds; and avoidance of long-duration, tonal synthetic 'alarm' sounds. Parks et al (2007, 2011) observed an alteration of vocal behaviour in the presence of noise and Rolland et al (2012) identified increased evidence of stress hormones in the speies in the presence of ships.

While there are limited behavioural response studies relating to right whales, other mysticete behavioural response studies are considered relevant. These include:

Foraging behavioural changes:

- Richardson et al. (1995) observed foraging bowhead whales avoid airguns when received levels reached 152-178 dB re 1µPa (SPL), roughly 10,000 times louder than avoidance levels when the whales are migrating;
- Cummings (2009) in a review of sound impacts to foraging behaviour in whales observed an emerging pattern of (at least occasional) changes in foraging at sound levels of 170 dB re 1µPa (units not specified) or less;
- McCauley et al. (1998) observed foraging humpback whales showed behavioural responses commencing at levels 150-159 dB re 1µPa (SPL);
- Malme et al., (1985) observed foraging humpback whales responded up to 3 km from a single 100 in^3 airgun at levels of 150-169 dB re 1 µPa;

- Yazvenko et al., (2006) confirmed no statistically significant effect to foraging gray whale behaviour during a 3D MSS using pre-seismic, post-seismic and during seismic aerial observations between July 19 to November 19, 2001. Mitigations used in the survey minimised the number of gray whales exposed to received sound levels of 163 dB re 1µPa (SPL). This exposure threshold was based on avoidance observations for eastern gray whales by Malme et al. (1986) where the data estimated a 10%, 50% and 90% probability of gray whale avoidance reaction at 163, 170 and 180 dB re 1µPa (SPL) respectively (Nowacek et al., 2012). It concluded that the 2001 sesimic survey had no measurable effect on bottom feeding activity of western gray whales off Sakhalin Island. Yazvenko noted high variability in the feeding activity index (*the index used as to equate feeding activity of whales in the area*) and therefore admitted low experimental power in his study.

Morrice et al. (2004) in a seismic survey in EPP-32 in 2003 (*area has minor overlap with the proposed Duntroon OA*) observed foraging blue whales within approximately 2.4 km of an active seismic source array, with cow/calf pairs, considered the most sensitive of whale aggregations, recorded within 7.1 km orf the operational array. There were no apparent changes to blue whale behaviours (i.e. avoidance of the operating vessel) to within 2.4 km of the active source before it was shut-down. No received sound levels were measured to confirm received sound levels.

Migration and resting behavioural changes:

Behavioural studies undertaken into migration and resting behavioural changes include the following:

- McCauley et al. (2000) observed the following humpback whale behaviour from an operating 2678 in^3 seismic array in ~ 120 m water depths:
    - Stand-off (i.e. closest distance of approach by animals to source) for migrating humpbacks was observed at an approximate distance of 1.8-4.6 km at received sound levels of 157-164 dB re 1µPa (SPL). These results were consistent with sound exposure/distances observed for gray whales of 160 dB re 1µPa SPL (Malme et al., 1985) (*refer below*) and for gray and bowhead whales of 150-180 dB re 1µPa SPL (Richardson et al., 1995);
    - Resting cow-calf pods began avoidance at 9 – 15 km from the operating array and received sound level of 140 dB re 1µPa (SPL) although other cohorts reacted at higher levels (157-164 dB re 1µPa);
    - Resting cow-calf pods began standoff at 7.3-12km and received sound level of 143 dB re 1µPa (SPL); and
    - A single operational air-gun was tolerated by investigating (probable) male humpbacks at 0.65 – 1.1 km and a received sound level of 179 dB re 1µPa (SPL).

  McCauley et al (2000) observed that resting behaviour in cow-calf pods were more sensitive to the approach of air-guns than animals involved in purposeful migratory swimming behaviours. Humpback whale pods on an interception course with the survey vessel, maintained course until 4-5 km from the operational array where bearing and speed adjustment were observed with an avoidance range of approximately 3 km around the operational array. McCauley et al (2000) concluded that 'any risk factor associated with the seismic survey was confined to a comparatively short period and small range displacement' (p177).

- Malme et al (1983;1984) documented behavioural reactions of migrating gray whales to seismic pulses. The study concluded that received levels exceeding 160dB re 1µPa (SPL) were required to cause migrating gray whales to avoid airgun sounds, although statistically significant reactions that were less profound occurred at much lower received levels. Malme et al (1984) calculated 10, 50 and 90% probabilities of gray whale avoidance reactions in these conditions to 164, 170 and 184 dB re 1µPa respectively;

- Migrating bowhead whales, at received levels from 120-130 dB re 1µPa (SPL), showed strong avoidance reactions to an operating acoustic array (Richardson et al, 1999; Manley et al, 2007), however while feeding remained in the area until sound levels exceed ~ 160 dB re 1µPa (SPL) (Richardson et al, 1986; Ljungblad et al., 1988; Miller et al, 1995).

- Dunlop et al (2017) as part of the BRAHSS Project, observed that humpback whales were more likely to avoid an operational airgun array within 3 km of the source at received noise levels over 140 dB re 1µPa^2.s (SEL) meaning that both the proximity and the received level were important factors and the relationship between dose (received level) and response is not simple. The 'control' in this study was the noise effects of the vessel without the array operating and behaviour assessment was determined in change in movement behaviour (i.e. a decrease of speed of movement and/or an increase in course deviation). When controlling for the received level, humpback groups had a greater response to a smaller source size (which was closer) than to the larger source illustrating that proximity to the source is also important.

  Dunlop et al (2017) noted that the derived values (exposure and distance) did not represent a response threshold, but responses were more likely to occur within those bounds than outside them. In addition, the response was highly variable in that some groups did not respond in within these values while others responded outside them. That is, not all movement responses translated into an avoidance response; therefore, a change in movement behaviour should not be assumed to be avoidance of the source. Dunlop et al (2017) noted that the study is only applicable to migrating whales approaching a source vessel that is moving directly across their migratory path, although the whales do show significant behaviour typical of breeding grounds.

Odontocetes:

Dolphin and other odontocete whale species show a variety of reactions to seismic surveys. Stone (2015) in a review of the effects of seismic on marine mammals in UK waters during the period 1994-2010 observed that cetaceans can be disturbed by seismic exploration. These findings included (Stone, 2015)

- When 'large arrays' of airguns (>500 in^3) were firing a significant response (lateral displacement, more localised avoidance or a change in behaviour) was evident for all small and medium-sized odontocetes (including beaked whales) where sample sizes permitted testing, except of Risso's dolphin. The minke whale and the fin whale (baleen whales) were the only species where a significant response to 'large arrays' was found. Lateral displacement, where found, sometimes extended beyond the visual range of the observer. Behavioural responses observed when 'large arrays' were firing included changes in swimming or surfacing behaviour and there were indications that cetaceans remained near the water surface at these times. Cetaceans were recorded as feeding significantly less often when 'large arrays' were active.

- On surveys with 'large arrays' detection rates were significantly higher when airguns were not firing for the grey seal, minke whale, all beaked whales combined, killer whale, white-beaked dolphin, Atlantic white-sided dolphin and harbour porpoise (refer Figure 6-16).

- There was evidence that the soft start may be an effective mitigation measure. Detection rates of cetaceans during the soft start were significantly lower than when the airguns were not firing and on surveys with 'large arrays' more cetaceans were observed avoiding or travelling away from the survey vessel during the soft start than at any other time. These results were found for all species or species groups that were able to be tested.

Figure 6-16: EPP-32 seismic lines and initial aerial survey program (Morrice et al. 2004)

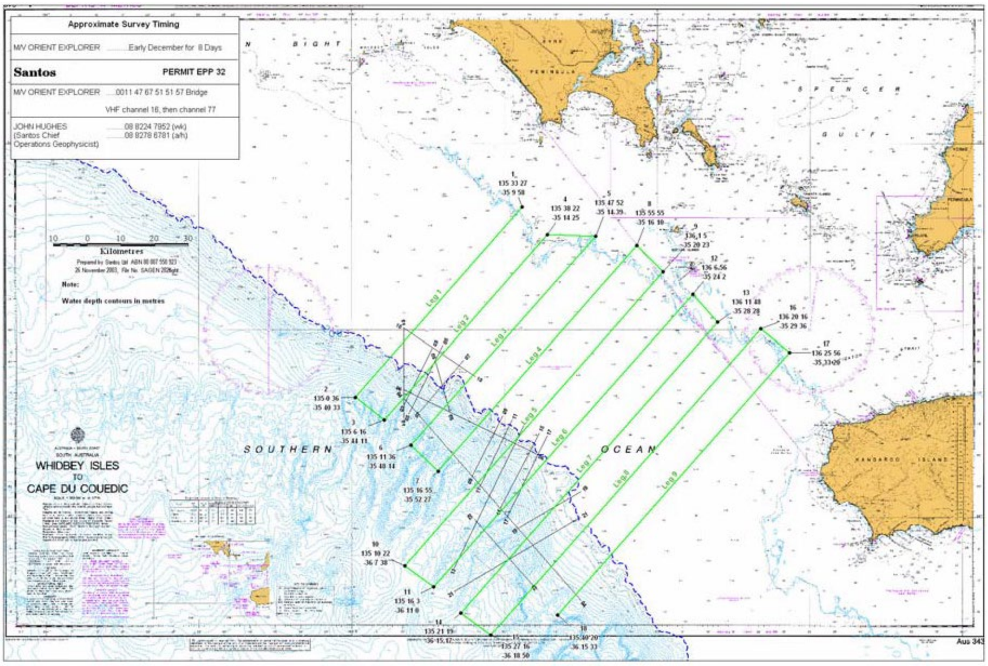
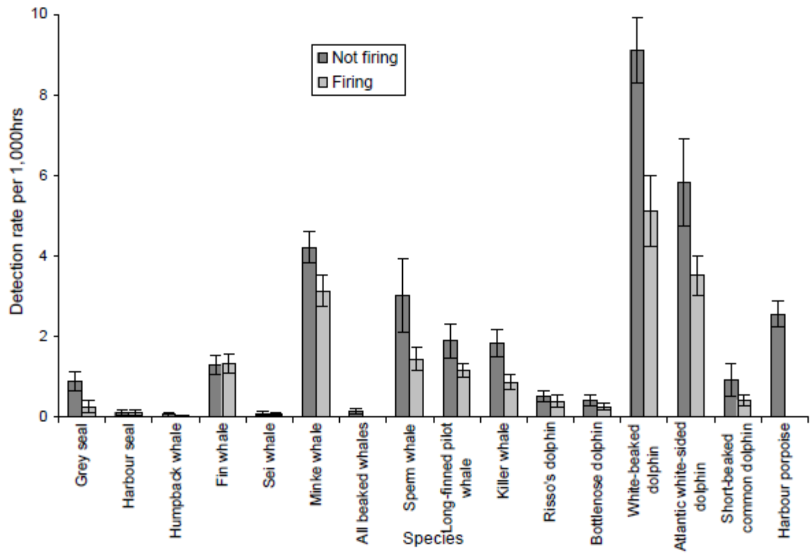


Figure 6-17: Mean Detection rates (& standard error) of marine mammals in relation to airgun activity on surveys with large arrays (Stone, 2015)



Goold (1996) studied the effects on common dolphins (*Delphinus delphis*) over a three month period before, during and after a 2D seismic survey in the southern Irish Sea. The results from this study suggested general avoidance by common dolphins to seismic sound. Monitoring during the period of the survey was restricted to the immediate vicinity (1-2 km) of the seismic vessel; however observations suggest tolerance to sounds outside a 1 km radius of the operating array. Other studies also document that small odontocetes show some avoidance at distances less than 1 km (Stone 2003; Gordon et al. 2004), however some also approach the seismic vessel and even bow ride (Haley and Koski 2004; Smultea et al. 2004; Holst et al. 2005). Dall's porpoise also shows little avoidance of seismic survey vessels, but the harbour porpoise has been reported moving away from surveys at received levels > 155 dB re 1µPa SPL (Calambokidis and Osmek, 1998; Bain and Williams, 2006).

In contrast, sperm whales show little response to seismic surveys, but noise may disrupt/delay foraging and swim effort (Mate et al. 1994; Madsen et al. 2002; Stone 2003; Stone and Tasker 2006; Jochens et al. 2008; Miller et al. 2009). Miller et al. (2009) tagged 8 sperm whales, recording sounds and movement while exposing them to operating airgun arrays. For seven of the eight animals observed, they found that gross diving behaviour did not change. They did not change their buzz rates however oscillations in pitch were affected. One whale exhibited the longest resting period observed in any sperm whale (265 min.) and recommenced diving immediately after the final airgun pulse. Data from the seven whales which exhibited diving were assessed for alterations to foraging behaviour. Pre-exposure conditions were not compared with exposure conditions because of lack of data however full-array exposure and post-exposure control data for the seven whales were included in the analysis. During the operational period, the whales significantly reduced their pitching movements by 11% and all seven sperm whales studied reduced their fluke strokes on foraging dives in the presence of seismic noise. However, the analysis performed "*suggest that the odds favour the conclusion that there is a decrease in foraging attempts at exposure levels ranging from 111 – 147 dB re µPa SPL at ranges of approximately 1.4-12.6 km from the sound source*" (Jochens et al. 2008). Recognising the small sample size of the exposed subjects, definitive statistical significance could not be established for foraging effects. Miller et al. (2009) concluded that sperm whales in the highly exposed Gulf of Mexico habitat did not show any significant avoidance response to airguns, but exhibited subtle effects on their foraging behaviour.

Weir (2008) studied the overt responses (i.e. not subtle responses) of sperm whales and Atlantic spotted dolphins from a seismic vessel off Angola between August 2004 and May 2005 (10-month survey period) using a dual source airgun array of volume 5085 in^3 or 3147 in^3. During the study, sperm whales showed few overtly observable responses to airgun sound. The following observations were made:

- The encounter rate and mean distance were similar during full array seismic and guns off although it is possible that individuals/groups may have spent longer periods at the surface during full array seismic, perhaps increasing their detection. The behaviour of sperm whales rarely changed during encounters, with animals frequently engaged in socialising bouts and feeding dives without obvious reaction as the active source passed. Over half of the sperm whale encounters consisted of nursery groups of calves, juveniles, and adult females;
- Atlantic spotted dolphin encounters occurred at a significantly greater distance from the airgun array during full power compared with guns off and positive approach behaviour by Atlantic spotted dolphins occurred only during the guns-off period; and
- There was no evidence for prolonged or large-scale displacement of any species from the region during the 10-month survey duration.

Madsen et al. (2002) observed the behaviour of adult sperm whales in polar waters during exposure to pulses from a remote (> 20 km) seismic survey. The estimated sound pressure received by the whales were 146 dB re 1µPa PK-PK (124 dB re 1µPa^2.s) in the frequency range 210-260 Hz. The whale's exposure to the seismic survey pulses did not:

- Elicit observable avoidance and the whales stayed in the area for at least 13 days of exposure;
- Fall silent or change their normal vocal patterns during feeding dives; or
- Cease clicking as reported from previous investigations, but two whales seemed to direct their high power, narrow-beam sonar towards the transmitter

The available literature generally supports that there is little behavioural effect of seismic sound on odontocetes. Some literature identifies, particularly for dolphin species, minor levels of displacement while the acoustic array is operational; and another, possible reduced levels of foraging.

Adopted behavioural impact thresholds:

Southall et al. (2007) extensively reviewed marine mammal behavioural responses to sound and found that most marine mammals exhibited varying behavioural responses between 140 and 180 dB re 1µPa (SPL) although some species in specific behavioural modes (i.e. migrating bowhead whales) respond to lower received sound levels. A lack of convergence of data from the multiple studies prevented the authors from suggesting explicit criteria. The causes for variation between studies included lack of control groups, imprecise measurements, inconsistent metrics, and context dependency of responses which included the animal's activity state.

Foraging: NMFS has historically used a relatively simple sound criterion for potentially disturbing a marine mammal. Currently, for impulsive sounds, the received sound threshold is 160 dB re 1µPa (SPL) for marine mammals (NMFS, 2013). For **foraging** mysticetes (e.g. blue, fin, sei and humpback whales) and foraging odontocetes (e.g. sperm whale) this received sound threshold is adopted for assessing the onset of foraging distruption based upon the available scientific studies (Richardson et al, 1995; Cummings, 2009; McCauley et al, 1998; Malme et al, 1985; Yazvenko et al, 2006).

Mysticete Migrating and Calving Disturbance: Southall et al (2007) in their review of available literature relating to behavioural response of low frequency cetaceans to seismic pulses developed an ordinal ranking of behavioural response 'severity' delineating behaviours which are considered biologically *unimportant* (i.e. relatively minor and/or brief responses including altered orientation behaviours, alert behaviour, minor changes in speed, direction and/or dive profile but not avoidance, moderate changes in respiration, minor cessation or modification in call behaviour) with more biologically significant ('relevant') responses related to avoidance of sound sources, alterations in foraging, reproduction or survival and vital rates. This approach recognises behavioural disturbance is graduated and that some noise induced changes in behaviour are more significant than others.

The Southall et al (2007) review identified onset of more significant behavioural responses from multiple pulses for migrating bowhead whales occurred at received levels around 120 dB re 1µPa (SPL) (Richardson et al, 1999). For all other low-frequency cetaceans (including bowhead whales not engaging in migration), significant behavioural response onset was observed at received levels of 150 – 160 dB re 1µPa (Malme et al, 1983, 1984; Richardson et al, 1986; Ljungblad et al, 1988; Todd et al, 1996; McCauley et al, 1998, 2000) or perhaps higher (Miller et al, 2005). There is essentially no overlap in the received levels associated with the onset of behavioural responses by members of these two groups based on information available. Low frequency cetaceans, other than migrating bowhead whales, appear much more tolerant of exposure to multiple pulses, although data is limited to a few species (primarily humpback and gray whales) (Southall et al, 2007).

As reflected in Lucke et al (2018), despite the numerous studies on marine mammal behavioural responses to sound exposure there is not yet consensus within the scientific community regarding the appropriate metric or sound levels useful for assessing behavioural reactions. It is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016; Gomez et al, 2016). Because of the complexity and variability of marine mammal behavioural responses to acoustic exposure, the NMFS has not yet released updated technical guidance providing criteria or thresholds for evaluating behavioural disruption (NMFS 2018).

Initially, the probability of inducing behavioural responses at 160 dB re 1 µPa (SPL) was derived from the HESS (1999) report which, in turn, was based on the responses of migrating mysticete whales to airgun sounds (Malme et al. 1983, Malme et al. 1984). The HESS team recognized that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above 140 dB re 1 µPa (SPL). An extensive review of behavioural responses to sound was undertaken by Southall et al. (2007, their Appendix B). Southall et al. (2007) found varying responses for most marine mammals between 140 and 180 dB re 1 µPa (SPL), consistent with the HESS (1999) report. Absence of controls, precise measurements, appropriate metrics, and context dependency of responses (including the activity state of the animal) all contribute to variability.

Wood et al (2012) proposed a step function of the probability of response for impulsive sounds using a frequency weighted SPL metric. Based upon the Southall et al (2007), reflecting that most marine mammals exposed to impulse noise demonstrate responses of varying magnitude in the 140-180 dB re 1µPa (SPL) exposure range, Wood et al (2012) applied a probabilistic metric at which 10%, 50% and 90% of individuals exposed were assumed to produce a behavioural response at exposures at exposures of 140, 160 and 180 dB re 1µPa (SPL) respectively. However, as noted by Southall et al (2007) certain marine mammal species in specific behavioural modes, appear to be significantly more sensitive to noise exposure. For instance, the migrating bowhead whale is much more likely than other mysticetes to respond clearly to seismic gun noise at much lower (~120-140 dB re 1µPa SPL) received sound levels (Richardson et al, 1999). As a protective approach for this behavioural state – 10%, 50% and 90% response probability for migrating mysticetes is estimated to occur at M-weighted exposure levels of 120, 140 and 160 dB re 1µPa (SPL). These received sound thresholds for migrating mysticetes have been applied in this assessment, particularly for the SRW, the species known to be seasonally present in coastal regions during the Duntroon survey timeframe, within the calving BIA and during migration (coastal and oceanic). The Wood et al (2012) approach has been adopted also incorporating the frequency weighting from the NFMS (2018). It is noted that adoption of this criterion is considered very conservative based upon behavioural response studies reviewed for LF cetaceans. The lower received levels (i.e. 120 dB re 1µPa (SPL)) identified in Table 6-50 are associated with biologically *unimportant behavioural responses* as defined by the ordinal ranking proposed by Southall et al (2007). Biologically important ('relevant') behavioural responses within the calving BIA and during migration (coastal and oceanic) adopt an assessment threshold of 140 dB re 1µPa (SPL).

Table 6-50: Behavioural exposure criteria for calving and migrating mysticetes – probability of behavioural response to LF-weighted sound pressure level (SPL dB re 1µPa) (MFMS, 2018). Adapted from wood et al (2012).

Probability of response to frequency-weighted SPL (dB re 1µPa)		
120	140	160
10%	50%	90%

Extent and Duration of Exposure and Identified Potential Impact:

Foraging: Acoustic modelling performed for the Duntroon survey identifies that a 160 dB re 1µPa (SPL) has a maximum horizontal distance from the operating array according to topographical feature within the Duntroon OA as shown in Table 6-51.

Table 6-51: R_{max} horizontal distance (in km) from the 3260 in^3 array to modelled maximum over depth and maximum ≤ 600m for the 160 dB re 1µPa SPL (odontocetes and foraging mysticetes) (Wladichuk et al., 2018)

Topographical Feature	Relevant Depth Range	R_{max} (km) (max)	Ensonified Area (km^2) (Maximum over Depth)	R_{max} (km) (<600m water depth)	Ensonified Area (km^2) (≤ 600m water depth)
Continental Shelf	< 600m	9.09	124	9.09	124
Continental Slope	< 600 m & Max. Over Depth	13.05	105	13.05	103
Deep Water	< 600 m & Max. Over Depth	7.6	74.4	6.68	24.3

Cetacean foraging BIAs within the Duntroon OA include the following:

- *Pygmy blue whale BIA* (foraging – abundant food source; foraging likely and species distribution): Threats identified under the Conservation Management Plan for the Blue Whale 2015-2025 requires anthropogenic noise in BIAs will be managed such that any blue whale continues to use the area without injury and is not displaced from a foraging area. When undertaking survey activities in the BIA, a maximum ensonification area of 124 km^2 will be present at any time. This is 0.5% of the blue whale abundant food source BIA (24,560 km^2) and 0.09% of the SGS Bioregion.

  The Duntroon survey will be undertaken during September 1 to November 30. September and October are not within upwelling timeframes and foraging blue whales have not been observed in the eastern GAB during that period (refer Section 3.7.5.2), however the potential for upwelling in November is possible and foraging blue whales have been observed in the eastern GAB. Physical parameters leading to upwelling events and the production of zoo-plankton (i.e. krill) are described in Section 3.7.2. During November, PGS will utilise upwelling forecast tools (i.e. wind direction/speed, sea bottoms temperature monitoring and sea surface temperature (SST) monitoring) to identify if environmental conditions reflect those observed during previous upwelling events where foraging blue whales have been present. PGS notes that these upwelling parameters do not predict blue whale abundance or presence, however identifies conditions where upwelling and possible zooplankton generation may lead to blue whale presence and foraging.

  PGS will engage an expert third-party (SARDI – John Middleton) to monitor the following environmental variables to identify the potential for upwelling and conditions suitable for blue whale foraging within the blue whale foraging BIA:

- **Wind direction and speed** (*for wind stress > 0.03 Pa*), recognising the south-easterly wind component contributing to upwelling conditions (from Bureau of Meteorology website [Neptune Island]);

- **Sea bottom temperatures (SBT) within the upwelling area/foraging BIA**. SARDI has confirmed that real-time monitoring of sea-bottom temperatures can occur via the SARDI Southern Australian Regional Ocean Model (SAROM) located at http://pir.sa.gov.au/research/esa_marine/sarom. Scientific literature (McClatchie et al, 2006) identifies this is a condition leading to upwellings in/from the Kangaroo Island Pool. It is proposed that SARDI monitor this cold water intrusion footprint and advise PGS if this precedent condition being triggered;

- **Sea surface temperatures (SST) in the foraging BIA** utilising the http://www.bom.gov.au/oceanography portal for SST (*noting temperature is shown in increments from 10-28°C*). Proposed trigger values to identify suitable foraging conditions would utilise the previous SST for the area recorded when blue whale foraging has been observed (19.2°C ± 0.77 °C) (Gill et al, 2011).

PGS understands that sea surface chlorophyll (SSC) is also an important environmental variable which has correlated with blue whale foraging in the upwelling area/foraging BIA, however has been unable to find a real-time portal to monitor this parameter.

If SE winds are present at Neptune Island and the SBT and/or SST environmental indicators for upwelling are triggered, PGS will initiate daily aerial surveillance to detect blue whales presence or migration into the survey area. This surveillance would be undertaken by qualified observers utilising recognised surveillance techniques. The surveillance area will focus on the area 15 km either side of the shelf break but extend 100 km[100] beyond the MC3D/MC2D survey boundary to detect any migrating blue whales within 24hrs of the survey area. If blue whales are detected within this zone, PGS will assume that foraging is possible and halt the Duntroon survey for the season. If blue whales are not detected, daily aerial surveillance will continue over this area until either blue whales are detected or until November 30, the last day of acquisition for the season.

Note as the EPP-41/42 MC3D survey is sequenced first within the Duntroon survey program, acquisition will be undertaken in BIA areas during periods where upwelling conditions are very unlikely (pers.com J. Middleton, SARDI, 2018). This reduces the potential for spatial overlap of the the MC3D survey[101] with the foraging BIA during later timeframes where up-welling related foraging is more likelihood. Additional controls adopted (surveillance, cessation of survey in November if blue whales sighted) ensure that anthropogenic noise in this BIA is managed so blue whales can use the area without injury and are not displaced from a foraging BIA. While the Duntroon survey spatially overlaps the blue whale foraging BIA, controls adopted ensures the survey activity is consistent with the Conservation Management Plan for Blue Whales (CoA, 2015).With these controls adopted, no injury or foraging displacement is predicted within the foraging BIA (SLIGHT consequence).

- *Sperm whale (foraging):* Sperm whales are known to forage within the canyon systems of the eastern GAB continental slope (i.e. foraging BIA for the species). Displacement effects from seismic activities have not been observed in this species, although there is suggestion of reduced foraging associated with acoustic sound exposure above 160 dB re 1µPa (SPL). PGS will adopt a 13.05 km buffer between the operational array and sperm whales observed to display foraging behaviours during survey activities. This behaviour will be established through a PAM system (to establish presence) and visual observation using support vessels (as required).

[100] Distance is based upon the largest mean distance per day travelled by tagged pygmy blue whales (89.66 km) as per Double et al, (2014).

[101] The MC3D survey has aa spatial overlap of 8.7% of this foraging BIA and the MC2D survey has a spatial overlap of 1.2% of the BIA.

Non-detection of the sperm whale may lead to its temporary foraging activity interruption in the foraging BIA. Given the acoustic source is constantly moving, foraging impacts in any one location will be temporary and recoverable. At any one time, the area ensonified above 160 dB re 1µPa SPL is 124 km^2 (refer Table 6-51). This is 0.2% of the Sperm Whale BIA within this region (57,446 km^2 – includes west BIA and slope off GAB BIA). Additionally, any one location will be affected by the 160 dB re 1µPa SPL for approximately 3.2 hours (i.e. time to travel ~26 km). On this basis, interruption to foraging is intermittent and temporary with foraging resuming rapidly (Miller et al, 2009) after the survey vessel passes.

Sperm whale prey species, such as the cephalopod, are also sound sensitive and may also displace to distances < 13 km from the operational array (refer Section 6.2.3.3). This may indirectly lead to temporary displacement of the sperm whale due to displacement of prey species, however should not reduce foraging opportunities. Given the open ocean location of the survey area, any foraging impacts through non-detection of the sperm whale is expected to be localised and temporary and affecting only a small proportion of the population in a critical habitat (i.e. MODERATE consequence). With controls adopted incidental effects are predicted (SLIGHT consequence).

Other threatened cetacean species which may forage within the Duntroon OA include the fin and sei whales. Threats identified in conservation advices for these species includes assessing and addressing anthropogenic impacts once the spatial and temporal distribution (including BIAs) are defined (note at this time these areas have not been established). The advices also state that if required, additional management measures should be developed and implemented to ensure the ongoing recovery of the species. These species are known to forage with pygmy blue whale species during upwelling events. Control measures adopted for pygmy blue whale to prevent foraging displacement will therefore protect the fin and sei whales from foraging disruption.

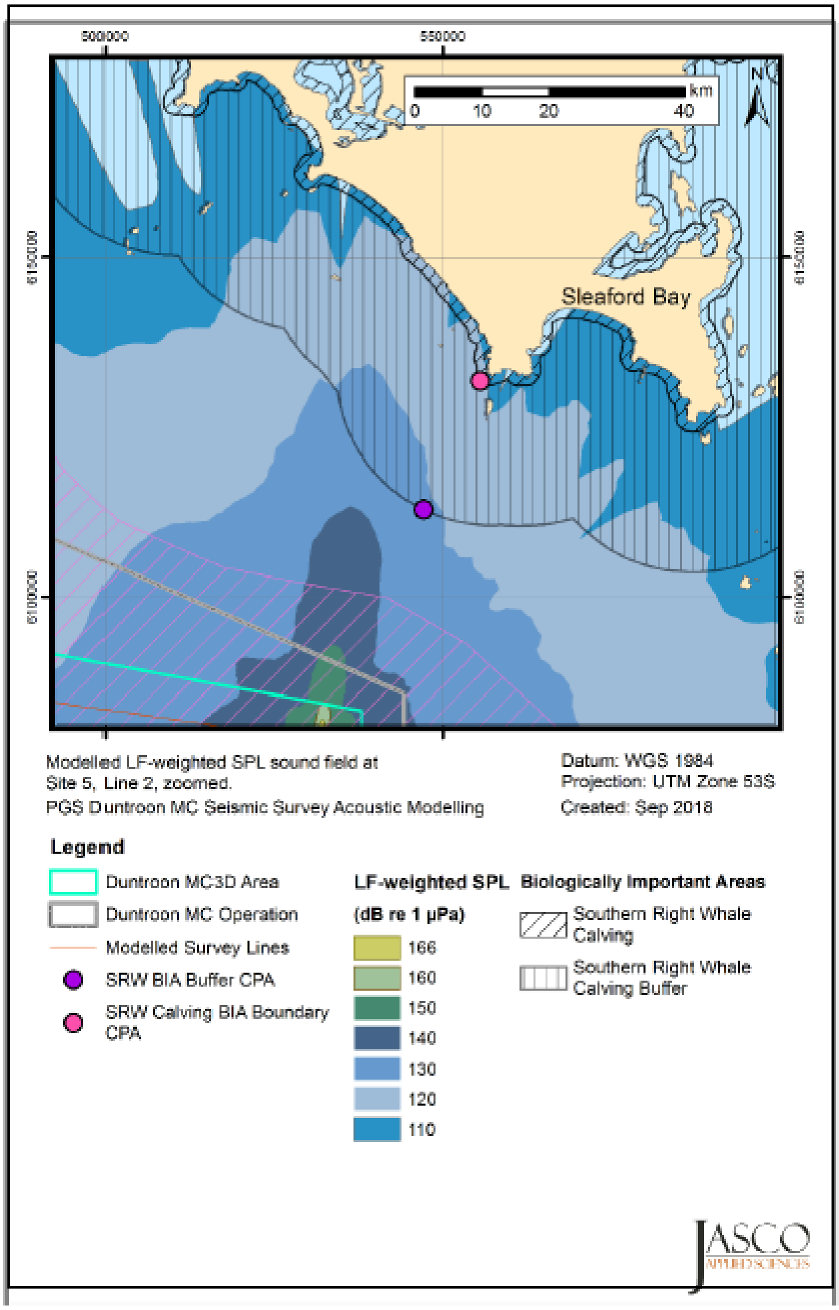
Calving Areas: The Duntroon survey area lies adjacent to a calving BIA for the SRW. The known and established main breeding area within the GAB (SA) is located at the Head of Bight (HOB) (~ 380 km NNW of survey area). Within coastal calving grounds, SRW are primarily distributed within 1 km of shore in water depths less than 20 m (Charlton et al, 2015). The closest emerging calving area to the survey area is Encounter Bay (~ 300 km east of survey area). Several additional areas for SRW are emerging which may be of importance, particularly to the south-eastern population, where small but growing numbers of non-calving whales regularly aggregate for short periods of time (SEWPC, 2012). This includes Sleaford Bay at the southern end of the Eyre Peninsula ~ 51 km NNE of the survey area. Emerging calving grounds are classified as having around three female and calf pairs per year (SEWPC, 2012). Whilst long term annual monitoring studies have been conducted in southwestern Australia (Bannister 2017) and at the major aggregation ground at Head of Bight, SA (Charlton 2017), little is understood about SRW in small and emerging calving grounds in SA including Sleaford Bay, Kangaroo Island and Encounter Bay (Charlton, 2018).

Acoustic modelling predicts the following sound exposures within coastal (nearshore) areas adjacent to the Duntroon survey area (Wladichuk et al, 2018) (refer to Figure 6-17):

- At the SRW calving BIA boundary, the sound exposure is predicted to be 121.8 dB re 1µPa (SPL) (unweighed), 125 dB re 1µPa (SPL) (weighted) from the nearest survey line to the coast;
- At Sleaford Bay (~51 km north), the nearest emerging aggregation area to the survey area, the sound exposure is predicted to be 110 dB re 1µPa (SPL).

At Sleaford Bay, received sound levels to SRW present at the location during the Duntroon survey period are not predicted to be exposed to received sound levels which would cause any type of behavioural impact (*biologically unimportant* or *biologically significant*). In addition, the key coastal habitats where calving is seasonally present (i.e. Head of Bight ~ 380 km NNW and Encounter Bay ~ 300 km east) further away from the Duntroon survey area are also not predicted to receive sound levels sufficient to cause any behavioural response from Duntroon survey activities. This conforms with the objectives contained in the Conservation Plan for the SR whale to protect SR whale aggregations from behavioural impacts.

Figure 6-18: Sound level contour map focussed on the coastal footprint showing maximum over depth LF-weighted SPL results for the 3260 in^3 array towed at 7 m water depth at the closest point to the SRW BIAs. Receiver locations for sound levels at the boundaries are shown as circles (Lucke et al, 2018)



Migration: Cetacean species which may transit the Duntroon OA or undertake coastal migrations during the survey period include the:

- *SR whale*: The SR whale undertakes coastal migrations between aggregation areas while present on the SA coastline between May and October. Modelling predicts at the calving BIA boundary, modelled sound exposures (121.8 dB re 1µPa SPL (unweighted)) is unlikely to have a behavioural response to coastal migrating SR whales (Wladichuk et al, 2018). It is noted that the coastal area affected by these sound levels (> 120 dB re 1µPa SPL (unweighted)) is estimated to be 25 km in length and exposed to westerly weather patterns (i.e. it offers no protection to aggregating whales as compared with Sleaford Bay located further to the east (SEWPC, 2012) (Lucke et al, 2018).

To assess possible impacts to coastal SR whale migration, animat modelling results for the nearshore coastal migration corridor estimates 5 SR whales from the entire Australian SR whale population (0.2% of the entire Australian SR whale population) and 1 SR whale from the eastern sub-population (0.4% of eastern SR whale population) may be affected by the sound level of 120 dB re 1µPa (SPL) (Lucke et al, 2018) (i.e. *biologically unimportant* behavioural impacts). It is noted that McCauley et al (2000) observed avoidance reactions in resting humpback pods with calves commencing at 140 dB re 1µPa (SPL). No SR whales are predicted to be exposed to received sounds ≥ 140 dB re 1µPa (SPL) (50% response likelihood) within the nearshore area. These modelled sound exposures have been undertaken from the closest point of the EPP-41/42 MC3D survey to shore. Given the design of the Duntroon surveys across both continental shelf, slope and deep-water environments, sound within coastal corridors will not be continuous and will reduce as the survey moves further away from the coast and off the continental shelf.

While coastal migratory pathways are reasonably well defined for the SR whale (noting a seasonal movement west along this coastal corridor), offshore migratory routes to/from the Australian coastline are less defined with tagging studies identifying cow/calf pairs migrate directly south as well as west during oceanic migrations (Charlton, 2018). Behavioural studies into seismic sound impacts to migrating mysticetes have observed some deviation as a result of an operational array (Dunlop et al, 2017; McCauley et al, 2000; Richardson et al, 1999; Manley et al, 2007), however proximity to the operating source array, also appears to be a factor in the level of disruption to migration (Dunlop et al, 2017).

It is possible that SR whales undertaking oceanic migrations may be exposed to high levels of sound close to the operational array, however sound exposures will be controlled via implementation of controls detailed in the EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008) (*refer PTS/TTS impacts*). 'Animat' modelling undertaken in 'offshore' areas to understand the number of SR whales potentially exposed to sound levels which could elicit behavioural responses during oceanic migration predicted 5.4 SR whales from the entire Australian SR whale population (0.25% entire Australian SR whale population) or 1.12 SR whales within the eastern sub-population (0.44% eastern SR whale population) may be affected by the sound level of 120 dB re 1µPa (SPL) (Lucke et al, 2018) (i.e. *biologically unimportant* behavioural impacts). For received sound levels of 140 dB re 1µPa (50% response likelihood), a sound level where avoidance behaviours in migrating Australian humpback cow/calves have been measured, 1.15 SR whales within the entire Australian SRW population (0.05% entire Australian SRW population) or 0.24 SR whales within the eastern sub-population (0.09% eastern SR whale population) may be exposed to sound levels sufficient to cause a *biologically significant* behavioural response (e.g. deviation or avoidance) during migration.

At a population level, SR whales affected by sound levels leading to *biologically significant* behavioural responses (i.e. migratory deviation) is very low and not expected to be significant as measured against the significance criteria outlined in EPBC Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DOE, 2013). This includes species recovery aspects.

In addition, the Duntroon OA is within open ocean waters and while small deviations in migration pathway may be experienced by a very small number of animals there are no areas where sound would restrict migration, impede access or deter species from Sleaford Bay (refer to Figure 6-17).

- *Other LF whale species*: Other mysticetes identified in Section 3.7.5.6 as having a possible presence in the Duntroon OA may also experience behavioural impacts (i.e. avoidance) during migration from the operating acoustic array if present in the survey area. The Duntroon survey has been positioned to avoid overlap with the seasonal presence of most mysticetes in the Duntroon OA and is within open ocean waters where sound impacts are unlikely to restrict or impede access to other locations. Behavioural impacts to these species will be minor and temporary (MINOR consequence).

Consequence Summary:

- *Foraging*: If the MSS activity resulted in foraging impacts to:
    - Pygmy blue whales (and other threatened fin and sei whales) the consequence is considered MODERATE with a minor disruption to a small portion of the population in a critical habitat but with no threat to population viability, given the localised and short-term impact predicted. With identified controls implemented to eliminate temporal and spatial overlap, impacts are expected to be incidental (SLIGHT consequence).
    - Sperm whales, the consequence is considered MODERATE with a minor disruption to a small proportion of the population in a critical habitat. With controls implemented, impacts are expected to be incidental (SLIGHT consequence).
- *Migration (Ocean and Coastal):* If survey activities resulted in behavioural impacts to migrating whales:
    - Impacts to SR whales in coastal migration areas is expected to be incidental (SLIGHT consequence) and for SR whales in oceanic environments, impacts are expected to minor and temporary (MINOR consequence);
    - For other migrating species (Humpback and other LF whales) impacts are minor and temporary (MINOR consequence).
- *Calving Locations (Coastal – Southern Right Whale):* Sound impacts to aggregation areas, from the nearest acoustic shot location to shore will be incidental to the local environmental setting (SLIGHT consequence).

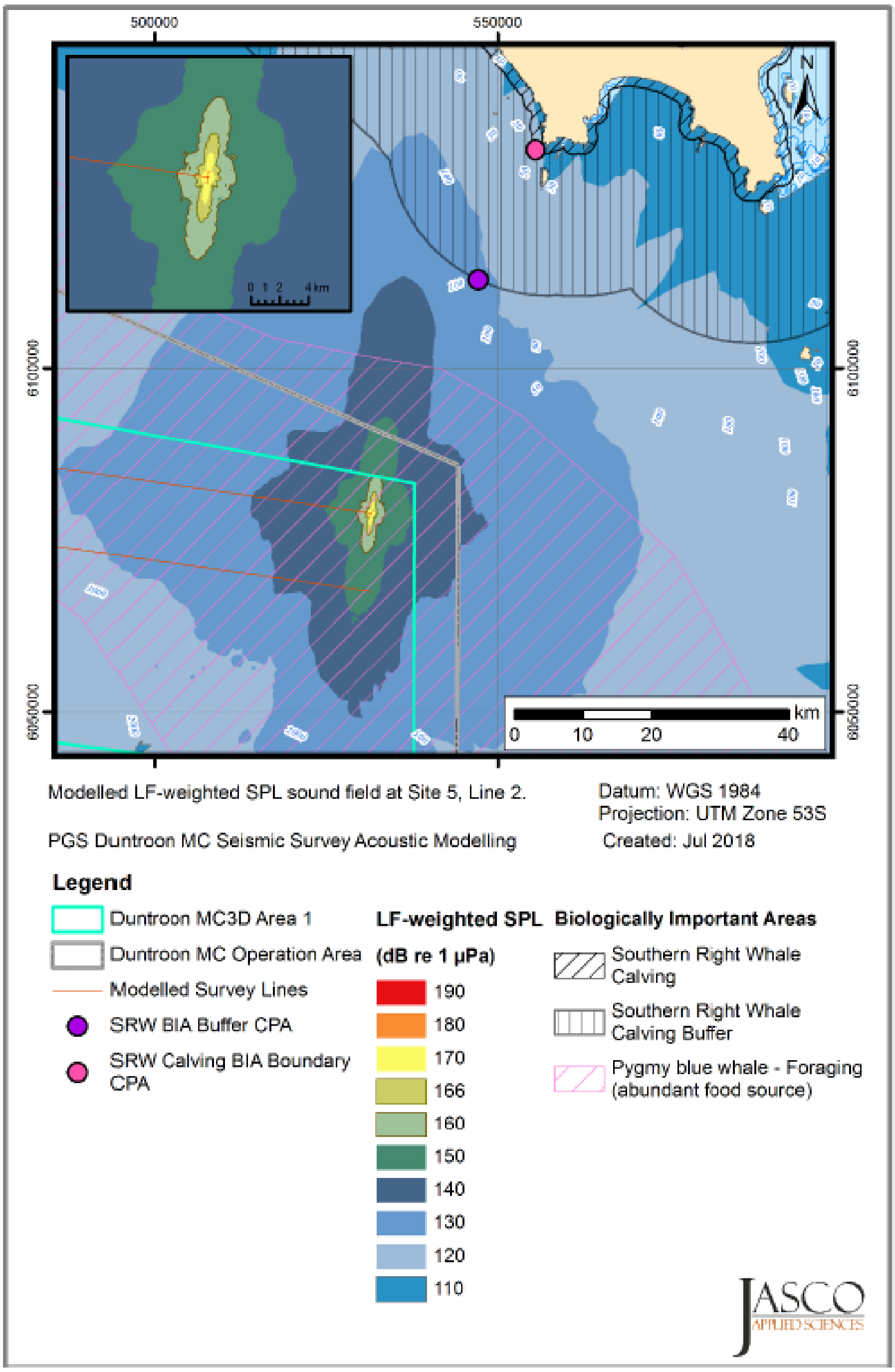
Acoustic Masking:

Species Sensitivity:

Marine mammals use sound for foraging, orientation, communication, navigation, echo-location and predator avoidance (Richardson et al, 1995).

Acoustic masking occurs when sounds interfere with an animal's ability to perceive biologically relevant sounds. It can be defined as a reduction in communication and listening space (active acoustic space) that an individual might experience due to an increase in background noise (ambient and anthropogenic) in the frequency bands relevant for communicating and listening. For example, acoustic masking can decrease the range over which an animal might communicate with its peers, or detect predators or prey, by decreasing their listening space or total active acoustic space (Clark et al., 2009). Masking can occur naturally from wind, precipitation, wave action, seismic activity, and other natural phenomena. For example, the ranges over which fish-eating killer whales use echolocation clicks to detect chinook salmon can be reduced by more than 50% in moderate rain (Au et al., 2004).

Figure 6-19: Line 2, Shot 5 – Sound level contour map showing maximum-over-depth LF-weighted SPL results for the 3260 in^3 array towed at 7 m depth, on a heading of 278° at the closest point to the SRW BIAs, receiver locations for sound levels at the boundaries are shown as circles (Wladichuk et al, 2018)



Marine wildlife almost certainly has adapted to naturally occurring signal masking, yet the reduced active acoustic space under noisy natural conditions is a physical constraint that cannot be overcome completely and must be taken into consideration in acoustic impact assessments. The amount of masking an animal experiences is determined by the amplitude, timing, and frequency content of the interfering sounds, as well as how sounds are spatially distributed. Masking may lead to altered communications, potentially increased metabolic costs and may inhibit receipt of biologically important sounds used for finding prey, identify predators, courtship or group cohesion, navigational aid and calls between mothers and calves decreasing the range over which an animal communicates. The context of the exposure plays a critical and complex role in the way an animal might respond (Gomez et al., 2016). As individual animals vary widely in the response type and the degree of response, behavioural responses to masking are difficult to accurately determine (Nowacek et al. 2004) and some mammals have shown some adaption to enable them to minimise masking impacts (e.g. increasing call source level and/or frequencies) (Tyack, 2008).

Predominantly, acoustic masking within the marine environment has focused on interactions between shipping sounds and baleen whales given these whales communicate at similar low-frequencies to shipping. Since the 1960s sound levels in the marine environment at the 20 Hz frequency level have increased by 10-12 dB due to increased shipping activity (McDonald et al. 2006; cited in Tyack, 2008). Elevations in ambient noise reduce the minimum detection range of species. Hatch et al. (2012) estimates that calling right whales may have lost on average 63-67% of their communication space due to shipping noise.

Sound from seismic activity contributes to ocean-wide masking (Hildebrand, 2009) particularly for species whose hearing thresholds are close to natural background levels (Nowacek et al. 2015). Little is known however, about the individual masking effects of seismic sounds alone, other than the aggregated noise from seismic surveys and shipping leads to higher marine sound levels resulting in increased masking (Nowacek et al, 2015).

Detailed below are relevant characteristics of sound signals and noise characteristics (loudness, frequency content and timing) which influence masking:

- *Sound signal amplitude*: The minimum amplitude at which a sound can be heard above the background noise is termed the Critical Ratio (CR). More specifically, the CR is the amplitude difference between the pure tone signal (in dB re 1µPa) and the spectrum level of the background noise at that frequency (in dB re 1 $\mu Pa^2/Hz$) that is needed for the animal to hear the signal. A signal received at a level below the CR in relation to the background noise will be masked. Critical ratios at low frequencies are fairly constant, but at mid frequencies start to increase with frequency. Johnson et al. (1989) found a roughly constant CR for a Beluga whale from 40 to 2,000 Hz (~18 dB), but that the CR increased up to ~40 dB at 100 kHz. Au and Moore (1990) measured CRs in a bottlenose of ~31 dB at 30 kHz and ~45 dB at 140 kHz.

- *Frequency:* The inner ear acts as a bandpass filter in converting the received sound from mechanical to electrical energy. This bandpass filtering is achieved by having different hair cells along the cochlea 'tuned' to different frequencies. However these hair cells are not just sensitive to the frequency they are 'tuned' to, but also to a range of frequencies (a band) around this frequency of highest sensitivity. The width of the frequency band over which hair cells are sensitive is called the Critical Bandwidth (CBW). Noise outside the CBW will have little effect on the detection of a signal in that band, unless the noise is very loud. CBWs tend to be proportional to the frequency of sensitivity, rather than a constant bandwidth. The wider the CBW the more likely broadband noise is to mask a signal. At the upper and lower end of hearing CBWs tend to be wider and may be more susceptible to masking (Richardson et al. 1995).

- *Timing:* The relative timing and length of a signal and noise also impacts the level of masking. The noise must occur at the same time as the signal to produce masking. In addition, repeating a signal, or lengthening it may also reduce the amount of masking. For example, there is some evidence that repetition of signals in seals and odontocetes increases their detectability (Moors and Terhune 2004; Johnson 1991). Likewise, on small time scales, increases in duration of a signal can increase their detectability (Kastelein et al. 2010).

Studies assessing masking effects of anthropogenic noise on marine mammals observe masking impacts by documenting masking compensation strategies (responses the animals use to overcome the masking effects of the noise). For example, in response to anthropogenic noise marine mammals have increased the duration of their calls (humpback whales; Miller et al. 2000), altered the pitch of their calls (right whales; Parks et al. 2007), called more or less often (blue whales; Di lorio and Clark 2009) and called louder (killer whales; Holt et al. 2009). There have also been efforts to quantitatively predict the spatial zones associated with potential masking effects from anthropogenic sounds (e.g., Clark et al. 2009, Hannay et al., 2016). Although masking effects have been documented in a number of species, it is very difficult to quantify the survival or reproductive consequences of this masking on an individual, or masking on the population.

In order to estimate impact of masking through considering the reduction in active acoustic space quantitatively, it is necessary to consider parameters such as call source levels and their adaptive compensation (Lombard response), detection thresholds based on the receiver perception capabilities, signal directivity, band specific (spectral) noise levels, and noise and signal duration. Instead, a qualitative assessment of masking has been undertaken for this risk assessment, and only species with an overlap between the frequency content of the seismic pulses and their hearing capabilities have been considered. This includes baleen and killer whales.

Extent and Duration of Exposure and Identified Potential Impact:

The sound generated by seismic surveys are, by design, brief, repeated every 16.67 to 25 m, depending upon the acquisition methodology, impulsive and low frequency (strongest from 10 to 120 Hz), but energy has been measured up to 100 kHz (Richardson et al. 1995; Bain & Williams 2006; Gotz et al. 2009), resulting in overlap with the hearing sensitivities of primarily baleen whales and odontocetes. However, frequencies over 500 Hz typically attenuate at distances beyond 1 km of the array in Australian waters (McCauley et al. 2016).

At close range, airgun direct path pulses are quite short on the order of tens of milliseconds, but the effective source level of full-scale airgun arrays can be quite high (up to ~260 dB (p-p) re 1 µPa @ 1m; Gotz et al. 2009 and for Duntroon up to 256.7 dB re 1µPa PK). At longer ranges however, signal duration is affected by multipath propagation (e.g., reverberation can occur) (Guan et al., 2015). High frequency sound is absorbed readily by seawater and the frequency spectrum of the pulse alters with distance. The extent of this absorption, the resulting propagation modes and the spreading of the pulse in time are highly dependent upon the path between source and receiver, and the environmental parameters such as the sound speed profile and geo-acoustics. Typically, higher frequency sounds attenuate and pulses spread out in time. Therefore, while the frequency overlap between airgun pulses and baleen whale vocalisations is considerable, at longer ranges only lower frequencies within the impulse are present, and therefore for species with vocalisations over approximately 500 Hz, there is less overlap. Additionally, as the distance from the source increases, the signal has less energy. However, multipath arrivals with short time delays can increase the relative duration of a transmitted pulse, and at low frequencies over long ranges, the seismic impulse begins to approximate characteristics of continuous noise. For example, one measurement program in Greenland demonstrated that long range measured pulses had effective pulse lengths typically in the order of four seconds (Wisniewska et al., 2014). In Australian waters it has been shown that a seismic survey recorded at greater than 160 km away had pulses of lengths 3-4 seconds long, and the noise level did not return to ambient between pulses (McPherson et al., 2016). However, pulses had no energy above 40 Hz, which is similar to the reported attenuation of higher frequency components by Duncan and Gavrilov (2012). Additionally, the work by McPherson et al., (2016) concluded that when discussing the potential influence of seismic impulses on masking, the variability of ambient environment, and contextualisation of the inter-pulse noise levels, is important. This is because when the received pulse levels are low, variations in the local soundscape, including calls from other whales can increase the inter-pulse noise levels.

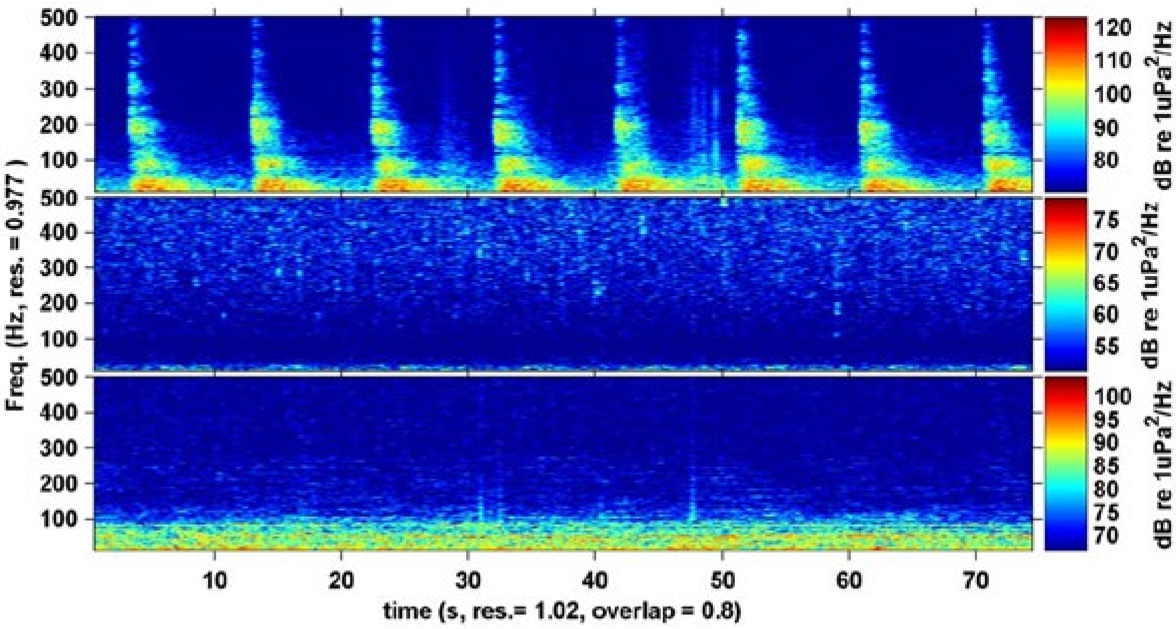
Clark and Gagnon (2006) documented a cessation of fin whale vocalizations across an area of 10,000 square nautical miles during a seismic survey. Vocalizations resumed after the survey suggesting the whales were not displaced but stopped vocalising which may be an indication that masking was occurring. Further evidence of potential baleen whales masking is suggested by Di Iorio and Clark's (2009) finding that Blue whales increased their calling rate during a seismic survey using sparkers (a lower amplitude seismic survey technique). Richardson et al (1995) also identified that distant sources of man-made noise were unlikely to mask short-distance communication between animals. Noise from a distant source, if audible, was likely to be well below the received level of calls by a nearby animal. McDonald et al. (1995) observed that a blue whale stopped vocalising when it was within 10 km of an active seismic vessel. It has been shown that fin whales shortened the duration, decreased the frequency range, and lowered the centre and peak frequencies of their calls in response to shipping and airgun noise (Castellote et al., 2012). Bowhead whale calling rates initially increased alongside seismic sound exposures, but call rates levelled off and peaked as seismic levels increased and then began to decrease when the cumulative SEL 1-minute values increased above 118 dB re 1 µPa^2.s, until they are silent when cumulative SEL 10-min values were above ~160 dB re 1 µPa^2.s (Blackwell et al., 2015).

As shown in Section 3.5.4, one example of impulsive sound propagating across the Australian southern continental shelf in approximately 115 m of water within 40 km of an operating array demonstrated that the geo-acoustic profile of a limestone cap over an elastic seabed eliminated the higher frequency components completely. Another example from southern Australia shows that for a seismic survey in the deeper waters of the GAB, while airgun impulses are apparent at the edge of the shelf, the signals did not propagate onto the shelf (refer Figure 6-19) and therefore did not reach the calving grounds of the SRW.

Southern right whale: Along the SA coastline southern right whales aggregate seasonally between late May and October. SRW 'calls' are an up-sweep at 50-200 Hz for long-distance contact and to bring groups together (Clark, 1983; cited in Richardson et al. 1995). A down call, at a frequency of 100-200 Hz, may be used to maintain acoustic but not physical contact. Source levels have been estimated between 172-187 dB re 1µPa @ 1m (measurement not defined) (Richardson et al. 1995). Other sounds include mixtures of amplitude and frequency modulation all with the major energy at 50 – 1000 Hz (Clark, 1982, 1983; cited in Richardson et al. 1995). Webster and Dawson (2011) in field studies to understand the vocal repertoire of southern right whales in New Zealand waters established that the majority of calls from the species were up-calls with an average peak frequency of 127 Hz (SD +34.71, range: 61-208 Hz) with an average peak frequency of all calls of 156 Hz (SD+ 168.04, Range: 37 – 1599 Hz). The average call duration was 0.74s (SD = 0.32, range: 0.18-2.15s).

Acoustic modelling from the closest modelling site to the coast predicts sound levels in coastal areas to be ~ ~121.8 dB re 1µPa (SPL). Measured ambient sound levels at the Head of the Bight in 50 m over approximately a six-month period had a median of 98 dB re 1µPa (broadband SPL, 3 to 3180 Hz) (McCauley et al, 2013). The impulses propagating across the continental shelf from the survey are expected to only contain low frequency components. If the geo-acoustics close to the coast are similar to those in Bass Strait as reported in Duncan and Garilov (2012) and Erbe et al. (2015), then potentially the pulses will contain no frequencies higher than approximately 40 Hz, which is below the typical frequency band of southern right whales. If this is compared to the CBW introduced earlier, there will be overlap between the estimated lowest CB's of the SRW and the seismic impulses. However, the low received sound level of the seismic impulses is expected limit the extent of the impact. As the audiogram for the SR whale is unknown (Erbe et al. 2015), it is difficult to estimate impacts due to seismic impulses of low amplitude and frequency below the typical vocalisation range of the whale. No significant impacts are expected from airgun impulses at emerging SR whale aggregation sites at adjacent coastal areas.

Figure 6-20: Spectrograms of 75 s samples taken during northern most-seismic line on 18-Nov-2011 09:34 (CST) from: (top) site BP-SL-02 (on shelf edge nearest to line, source around 42 km away); (middle) site BP-SL-01 (Head of Bight); and (bottom) eastern most site BP-SL-03A. No seismic signals were evident at BP-SL-01 during any seismic.



When the seismic survey is in deeper water off the shelf, no signals are expected to reach the SR whale calving grounds, based on both the modelling report (Wladichuk et al, 2018) and measurements of another seismic surveys in the Great Australian Bight (McCauley et al, 2013).

Other Baleen Whales: The Duntroon survey is temporally located in a period which avoids foraging blue whales (& associated other baleen whales such as sei and fin whales).

Whales utilising the sections of the Duntroon OA which lie in deep water or on the continental slope are more likely to experience masking from the survey, with modelled sound footprints demonstrating the ensonification of this region.

However, baleen whales utilising the on-shelf section of the Duntroon OA are likely to only experience masking while the vessel is either operating on the shelf, or along shallow sections of the continental slope. The modelling results for the sites located either at the base of the continental slope, or further offshore demonstrate that sound from the survey will not propagate into the waters of the continental shelf (refer modelling report in Appendix B). This is also demonstrated in the measurements from McCauley for BP.

For any baleen whales present in the Duntroon OA, it is expected that the seismic signal will display distinct pulses which may mask a portion of the sounds emitted/received by the species. The majority of the survery is acquired in deeper waters, with only a small portion of the acquisition on the shelf. This will be on an intermittent basis given the survey design

Odontocetes: There is evidence that mid frequency cetaceans continue to utilize calls and echolocation during seismic surveys. Goold and Fish (1998) reported whistles and clicks from common dolphins during a seismic survey although they did not specifically test for masking effects. Miller et al. (2009) also reported a continuation of foraging clicks from sperm whales exposed to airgun noise. There was some evidence (although not significant perhaps due to small sample size) that buzz train rates decreased during seismic exposure. Because of the lower frequency overlap, masking is less likely in MF cetaceans than it is in baleen whales (LF cetaceans). Likewise, with high frequency cetaceans, the frequency overlap is even lower. No data is available of vocalizing high frequency cetaceans exposed to seismic airguns; however, data available from pile driving detected echolocation clicks of harbor porpoises before and during construction of an offshore wind farm, although the latency between echolocation bouts was much larger during construction than before (Carstensen et al. 2006). Based on the frequency range of the acoustic pulse and the rapid attenuation of high frequency components in seawater, mid and high frequency cetaceans both at short and long range from the operational acoustic source are not expected to be impacted by significant levels of masking.

Summary:

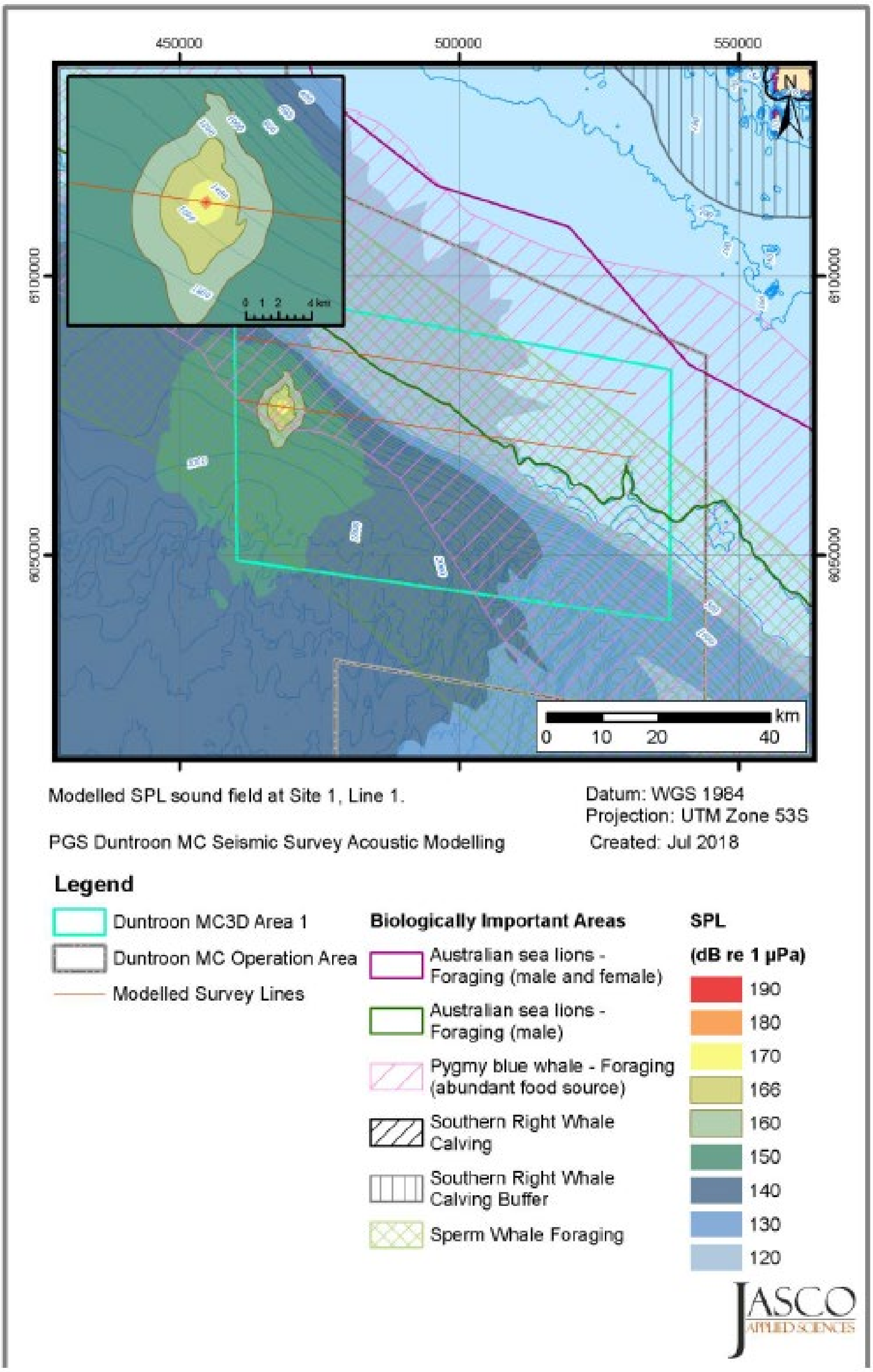
- Masking of MF and HF cetacean call signs during the Duntroon survey, due to the signal pulse and frequency characteristic, is not expected to cause significant levels of masking in mid or high frequency cetaceans during survey activities (SLIGHT consequence).

- Masking in LF cetaceans in proximity to the operating array is possible with some obscuring of call signals (MINOR consequence).

Stakeholder Feedback:

- Natural Resources Kangaroo Island (**Stakeholder No: 43 Records**), DEW (**Stakeholder Record 14**) and TWS (**Stakeholder Record 42**) expressed concern with survey activity undertaken in May due to the likely presence of southern right whales. Additional assessment information has been provided to Natural Resources Kangaroo Island, DEW and TWS on the altered timeframe for the Duntroon survey and the assessed impacts to the SRW based on acoustic and animat modelling. Based on of this assessment, impacts to the SR whale within the calving BIA are not expected to receive sound levels sufficient to cause biologically significant behavioural change in aggregation areas along the SA coastline which aligns with the Conservation Management Plan for the southern right whale. It is noted that the Duntroon survey activity is not undertaken within the SR whale calving BIA and is at a significant distance which prevents significant impacts. DEW has provided feedback to PGS that the survey meets with their expectations, Natural Resources Kangaroo Island has acknowledged receipt of the PGS correspondence dated 16th October 2018, but PGS has not received a reply from this stakeholder. *Refer to separate entry for TWS response*.

Figure 6-21: Modelled SPL at Line 1, Site 1 (deeper waters) showing maximum-over-depth SPL results for 3260 in3 array towed at 7 m depth on a heading of 098° (Wladichuk et al, 2018)



- Kangaroo Island Council (**Stakeholder No: 21 Records**) raised concerns relating to seismic impacts on marine mammals and was also aware of the recent FRDC report on lobsters and scallops. PGS has provided feedback to the council that mitigation controls such as MFOs and PAM in accordance with EPBC Policy Statement 2.1 will be adopted in the Duntroon EP. A copy of the EP is offered to the Kangaroo Island Council as it is submitted to NOPSEMA. Further update on the structure of the surveys and the sensitivities considered in its design was provided to Kangaroo Island Council in September 2017. The altered timeframe associated with the survey (September 1 to November 30, 2019/2020) was supplied to the KI Council during July 2018. *No further feedback provided to date*.

- Kangaroo Island Eco-action **(Stakeholder Record 33)** is against exploration in the GAB as they do not consider it an appropriate environment. KI Ecoaction required strict adherence to the shutdown standards. PGS has provided feedback on the adoption of EPBC Policy Statement 2.1 requirements which are being incorporated into survey design. These controls will be observed. *No further feedback has been provided*.

- Kangaroo Island Dolphin Watch **(Stakeholder Record 32)** has concerns around significant and sub lethal impacts to species particularly cetaceans (PTS/TTS, forging, behavioural and masking leading to possible impacts on foraging or displacement) and wanted assurance over the standards to be adopted on the survey (PAM, controls to mitigate sound). PGS, to provide transparency will utilize a trained local representative as MFO on the vessel to provide this assurity. A copy of the Duntroon EP is provided to Kangaroo Island Dolphin Watch after submission to NOPSEMA. KIDW will continue to provide PGS with studies on cetaceans and anthropogenic sound impacts. Further update has been provided to KI Dolphin Watch on the plans for the altered survey timeframe to September 1 to November 30, 2019/2020. *No further concerns have been raised to date.*

- The Wilderness Society **[Stakeholder Record 42]**, a recipient of the Duntroon EPs , has provided the following feedback: PGS must recognise that whales are known to be present in the GAB outside peak periods (*included in this EP*); survey timeframes should not extend into May 2018 due to the presence of the southern right whale (*assessed, timeframes altered and population impacts not found to be significant*); adequate controls must be in place to protect listed species to ALARP (*e.g. MFOs on all vessels*); a concern PGS does not intend to undertake any additional baseline surveys to establish the presence of blue pygmy whales in the operational area during January to May nor to record this data during the period of the survey (*both not adopted, survey has provided for encounter on a precautionary basis; operational phase monitoring will support operations*); and concern a holistic ecosystem approach was not undertaken taken to assess survey impacts on the GAB environmental sensitivities (*ecosystem components have been assessed – direct and indirect*), nor the long-term or cumulative impacts of the ongoing and numerous surveys in proximity to the operational area had been undertaken (*included*). *Updated Duntroon EP was sent to this stakeholderafter the October submission of the Duntroon EP to NOPSEMA*

  TWS **(Stakeholder Record 42)** responded to the Duntoon EP (Rev 1) in April 2018 providing feedback on the EP submission to NOPSEMA in October 2017. Concerns raised relating to whales included the ‘unknown’ behavioural impacts of noise on SR whales (*literature survey has been provided to TWS*); oceanic migration pathways of the SR whale are likely to intersect the area affected by noise from the Duntroon survey and the survey area is adjacent to the calving BIA which may affect the recovery of the species (*impact assessment details have been provided to TWS together with modelling and animat report to support no significant impact to recovery of species*); impacts associated with SR whale foraging or migratory behaviours has not been undertaken (*impact assessment has been provided*); concerns associated with control measures adopted to prevent cetacean impacts within the previously EP revision (i.e. survey timeframe of March 15 – May 31, 2019) (*controls have been clarified and revised based upon the new survey timeframe and relevant details provided to TWS on specific controls queried*); EP does not include requirements issued under the South-west Marine Networks Management Plan issued on 1 July 2018 (*material has been included in this latest revision*); TWS request for data from all aerial surveys within 24 hours of receipt and all monitoring data (e.g. shutdown mitigation, etc.) (*PGS has committed to provide the aerial survey data to TWS at the completion of survey with a summary of whale sightings on a weekly basis*); completion of interpretation associated with bioacoustics data during seismic surveys (*project completion lies with CSIRO*); and implementation of best practice monitoring guidelines from the Italian Ministry of Environment (2015) on the Duntroon survey activities (*guidelines not seen as holding merit for Duntroon survey area*).

PGS correspondence dated 27th July 2018 and 29th September 2018 provided an update to the Duntroon survey timeframe (September 1 to November 30, 2019/2020). TWS Correspondence (dated 19th October 2018) identified the following concerns with information provided: PGS has not undertaken consultation with TWS in a 'collaborative arrangement' prior to EP submission (*PGS notes that it has fulfilled all legislative requirements for consultation and provided full copies of the EP*); clarification of 'significance' of impacts to the SR whale in coastal areas and during migration (*PGS provided an explanation of the EPBC significance criteria used*); lack of behavioural reaction sound thresholds to assess impacts (*PGS has supplied literature survey on behavioural impacts and adopted conservative criteria for assessment purposes*); data source for the animal ('animat') modelling (*contained in JASCO report for 'animat' modelling provided to TWS*); cumulative sound impacts from survey (PGS hass adopted internationally recognized received sound threhsolds to assess cumulative impacts); and cumulative sound impacts from multiple seismic surveys to migratory pathways intefering with the recovery of the SR whale population (*impact assessment of cumulative sound to coastal corridors provided*). PGS also provided TWS with an update on control measures of interest to TWS which has been altered as a result of further assessment. PGS has not received a reply from PGS Correspondence sent to TWS on 2nd November 2018.

- The Director of National Parks (DNP) (**Stakeholder Record 63**) identified that the conservation values within the Western Eyre CMP includes seasonal calving for SR whale and requires the environment plan to consider impacts on these values ensuring that the impacts are reduced to ALARP. All conservation values within the Western Eyre CMP have been considered in this EP and impacts have been reduced to levels which are ALARP. Further PGS correspondence dated 20th July 2018 provided to DNP on altered survey timeframes (September 1 to November 30) resulted in additional feedback from DNP associated with the South-west Network Marine Park Management Plan, emergency response details and milestone notifications required. These have all been incorporated into the EP.

- The Blue Whale Study (**Stakeholder Record 29**) identified that the region was unpredictable from a seasonal upwelling perspective and foraging may be encountered. Sound disturbance could displace the whales from foraging areas with no alternate food sources available. PGS has identified that this may occur, has altered the timeframe of the survey to prevent impacts to seasonal foraging activities and has developed strategies to minimise the spatial and temporal overlap of blue whales during November. This information has been provided to BWS.

  BWS (Stakeholder Record 29) provided feedback that their concern has been addressed by shifting the survey to the September-November period. This timeframe is less likely to have an impact on foraging pygmy blue whales although their appearance cannot be ruled out in October or November (sightings have been made off Portland in these months in the recent past (non - published literature)). The monitoring/detection approach for onset of upwelling favourable conditions using wind stress and SST is appreciated. BWS provided feedback that kill can be in the system before upwelling is established at the commencement of a season and have noted whales feeding before the upwelling season itself has commenced. PGS has requested further information from BWS with respect to this anecdotal information on blue whale foraging activity and locations in October and November (currently unpublished).

- GABRWS (**Stakeholder Record 67**) expressed concern with the Duntroon survey positioned in the period March to May due to impacts on pregnant SRWs migrating to the coast. GABRWS has been advised of the altered timeframe and information associated with the impacts assessment to coastal and migrating whales has been provided. There has been no feedback from this stakeholder to date.

Controls Assessment:

Table 6-58 provides an assessment of possible controls to reduce impacts to cetaceans from the Duntroon survey activity.

Table 6-52: Assessment of possible controls to reduce impacts to cetaceans

Control Measure	Practicable?	Will it be Implemented?	Justification
Temporal Control: Acquisition will occur in designated window (September to November) to avoid overlap with biologically important periods for the blue whale.	Yes	Yes	Good Industry Practice. Prevent temporal overlap with biologically important periods. Selection of this timeframe utilises periods when blue whales are not present in the region (September – October), and for the November period, upwelling related conditions will be monitored and aerial surveillance initiated if upwelling conditions are triggered, to identify blue whale presence in the area. Any blue whale presence migrating into the survey area and within 100 km of the MC3D survey area boundary will be assumed to be foraging related and survey operations shall be halted for the season. This control avoids the primary period when upwellings may occur and associated foraging activities of the pygmy blue (& other baleen) whales. This control is considered effective, reliable and survivable.
Seismic line removal across BIA areas for the sperm and blue whale.	No	No	Survey lines are required across the continental slope and within the foraging BIA areas for the pygmy blue and sperm whale to achieve survey objectives for the MC2D and MC3D (EPP-41/42) survey areas. The EPP-46 survey area is not yet finalised however MC3D acquisition will not be undertaken in the Gulper shark closure area (i.e. spatial exclusion).
Implement EPBC Policy Statement 2.1 (Part A) Standard Management Procedures A1 to A4 including: • Pre-startup observation and use of soft-start procedures (30 mins observation time in whate depths < 200m; 60 minutes observation time for water depths > 200 m); • Adoption of operational buffer zones – 3 km observation zone, 2 km power down zone and 500 m shutdown zone. • Start-up delay Procedures; • Operational Procedures [Note 3] • Stop work Procedures; • Adoption of night time/low visibility procedures • Trained crew observing for cetaceans	Yes	Yes	Good industry practice. Standard practice for industry. Crew will be briefed on environmental matters including information on the EPBC Policy Statement 2.1, whale identification and legal obligations in Australian waters. Adoption of JNCC requirements for longer observation periods in deeper waters is due to the possible presence of sperm whales (JNCC, 2017). Notes: 1. Due to disturbances associated with foraging sperm whales, a power-down will occur if the species is detected within 13 km of the operational array to prevent foraging disturbance. 2. In deeper waters *observation* includes PAM on pre-shooting searches as per the JNCC requirements. 3. In accordance with the JNCC procedures, due to the longer pre-shooting time required in deeper waters, pre-shooting searches can commence before the end of a preceding survey line (whilst airguns are still firing) IF the line changes will take less time that the pre-shooting search and soft-start combined (i.e. 90 minutes) (JNCC, 2017).
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B1: Use of MFOs (survey vessel).	Yes	Yes	Good Practice – well defined and established procedures. Two experienced MFOs will be present on the survey vessel to observe and initiate shutdown and powerdown procedures if cetaceans are sighted within respective zones. MFOs will be trained and experienced in whale identification and behaviour and distance estimation. An additional trained but (possible) not experienced MFO will supplement the MFO complement on the survey vessel (fulfils commitment made to Kangaroo Island Council and Kangaroo Island Dolphin Watch). This resource shall supplement MFOs onboard. The inexperienced MFO will also obtain experience during vessel mobilisation.
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B1: Use of MFOs (support/chase vessel).	Yes	Yes	Support/chase vessels will each have one trained and experienced MFO to observe for cetacean presence and behaviour. Crew relieving the MFO will have training in whale observation and distance estimation.
Independent monitoring of fauna interactions with survey	Yes	Yes	PGS shall assist in training a community representative from Kangaroo Island Community to assist with MFO activities on the survey vessel. Subject to this person's availabity at the time of the survey, this person will be employed for a minimum of one swing during the project.

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B2: Night-time/poor visibility (limiting soft starts to conditions which allow for visual inspection of the precaution zone).	Feasible	Yes (in accordance with Part A Management Procedures)	PGS will adopt the night-time and low visibility procedures as per the Part A management measures. That is, within a location soft-starts and operations may proceed provided: • there has not been 3 or more whale instigated power-downs or shut-downs during the preceding 24 hours; or • Startup may also occur if operations have not been underway in the preceeding 24 hours and the vessel (& surveillance craft) have been in the vicinity (approximately 13 km) of the proposed start-up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period and no whales have been sighted. Operations may proceed (as normal) provided there has not been 3 or more whale instigated power-down or shut-down situations during the preceeding 24 hours. If 3 or more whale instigated shutdowns/powerdowns occur (i.e. high numbers of animals): • Soft starts will be undertaken at that particular location if good visibility conditions are present and PAM operator has confirmed no whales are not present in the low power/shutdown zones or sperm whales within 13 km of the array; and • Operations at night or in low visibility will not be undertaken at that particular location. In this instance adaptive management measures will be considered (refer *adaptive management*). In general, limiting soft starts to conditions which allow for visual inspection will only increase the survey duration, overall cost and length of survey (with associated impacts).
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B2: Poor visibility (Daylight spotter vessels or aircraft).	Yes	Yes (in certain conditions)	. Aerial surveillance will also be implemented if upwelling- related environmental triggers are detected in November to identify the possibility of blue whale migration into the aea. During aerial surveillance the aircraft will maintain continuous contact with the survey vessel (as appropriate) to provide cetacean information. Aerial surveillance will also be considered during survey operations to supplement vessel surveillance and provide information on whale presence and behaviour in BIAs if whale numbers are higher than expected (i.e. 3 or more shutdowns/powerdowns per day or 3 or more whale sightings recorded in the low-power/shut-down zone during shut/powerdowns) to inform adaptive management measures. Aerial surveillance comes with significant HSE risk and weather limitations and will only be considered if conditions are safe. PGS considers that daylight vessel-based surveillance is effective in most conditions given the low encounter with baleen whales expected and in establishing the local presence of whales and their activity. Aerial surveillance relies on good weather and has additional safety issues (i.e. remote areas over Southern Ocean, weather condition limited) and many areas of the southern MC2D areas within the Duntoon OA are too far from shore to provide coverage. PAM coverage will also provide additional surveillance capability, particularly for deep diving species (*refer to PAM*).
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B2: Night-time/poor visibility (Pre-survey research surveys).	Yes	Yes (prior to survey commencement)	PGS considers that initial awareness of the whale presence within the MC3D survey area prior to mobilisation is necessary to confirm the initial start position and sequencing of lines, given no on-water information from scout vessels is available. This aerial surveillance will be initiated up to 3 days prior to survey commencement. If this cannot be undertaken a vessel will be pre-deployed to the survey area to scout for cetacean activity. PGS has reviewed all available cetacean data from studies utilising data from 1950 – present. On this basis, PGS considers that sufficient consistent information is available to assess possible impacts from the survey and reliably develop mitigation controls. No additional surveys beyond the initial aerial survey undertaken before survey commencement and aerial surveillance if upwelling conditions are triggered are considered to provide additional environmental benefit given the MFOs on-board the survey vessels and PAM detection from the survey vessel.

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B3: Spotter Vessels and Aircraft	-	-	Assessed as part of Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B2: Night-time/poor visibility (Daylight spotter vessels or aircraft) and (Pre-survey research survey).
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B4: Increased pre-caution buffer zones (Foraging Sperm Whales)	Yes	Yes (in certain conditions)	Precaution zones for migrating cetaceans (excluding dolphins and porpoises) of 3 km observation; 2 km low-power and 500 m shutdown as per EPBC Policy Statement 2.1 Part A requirements. Application of these distances protects all whales (LF, MF, HF) from PTS and TTS impacts. Increasing the precaution zone will allow the MFO/PAM operators to implement controls to prevent sound exposure during other activities. Increased precaution zones are recommended when undertaking surveys in known critical habitats such as BIAs for foraging. The Duntroon survey is spatially and temporally positioned to avoid the primary upwelling period (December to March) and associated peak presence of LF cetacean species foraging in the BIAs with detection controls identified for whale entering the Duntroon OA during the November timeframe If foraging is detected within the sperm whale foraging BIAPGS will take a precautionary approach and implement an increased low-power zone to 13 km to reduce received levels and the potential for behavioural changes in sperm whale foraging. This will be detected through the application of PAM (refer PAM), initial survey surveillance and if whale numbers are higher than expected.g to prevent disturbance toforaging activities.
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B4: Increased precaution zones and buffer zones (application of a 60 min pre-watch)	Yes	Yes (in certain conditions)	Pre-watch timeframe for migrating cetaceans (excluding dolphins and porpoises) is 30 minutes as per EPBC Policy Statement 2.1 Part A requirements. Increased pre-watch times are recommended for critical habitats, where longer 'down-times' may be observed, (i.e. the time between surfacing events are longer for species that are feeding, migrating or inhabit deeper depths of the water column for species such as sperm whales). If As a sperm whale BIA spatially overlaps the Duntroon OA for waters > 200m PGS will take a precautionary approach and implement an increased pre-watch time of 60 minutes to assist with sperm whale detection.

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B5: Passive Acoustic Monitoring (PAM)	Yes	Yes	Passive acoustic monitoring is a technique that uses underwater microphones to detect, monitor and in some cases localise marine mammals that are vocalising. PAM is known to be particularly successful when implemented for odontocetes such as sperm whales, dolphins and porpoise known to emit regular distinctive clicks during long dives. PAM has limited application for detecting baleen whales such as blue whales due to the types of vocalisations made by these whales (long wavelength). As such PAM is not considered to provide any environmental benefit during the survey for baleen whales. While PAM has the capability to detect cetaceans up to tens of kilometers away, the detection range is dependent on the environment and in particular background noise. In particular the signal to noise ratio is a significant limitation for detecting whale calls during seismic surveys. The EPBC Act Policy Statement 2.1 recommends the use of Part B additional management measures (of which PAM is one mitigation measure of several) where the likelihood of whales encounters is **moderate to high** or where **habitat is considered to be important** (areas of aggregation). The Duntroon OA overlaps the sperm whale BIA. Given this BIA, PAM is considered useful in the detection and monitoring of this deep-diving species . PAM is generally considered unproven in Australian waters, and the successes of PAM to-date in the scientific literature are for fixed PAM observation method where noise signals are not compromised by vessel noise (Salgado Kent *et al.* 2012) and seismic noise. This is further supported by recent surveys (Nerites) undertaken by TGS in the GAB in which PAM was utilised. Of the 53 cetaceans recorded, only two were initially detected with PAM, with all others detected via visual cues. The two cetaceans detected using PAM were sperm whales, while blue whales were visually sighted. Sperm whales were also detected visually. PAM can provide a method of detecting individuals which do not have a significant surface presence and allows for detection during low visibility conditions but relies on the vocalisation of animals. When undertaking deep dives for foraging, sperm whales produce click vocalisations, a form of echolocation, while foraging. Research indicates that dives last on average 45 minutes within individuals vocalising for approximately 68% of the dive cycle and the majority of vocalisation occcuring at maximum depth when foraging (Watwood et al., 2006). This study identifies that dive depths varied between 400 and 1200 m (Watwood et al., 2006). PAM suppliers have confirmed that detection of sperm whales within 13 km of the operational array can be achieved (S. Childerhouse, pers.com 2018). Power-downs will be initiated on detection of sperm whales within this distanceand will assist in detection and will be adopted for this survey. Due to the limited detection range of current PAM technology for HF cetaceans (~300 m) and the possibility of TTS (PK basis) if within 980 m of the operating array, any bioaccoustic detections will require immediate shutdown of an active source or the delay of operations regardless of signal strength (DoC, 2013). PAM operation will occur on a 24 hour basis within the sperm whale BIA by two competent and experienced PAM operators who will integrate with MFOs to identify and localise cetaceans and apply power-down/shutdowns to odontocetes within the 500m (shutdown) and 2000m (powerdown) distance as necessary. Utilisation of support vessels to verify the presence and foraging behaviour of sperm whale will also be undertaken. A backup PAM monitoring system will be carried on-board during the survey. All PAM operators are trained in the repair of these systems. This ensures the robustness of this control.

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B6: Adaptive Management (Acquire data on different lines or cease operations)	Yes	Yes (in certain conditions)	It is inefficient and costly for a proponent to continuously shut down due to the presence of whales observing that continued operations in areas with high numbers of whales is also not a suitable outcome. If there are three or more power-downs/shut-down zone due to sperm (or other) whale presence in the preceding 24 hours or three or more sightings of these species within the shut/power-down zones when the acoustic array has been non-operational in the preceding 24 hr period, the density of whales in the area will be deemed to be "high" and cause the following measures to be implemented: • Surveillance: A support vessel will travel along the acquisition line to a distance of at least 13 km from the seismic array. If sperm (or other) whales are observed within the distance of observation by the MFO on the support vessel, the survey vessel will implement adaptive management. • Relocation: Survey vessel will relocate to another survey line > 13 km from the last confirmed whale sighting location where the support vessel has confirmed no whale presence. The survey vessel will not return to the original location within 24 hrs; OR • Cessation: If there are no options for the relocation (e.g. no other survey lines to acquire), all night time operations will cease at this location until 24 hours have passed with no whales observed. However if at this decision point, if there have been less than 3 sightings within the power-down/ shutdown zone in the preceding 24 hours, night-time operations can re-commence in this location.
Mitigation Acoustic Source	Yes	Yes	JNCC's analysis of marine mammal observer data from 1994 – 2010 collated the median closest distance from the acoustic source while the source was active and and not active. This data identified that the likelihood of whales approaching the the injury zone (within 500 m of the operational array) is extremely low. These observations are consistent with the general concensus that whales exhibit aversion to sound levels which may cause injury (DEWHA, 2008). Sound may also cause behavioural impacts to cetaceans in foraging areas. Spatial buffers will be applied to foraging whales to prevent displacement effects. However, to eliminate sound contribution to the environment in general and potentially contribute to masking effects, on line turns the operating array will be shut down other than when testing the guns. This is consistent with JNCC (2017) guidelines for airgun array volumes > 500 in^3 with line changes less than 40 minutes.
Use of smallest source size to meet survey objectives (3260 in^3)	Yes	Yes	Good Industry Practice. Due to the sub seabed depths of geophysical targets, a smaller energy source would be unable to meet the geophysical objectives of the survey and PGS would be unable to meet seismic data delivery requirements of clients. The selected source is smaller than the 4,130 cu in array PGS previously used in the region. The 3260 in^3 array will be the largest sound source utilised on the survey.
Acoustic Sound Source Verification (SSV)	Yes	Yes	PGS has previously undertaken sound source verification (SSV) for the 3260 in^3 array during operations within New Zealand to assess for compliance with the mitigation zones outlined in the New Zealand Code of Conduct (short-range modelling). The verification process utilised recorded seismic data from the survey to confirm that actual emitted sound levels were as per predicted levels (G. Bennett, 2017). The analysis found that the received levels were less than the levels modelled in the sound transmission loss modelling report. The sound modelling was performed by SLR Consulting Australia Pty Ltd, and the sound verification was performed by Talis Consultants (G. Bennett, 2017). Given the conservative nature of the buffer distance applied between the operating array and the SRW calving BIA boundary, PGS does not believe habitat monitoring is required as a control measure,however will install a sound logger to analyse received levels at the completion of the survey (refer to sound loggers) to inform future modelling events. PGS will however verify the accuracy of the shortrange sound modelling via MCS analyis using the Talis methodology contained in **Appendix L** to re-confirm modelling accuracy for future modelling events.

Control Measure	Practicable?	Will it be Implemented?	Justification
In addition to whale management, MFOs an inducted crew will monitor for pinnipeds and other marine fauna.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds, turtles and seabirds. There is a limitation on the practicability of sighting of some species (e.g. shark, fish) and increasing visual observation to these species may serve to compromise implementation of EPBC 2.1 control provisions for key sensitive species (whales).
Use of drones as surveillance tools.	No	No	Drones offer safety benefits over aerial surveillance and can operate in broader weather windows. Although drones have been used for spotting and watching whales, they are untested on an operational seismic survey and as such will not be adopted during the Duntroon survey.
Use of acoustic seabed loggers (within SRW calving BIA)	Yes	Yes (for SRW BIA sound verification not for adaptive management)	This measure has been adopted to verify the propagation modelling component on the Duntroon acoustic modelling. The predicted sound level at the SRW BIA boundary of 125 dB re 1µPa (SPL) is 15 dB below the received sound levels adopted to assess biologically important behavioural impacts (i.e. avoidance) within this zone. This 'sound buffer' is adequate to eliminate the need for real-time acoustic monitoring and feedback into adaptive management measures. This logger will be positioned in the coastal zone for the 2019 season only. The MC3D MSS within EPP-41/42, the closest survey to coastal SA will be undertaken in this season. This information will be used to demonstrate received sound levels in the coastal zone from Duntroon survey activities to stakeholders. .
Use of sonobuoys	No	No	PGS has evaluated the potential use of these devices in the survey area to detect baleen whales near a moving survey platform. The measure is highly research oriented around defence activities and procurement and deployment of such equipment is difficult (perhaps impossible). The operational logistics of deploying large numbers of sonobuoys is significant and PGS is concerned about the environmental issues of allowing them to sink to the seabed after their 32-hr life. Another factor is the issue in transmitting the signal recorded at the sonobuoy back to the seismic vessel (in real time) such that any low frequency, long time series vocalisations from baleen whales could be recognised quickly such that mitigation measures implemented..
Use of quieter technologies (air guns with bubble curtains, marine vibrators, DTAGS)	No	No	PGS has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Duntroon survey. Other than eSource (a technolology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration.

Sound Verification in Adjacent Areas (SRW BIA):

Verification of acoustic modelling within the GAB was undertaken as part of the Ceduna MSS located in waters off the continental shelf (depth range: 1000-2500 m, 4130 in^3 source size) utilising autonomous noise loggers located on the continental shelf edge (~ 190m water depth) plus a noise logger at the HOB (depth - 50 m). During the Ceduna MSS no airgun signals were detected at the HOB location with sound falling within ambient ranges at that location (McCauley et al, 2013) for the duration as predicted by acoustic modelling (Maggi & Duncan, 2011). This aligns with the predicted results from the Duntroon acoustic modelling report – when the array is operational in the deeper waters of the GAB, there is no signal detected on the shelf (Wladichuk et al, 2018).

Similar sound propagation modelling verification studies have been undertaken for Otway region MSSs (~ 600 km SE), an area which has similar seabed characteristics to the Duntroon survey area (i.e. calcarenite layers). An analysis of MSSs all utilising an acoustic source of 2500 cui[103] showed that when the seismic source was well up on the shelf (< 100 m water depth) sound transmission was largely attenuated within 5 km of the source and was almost completely attenuated within 15-20 km. In deep water measurements, sound transmission had less attenuation at any given range. Table 6-53 provides details of the Otway surveys with Figure 6-21 providing the graphical output of these received levels at autonomous bottom-mounted receivers (green points). The Antares survey was in relatively shallow water (mostly < 100 m water depth) and the Vic /P51 survey was in water depths which ranged from the shelf edge to 50 m.

As can be seen fromFigure 6-21, there is a large amount of variability in received levels at set distances from the acoustic source (up to 35 dB evident at 20-30 km). For the mean square pressure, surveys conducted in deeper waters always produced the highest signal range at any distance and propagated the greatest range (less attenuation) (McCauley, 2005). Table 6-54 provides the horizontal ranges for received sound levels on the Otway shelf for the data collected during these MSSs.

Table 6-53: General details of surveys in the Otway region (McCauley et al, 2005)

Survey (year, region, receiver, receiver location)	Number of Array Elements	Array Volume (Cui)	Range Received (min-max) (km)	Water Depth (mean at source/ receiver) (m)
Otway Basin 2D, 2003, Antares, Warrnambool (bottom receiver)	17	2500	18.9-19.6	49/70
Otway Basin 2D, 2003, Vic/P57 Site 7, Portland (bottom receiver)	17	2500	0.1-31.3	77/17
Otway Basin 2D, 2003, Vic/P57 Site 9, Portland (bottom receiver)	17	2500	0.4-25.5	78/57

Figure 6-22: Received equivalent energy (top) and mean squared pressure (bottom) from Otway seismic survey data (green) in log range (McCauley, 2005)

[103] Acoustic source had a modelled signal of 230.2 dB re 1µPa^2.s (SEL) a similar output to the proposed Duntroon survey acoustic source.

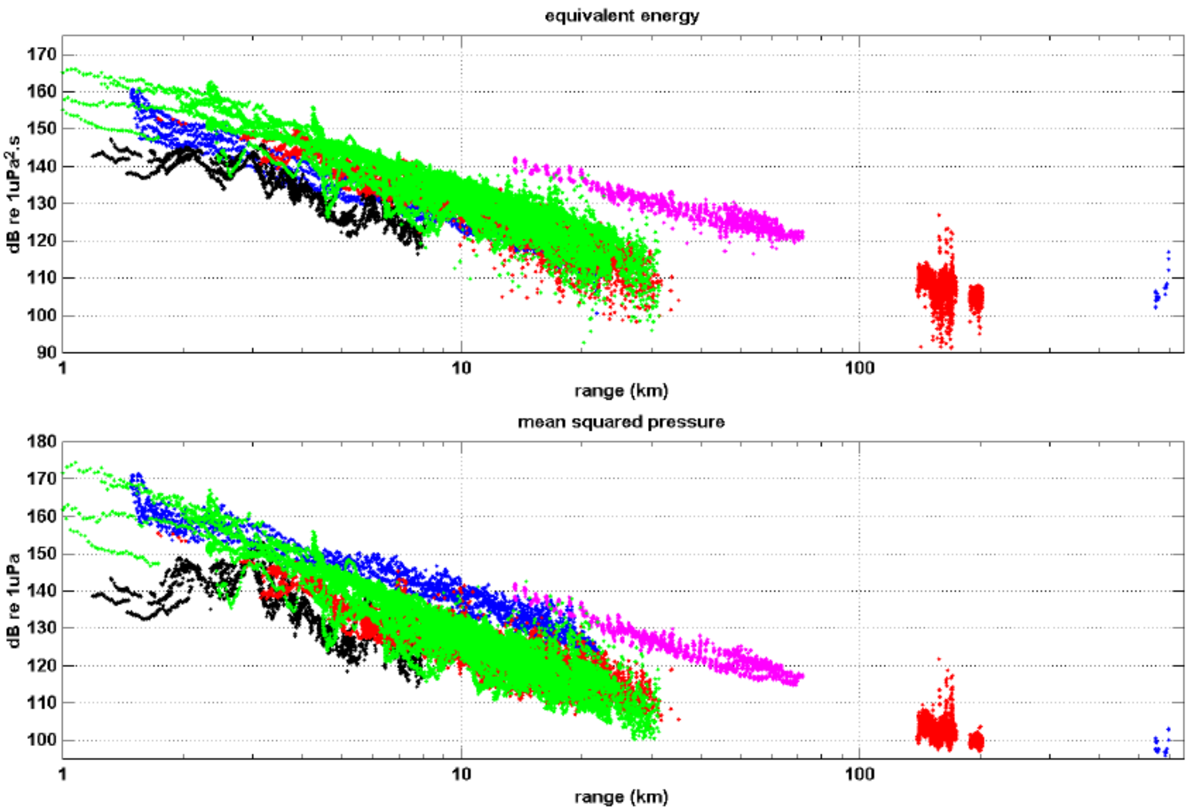


Table 6-54: Horizontal Ranges for received levels on-shelf from a 2500 cui seismic array (unfiltered) (McCauley, 2005)

Received Level (dB re 1µPa *mean square pressure*	On-Shelf Horizontal Range for deep receiver (km	
	Range (km)	Mean ± 95%
135	2.64-16.83	7.16 ± 0.18
140	2.45-7.00	5.75 ± 0.11
150	1.32-4.47	3.32 ± 0.15
160	0.94-2.92	2.16 ± 0.12
170	0.20-1.40	0.62 ± 0.85
180	<400 m	<400 m

Ground-truthing from these surveys identifies that:

- Sound from deep-water acquisition activities is not expected to transmit onto shelf environments which is consistent with the Duntroon acoustic modelling; and
- In shelf environments sound transmission is largely attenuated within 5 km from the source and is almost completely attenuated within 15-20 km.

Duntroon OA boundaries are located at least 51 km from the nearest SA coastline in minimum water depths of 100 m. Modelling has identified that from this closest approach distance, sound exposure at the SRW calving boundary should fall to ~125 dB re 1µPa which is not expected to result in biologically significant behavioural impacts. PGS will undertake sound logging to verify the received sound levels at this location.

***Adaptive Management*:**

As per EPBC Policy Statement 2.1 mitigation and management controls will be implemented to minimise potential acoustic impacts to whales by regulating aspects of the survey activity. The Duntroon survey has adopted spatial and temporal controls to lower the likelihood of encounter with protected species (migrating and foraging)..

In addition to these controls, PGS proposes to use the following approach during operations:

Whales: If there are three or more shut/power-downs due to whale presence in the preceding 24 hours; OR if there are three or more sightings of whale within the shut/power-down zones when the acoustic array is non-operational in the preceding 24 hr period; the density of whales in the area will be deemed to be "high" and cause the following measures to be implemented:

1. Surveillance: A support vessel will travel along the acquisition line to a distance of at least 13 km from the seismic array. If sperm (or other) whales are observed within the distance of observation by the MFO on the surveillance vessel, the survey vessel will initiate adaptive management.
2. Relocation: Survey vessel will relocate to another survey line > 13 km from the last confirmed whale sighting location to a location where the support vessel has confirmed no whale presence. The survey vessel will not return to the original location within 24 hrs; OR
3. Cessation: If there are no options for the relocation (e.g. no other survey lines to acquire), all night time operations will cease at this location until 24 hours have passed with no whales observed. However if at this decision point, if there have been less than 3 sightings within the power-down/ shutdown zone in the preceding 24 hours, night-time operations can re-commence in this location.

Based upon industry experience, it is very unlikely for more than three power-downs/shutdowns to occur within 24 hours. It is more likely that one or two power-downs/shut-downs may occur in 24 hours which is usually followed by a gap period of no observations. This would be indicative of low densities of whales transiting through the survey area and not necessarily indicative of increased populations of whales in the surrounding area.

The threshold of 3 or more power/shutdowns or three or more sightings within the power-down/shut-down zone when the array is non-operational will be used as the indicator that there is an unexpected higher density of marine fauna and/or foraging animals may be present in the region.

Summary of Mitigation Measures for Threatened/Migratory Cetaceans Species:

Table 6-55 provides a summary of the mitigation controls to be adopted for cetacean species during the Duntroon MSS.

Table 6-55: Summary of Control Measures by **Cetacean** Activity

Species/Activity Trigger	Mitigations
All whales (excluding dolphins and porpoises)	**Precaution Zones (Visual and PAM):** *Observation Zone:* 3+km horizontal radius from the acoustic array; *Low power Zone*: 2 km horizontal radius from the acoustic array; *Shutdown Zone:* 500m horizontal radius from the acoustic array. * An observation/ low-power zone of 13 km will be adopted for sperm whales detected via PAM to protect against foraging impacts <u>EPBC Policy Statement 2.1 (Part A):</u> A.2.1 (Trained Crew): Inducted and available on Support Vessels A.3.1 (Pre-Start-up Visual Observation): Visual observations for at least 30 minutes in water depths < 200 m and 60 miuntes in water depths > 200 m prior to commencement of soft-start procedures.

Species/Activity Trigger	Mitigations
	A.3.2 (Soft Start Procedures): Gradual initiation of acoustic array elements over 30 minutes. A.3.3 (Start-up Delay Procedures): Whales observed in the observation zone, acoustic source powered down if whale enters low power zone and source shut down if whale enters shutdown zone. A.3.4 (Operations Procedure): Continuous visual operations during daylight hours. Shut down on line turns or when vessel is moving to another part of the survey area. A.3.5 (Stop work Procedures): Whale enters the low power zone array is powered down and array is shutdown is whale enters the shutdown zone. A.3.6. (Night time and Low Visibility Procedures): Start-up will commence providing there have not been 3 or more whale instigated power-downs/shut-downs during preceding 24-hour period; OR if operations were not underway during the preceding 24-hour period, the vessel has been in the vicinity (~13km) of the start-up position and no whales sighted. Operations may proceed providing there have not been 3 or more whale instigated power-downs or shut-downs in the preceding 24 hrs. A.4. (Compliance Reports): Maintain records of procedures, MFO qualifications, whales (& other marine fauna) sightings and actions taken. <u>EPBC Policy Statement 2.1 (Part B):</u> B.1. (Marine Fauna Observers): Two MFOs will be present on the survey vessel to undertake observations. One MFO on-board each support/chase vessel. Additional trained (but not experienced) MFO from Kangaroo Island to assist qualified and experienced MFOs. B.2. (Poor Visibility – Aircraft): An initial aerial survey will be undertaken up to 3 days prior to survey commencement to inform start location, presence and activity level of whales. If an aerial survey cannot be undertaken a support vessel will be pre-deployed to obtain this information. Additional aerial surveillance will be undertaken in November if upwelling environmental conditions indicate upwelling triggers are present. Operational aerial surveillance may be undertaken in addition to vessel-based information (if required) should 'high densities of whales' be observed. B.3. (Night-time/Poor Visibility – Vessels): Daylight surveillance by vessels will assess presence of cetaceans. If sperm whales or high densities of whale are present, a support vessel will travel along the acquisition line to a distance of at least 13 km from the seismic array. If sperm (or other) whales are observed within the distance of observation by the MFO on the support vessel, the survey vessel will implement adaptive management. B.5. (Passive Acoustic Monitoring): PAM will be adopted to determine presence of deep-diving odontocetes. B.6. (Adaptive Management): Relocate seismic activity to distances > 13 km with verification that additional foraging cetaceans are not present in new area OR cease operations at the location until 24 hrs have passed with no whales observed.

Acceptability of Impact:

Impacts to cetaceans detailed in this assessment for the Duntroon OA are acceptable, with controls adopted as outlined in Table 6-52 and Table 6-55, based upon the following acceptance criteria. There is:

- No injury to pygmy blue, fin, sei, humpback, sperm, southern right or other whales within the Australian whale sanctuary (Conservation Plan for blue whale (DoE, 2015); Conservation Advice for Fin Whale, (DoE, 2015); Conservation Advice for the Sei Whale (DoE, 2015); Conservation Management Plan for the southern right whale (SEWPC, 2012); Conservation advice for the humpback whale, (DoE, 2015); EPBC Act 1999, S229 (Injuring or killing a whale));

- No interference with foraging behaviours in the pygmy blue foraging BIA including no displacement from the foraging areas (Australian IUCN Reserve Management Principles (IUCN VI); Conservation Plan for blue whale (DoE, 2015));
- No interference with foraging behaviours in the sperm whale foraging BIA (Australian IUCN Reserve Management Principles (IUCN VI));
- No biologically significant behavioural disturbance to SRWs in aggregation or calving areas located in SA waters (Conservation Management Plan for the southern right whale (SEWPC, 2012); Australian IUCN Reserve Management Principles (IUCN VI));
- Adherence to EPBC Policy Statement 2.1 requirements (Kangaroo Island Eco-action (Stakeholder Record 33); Kangaroo Island Dolphin Watch (Stakeholder Record 32), TWS [Stakeholder Record 42]);
- Adoption of PAM controls to mitigate sound Kangaroo Island Dolphin Watch (Stakeholder Record 32);
- Use of a trained local representative as MFO on the vessel to provide assurity of standards adopted (Kangaroo Island Dolphin Watch (Stakeholder Record 32)); and
- MFOs on all vessels (TWS [Stakeholder Record 42]).

Note: Natural Resources Kangaroo Island (**Stakeholder No: 43 Records**), DEWNR (**Stakeholder Record 14**), GABRWS (**Stakeholder Record 67**) and TWS (**Stakeholder Record 42**) expressed concern with survey activity undertaken in May due to the likely presence of southern right whales. These stakeholders have all been informed of the altered survey timeframe (September to November) with information on the predicted impacts. The assessment undertaken shows compliance with the requirements of the Conservation Plan for the southern right whale (SEWPC, 2012) and impacts to the species (migrating/coastal) is not expected to be significant.

Acceptability Statement: The Duntroon survey, with the adoption of controls in EPBC Policy Statement 2.1, will not injure or disturb foraging behaviours of whales within foraging BIAs or, within the pygmy blue whale foraging BIA, displace foraging whales or disturb aggregation or calving activities in SA waters.

6.2.3.9 *Water Sports/Tourism/Diving*

As identified in Section 3.8.2, the adjacent South Australian coastline supports recreational water sports (e.g. recreational diving at shipwrecks, shark cage diving at Neptune Islands (~65 km east northeast), surfing) and commercial diving for abalone (refer Section 3.8.3). The closest commercial abalone diving area to the Duntroon OA is the Avoid Bay SMU located ~ 36-50 km from the nearest Duntroon OA boundary.

Receptor Sensitivity:

Humans exposed to high levels of underwater sound can suffer from dizziness, hearing damage or damage to other sensitive organs depending on the frequency and intensity of the sound. Human hearing underwater with a ‘wet’ ear (i.e. water contact with ear canal) is less sensitive than it is in air and sound underwater is believed to produce less hearing damage than airborne sound. If the ears are dry (i.e. wearing a helmet) the noise exposure is the same as airborne noise (Anthony et al., 2009). Underwater auditory threshold curves indicate the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz and 1 kHz with a peak at 800 Hz (Parvin et al; cited in Anthony et al., 2009) and these frequencies have the greatest potential for damage. In general, within this frequency band, underwater hearing is 35-40 dB less sensitive than air.

Adopted Thresholds:

Studies (1993, 1995) undertaken on low frequency (100-600 Hz) underwater sounds to humans (divers) by the US Department of Navy identified that sound levels below a received SPL 160 dB re 1µPa was not expected to cause physiological damage to a diver. Further studies (1997, 1998) concluded that received SPLs of 157 dB re 1µPa did not produce physiological damage in humans however 2% of divers experienced “very severe” adverse reactions at a SPL of 148 dB re 1µPa. On this basis, the threshold was scaled back by 3 dB (a 50% reduction in signal strength) to provide a suitable margin of safety for divers. Interim guidance for the operation of low frequency sound sources in the presence of recreational divers is recommended not to exceed a received SPL of 145 dB re 1µPa (Department of Navy, 2001).

It is noted that Parvin et al. (2005) also provides recommended guidance on received SPLs to divers for the frequency band 500-2500 Hz of 155 dB re 1µPa.

The UK Diving Advisory Committee (DMAC) (2011) issued guidance on the proximity of diving operations from seismic surveying operations. This guidance recommends that where diving and seismic activity occurs within 10 km, a joint risk assessment should be conducted between both parties and a simultaneous operations plan developed. It is noted that the nearest diving location (abalone) in proximity to the Duntroon OA is Four Hummocks Island located approximately 50 km from the nearest survey line.

Based on this information a conservative SPL of 145 dB re 1µPa is used to assess impacts to commercial or recreational divers present in coastal areas adjacent to the survey operations.

Extent and Duration of Exposure and Identified Potential Impact

Abalone is present in coastal waters on near-shore reefs to a maximum depth of 40 m which are harvested by abalone fishermen along the Eyre Peninsula (refer Section 3.8.3). The nearest commercial abalone area is the Avoid Bay SAU which includes the Four Hummock, Little Hummock and Price islands.

The adjacent South Australian coastline also supports recreational water sports (e.g. recreational diving at shipwrecks, cage diving, surfing) along the Eyre Peninsula (closest proximity to seismic line is approximately 70 km) and Neptune Island (e.g. shark cage diving) (approximately 65 km from the nearest acquisition line). Anchorages for shark diving occur on the eastern coastlines of Northern Neptune Group Islands in water depths of approximately 12-18 m away from the prevailing westerly winds and swell. The western coastline of the islands is only suitable for diving in summer during easterly wind regimes (*Rodney* Fox Shark Expeditions, 2014; Shark Cage Diving, 2014)[105] [106] and calm seas. As the anchorage locations are on the lee side of the island it is expected that sound levels will be lower than the western coastline. Additionally, as previously identified seismic acoustic pulses are not expected to have behavioural impacts on shark species. Therefore, impacts to diving tourism are not expected from residual acoustic sound levels at the Neptune Islands.

Duntroon acoustic modelling predicts the SPL at adjacent shorelines and the Neptune Island Group from the nearest location modelled to shore (Site 1, Line 2) is approximately 120 dB re 1µPa. Modelling also predicts that sound levels fall rapidly inshore on the continental shelf to 140 dB re 1µPa (SPL) within 41 km of the operational array[107]. It is to be noted that the Duntroon survey will only be present on the continental shelf area for 26% of the survey duration. Acoustic operations in deeper offshore survey locations are not predicted to lead to the same level of ensonification across the continental shelf (Wladichuk et al, 2018).

Based on this predicted exposure in coastal environments, no significant impacts are predicted to recreational or commercial divers or recreational beach users which utilise the coastal environments. In accordance with information by Wenz (1962), this level of ensonification falls within background levels of sound within the marine environments (refer Section 3.5.4).

Summary:

Consequence: Impacts from survey operations to commercial or recreational divers in coastal environments (social value) are not expected to affect economic and recreational values.

Stakeholder Feedback:

As a precautionary measure, consultation has been undertaken with both charter boat operators which provide commercial cage diving activities **[Stakeholder Records 56]** and commercial abalone divers **[Stakeholder Records 53 & 54]** operating on the SA coastline. No concerns have been raised with regard to sound impacts to divers by these stakeholders.

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[105] Rodney Fox Shark Expeditions, 2014 available at https://www.rodneyfox.com.au/index.php/selectedContent/21965891
[106] Shark Cage Diving – Calypso Star Charters, 2014 available at http://www.sharkcagediving.com.au/shark-tours/dive-locations/
[107] Line 2, Site 5 @ 128 m water depth.

6.2.3.10 Cumulative Sound Impacts

Cumulative Sound:

A key initial step in the strategic business planning of MC MSS companies similar to PGS involves obtaining environmental approval with the view of marketing readiness to the petroleum block titleholder. Hence, the MC MSS company business model relies on securing a petroleum block titleholder client to purchase the data prior to its acquisition. It would be unnecessary for a petroleum block titleholder to obtain data from more than one seismic survey of the title, which in turn, would render mobilization of multiple surveys highly unlikely and commercially non-viable irrespective of whether environmental approval had been obtained for more than one survey over the same area. Subsequently, although multiple seismic surveys may be proposed, not all will go ahead as block titleholders will allocate work to one seismic company only.

There are two possible scenarios where surveys may overlap:

- When a 3D survey is undertaken after an initial 2D survey; or
- Acquiring seismic over acreage that another survey has covered as to achieve full-fold coverage of an area, run-in and run-out data is acquired outside of the full-fold area.

For EPP-46, the Duntroon MC2D and MC3D surveys will spatially overlap each other. Note that the MC2D survey is a lower density survey with lines separated by 5 km. There will only be very limited areas spaced over a wide grid which may be surveyed twice. Based upon cumulative sound assessments contained within this EP for individual species, cumulative impacts from these multiple lines are not expected to be significant at a population level.

The Duntroon MC2D and MC3D surveys will utilise a single PGS acquisition vessel. There will be no simultaneous survey activities by multiple PGS acquisition vessels.

Immediate past seismic surveys undertaken within the Duntroon OA in EPP-41/42 was a 2D seismic survey by Santos in 2003. Surveys activities undertaken in EPP-46 (2D) are significantly older (~1990s). As such repeated seismic sound exposure resulting from cumulative past impacts from preceding surveys in EPP41/42 and EPP-46 are not considered to be significant.

Simultaneous Survey (Third Parties):

It is possible that other marine seismic surveys may occur simultaneously close to the proposed Duntroon OA. This could result in cumulative impacts to marine fauna and matters of NES, such as whales, Australian sea lions and turtles. The cumulative impacts from seismic impulses within the marine environment are difficult to quantify because the acquisition of seismic data requires the temporary creation of sound/pressure waves that dissipate and soon disappear when the sound energy source is stopped. Unlike other activities that can result in the creation of contaminants and noxious materials (e.g. drill cuttings), there is no bioaccumulation of sound/pressure within the food chain. Nonetheless, there may be a temporary additive effect if sounds from one activity coincide and overlap spatially and temporally with another concurrent activity (e.g. masking). However, this “added sound” will disappear once one of the sound-generating sources stop or travel out of the area of concern.

Free-ranging megafauna such as cetaceans, turtles and pinnipeds present in the Duntroon OA would be exposed to the acoustic source for temporary duration. Over any area within the OA, sound exposure will be temporary and transient (vessel in constant movement). Based upon the controls adopted within this sound assessment section, marine fauna is unlikely to be significantly impacted at individual or population levels by survey activities.

The NOPSEMA website provides an overview of proposed seismic surveys that may occur at a future date. PGS is not aware of any MSSs which might possibly occur within the same timeframe and potentially within the Duntroon OA. PGS will continue to monitor the NOPSEMA website for potential spatial and temporal overlaps from third party MSS activity with the Duntroon OA, establish contact with titleholders where this overlap may occur and identify controls to prevent cumulative impacts. One measure PGS will implement in the event of simultaneous seismic operations is to offer and request sharing of cetacean observations with the other operational vessel. The intention is to gather as much information on cetacean distribution as practicable to assist with operational decision making on a daily basis. As PGS has no control over the management of any simultaneous surveys this measure is incorporated into this EP as a performance standard.

The Programmatic Environmental Assessment of Arctic Ocean OCS Seismic Surveys – 2006 established proactive measures for simultaneous seismic surveys with a minimum spacing of 24 km (15 nm) between seismic source vessels (BOEM 2014). More recently (27 February 2014), the Bureau of Ocean Energy Management (BOEM) published a final environmental review of geological and geophysical survey activities off the mid- and south Atlantic coast. The environmental impact statement from this review included a recommendation of a 40 km geographic separation distance between the acoustic sources of simultaneous seismic surveys to minimise the impacts to marine life by providing a ‘corridor’ between vessels that is below 160 dB re 1µPa SPL (*recognised behavioural limit for impulsive sound and significantly below thresholds which may cause injury to species*) such that marine fauna may pass through rather than traveling larger distances to go around the survey vessels. The BOEM environmental review recommended a 10 km corridor between seismic surveys which have a received level of < 160 dB re 1µPa (SPL) (BOEM, 2014).

BOEM (2014) also indicated that a typical radius for a 160-dB re 1µPa SPL threshold for a large airgun array was approximately 10-15 km radius from the operating array. Acoustic modelling undertaken for the Duntroon survey predicts that sound levels above a 160 dB re 1µPa SPL may occur within a maximum horizontal distance of 13.05 km from the operational array.

The Duntroon survey timeframe (September to November) has been positioned to avoid seasonal foraging of blue (sei and fin) whales however does temporally overlap with SRW migration from the SA coastline. PGS has adopted a received sound level of 140 dB re 1µPa as the level whereby migrating mysticetes may exhibit biologically relevant behaviours (i.e. avoidance). From acoustic modelling (water deths ≤ 600m), these received sound levels may be experienced up to 136 km for the operating array, however it is noted that this distance, in isolation to all other parameters where biologically relevant behavioural disturbance has been observed (i.e. proximity of the acoustic array is also a factor in determining behavioural response to an operational array (Dunlop et al, 2017)), is conservative. PGS, if simultaneous surveys are proposed for the region, will consult with the other acquisition party to develop a Simultaneous Operations (SIMOPS) Plan such that spatial separation between operating arrays provides a 10 km corridor where sound impacts are < 140 dB re 1µPa (SPL).

It is noted that this distance is conservative and does not accommodate other factors, such as the proximity of the operational array which also appears to be a factor in determining behavioural disturbance in migrating mysticetes (Dunlop et al, 2017).

Implementation of this spatial control is expected to prevent cumulative sound impacts leading to spatial ‘behavioural barriers/blocks’ which cause biologically significant changes to behaviour and limit the movement of megafauna and other pelagic species. Cumulative impacts from simultaneous surveys on this conservative threshold basis are expected to be negligible (SLIGHT consequence).

Stakeholders:

TWS (**Stakeholder Record 42**) based upon the review of the previous EP, identified that PGS had not undertaken a cumulative impact assessment of the ongoing and numerous survey activities in the area. This assessment above has reviewed the impacts and identified controls to ensure that cumulative impacts due to simultaneous multiple surveys are minimising impacts to ALARP.

6.2.3.11 Impacts to KEFs

The Duntroon OA and the acoustic footprint of Duntroon activities overlap KEFs within the region (refer Section 3.3). KEFs are of regional importance for either a region’s biodiversity or its ecosystem function and integrity. KEFs are not matters of NES and have no legal status, however, they may be considered components of the Commonwealth marine environment which is a matter of NES under the EPBC Act 1999.

In accordance with the Significant Impact Guidelines 1.1 (Matters of NES) (2013), relevant criterion on which to determine whether impacts will be significant with respect to acoustic impacts on the environment are:

- *The action will not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such than an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results; and*
- *Have a substantial adverse effect on a population of marine species or cetacean including its lifecycle (for example breeding, feeding, migration behaviour, life expectance) and spatial distribution*.

Table 6-57 provides an assessment of the Duntroon survey activity with respect to these two parameters with reference back to individual species assessment within this section. It is noted that one KEF described in Section 3.3.2 is not within the acoustic footprint for the Duntroon activity (i.e. Shelf rocky reefs and hard substrates) and is not assessed within this section. This KEF has been included within the EP based upon the EMBA for oil spills.

Stakeholders:

TWS (**Stakeholder Record 42**) and the DNP (**Stakeholder Record 63**) encourage PGS to undertake a holistic ecosystem approach with assessment also focussed on the productivity of the ecosystem and broader benthic diversity. This has been undertaken in this section to establish the potential effects of disrupting KEFs present in the Duntroon OA and greater bioregions. Given the levels of impact predicted to the individual trophic levels with the ecosystem, PGS does not expect there to be a measurable effect on the ecosystem functioning.

6.2.3.12 Impacts to Commonwealth and State Marine Reserves

The Duntroon multi-client survey OA overlaps the Commonwealth Western Eyre Marine Park (IUCN VI – Multiple Use and Special Use zones) proclaimed on 14 December 2013. Residual sound from the survey activities is also predicted to travel into the Commonwealth Western Kangaroo Island Marine Park (IUCN VI – Special Purpose Zone; Marine National Park IUCN IIA) and the South Australian Marine Reserves of the Western Kangaroo Island Marine Park, Neptune Islands Marine Park and Thorny Passage Marine Park. A summary of the residual sound levels which may be experienced in these reserves and other adjacent reserved is provided in Table 6-56.

Table 6-56: Residual sound levels in adjacent Commonwealth and State Marine Reserves

Marine Reserve	Distance to Nearest OA Boundary	Predicted Residual Sound Level SPL (dB re 1µPa) (Site 4 & 5 Line 2 modelling basis) (& refer to Figure 6-18)
Western Kangaroo Island CMP (Com)	47 km east	< 130
Western Kangaroo Island MP (SA)	59 km east	< 130
Neptune Island Group MP (SA)	42 km ENE	120
Thorny Passage MP (SA)	4 km NE (Rocky (South) Island)	< 150
Investigator MP (SA)	97 km ENE	< 120
Sir Joseph Banks Group MP (SA)	85 km NE	<120
Gambier Islands Group MP (SA)	85 km ENE	<120
South Spencer Gulf MP (SA)	115 km east	<120
South Kangaroo Island MP	127 km east	<120

Residual sound levels from survey activities in Investigator Marine Park, Sir Joseph Banks Group Marine Park, Gambier Islands Group Marine Park, South Spencer Gulf Marine Park and South Kangaroo Island Marine Park all located in coastal areas, are considered too distant from the survey activities to be affected by acoustic sound and would lie within background sound levels for the region (storm events, high wind speeds or periods of large ocean swells).

The conservation values for these reserves are described in **Section 3.2** and the potential impacts of underwater sound to those values has been assessed in this section.

Commonwealth Marine Parks

Marine reserves carry multiple levels of zoning depending upon the conservation values present within the area. Table 6-58 details the relevant zonings and management objectives for the Western Eyre and Western Kangaroo Island CMPs in addition to the recognised conservation values within the individual reserves.

Table 6-57: Acoustic Impact Assessment of KEFs

KEF	Ecosystem Sensitivity	Threats	Actions having a risk of significant impact on the Commonwealth Marine Environment	Description of Impact
Ancient Coastline	The ancient coastline 'escarpment' between 90-120 m creates topographic complexity , facilitate upwellings (enhanced productivity) and have benthic diversity (habitats and demersal fish species which connect the shelf to the slope environments). The western GAB is dominated by sponge communities of significant biodiversity and structural complexity.	Pressures of potential concern on the integrity of this habitat includes: • Changes in sea temperature • Changes in oceanography • Physical habitat modification (e.g. seabed trawling) • Extraction of living resources	Actions that have a real chance or possibility of resulting in modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat such that they cause an adverse impact on marine ecosystem functioning or integrity of the ancient coastline at 90–120 m depth off the Great Australian Bight have a high risk of significant impact on the Commonwealth marine environment	The Duntroon OA has minor overlap with KEF areas defined as the ancient coastline. The Duntroon survey will not acquire seismic within this area and does not interact with the seabed and accordingly does not physically modify the KEF. An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. benthic habitats (sponges) and demersal fish) has been undertaken within this EP. Acoustic impacts to benthic receptors has been assessed in Section 6.3.3.3 (marine invertebrates including porifera and crustaceans) and Section 6.3.3.4 (Fish species). As identified in those sections: • Impacts to sessile invertebrates such as sponges, bryozoans and ascidians from acoustic sound sources used not expected based upon available scientific literature and review of acoustic impacts to other sessile feeders such as corals. Ecological integrity of sponge and bethic habitats are not expected to be affected. • No injury or TTS impacts to demersal fish s as a result of the Duntroon survey are predicted with any behavioural impacts localised, temporary and recoverable. Demersal fish which connect the shelf and slope areas present in the Duntroon OA have the potential to be affected by PTS if located on the continental shelf within 150 m of the operational array and TTS if the animal remains within 4.97 km of the operational array for more than 24 hours. Impacts would only occur if an operating array was started at full power adjacent to these fish. In reality, with soft-start procedures adopted and fish mobility in the area, impacts are more likely to behavioural (localised avoidance) and is unlikely to have a significant adverse effect on the population. Not withstanding this, no acquisition will be undertaken within the Ancient Coastline KEF ensuring that no injury or TTS impact are imparted to demersal fish species. On this basis, ecological integrity of these habitats and its functioning is not expected to be significantly affected by sesimic operations as defined by the EPBC significant impact criteria.

KEF	Ecosystem Sensitivity	Threats	Actions having a risk of significant impact on the Commonwealth Marine Environment	Description of Impact
Kangaroo Island Pool, canyons and adjacent shelf-break & Eyre Peninsula Upwelling	This is a major area of productivity supporting areas of zooplankton biomass utilised by small pelagic fish which in-turn are prey for higher trophic levels (e.g. SBT, sharks, etc.). The pygmy blue whale is seasonally present within the KEF during summer/ autumn feeding on krill.	Potential pressures on the ecological functioning and integrity of this key ecological feature include: • oil spills affecting aggregations of species at upwellings • extraction of living resources and bycatch • changes in sea temperature, change in oceanography and ocean acidification as a result of climate change • noise pollution for marine megafauna	Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising in the area of the Kangaroo Island Pool, Kangaroo Island canyons and adjacent shelf break or the Eyre Peninsula upwellings have a risk of a significant impact on the Commonwealth marine environment.	The Duntroon OA overlaps with this KEF. An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. zooplankton, small pelagic fish) has been undertsken in this EP. Acoustic impacts to plankton has been assessed in Section 6.3.3.2 and pelagic fish species assessed in Section 6.3.3.4. As identified in those sections: • Impacts to plankton (including krill) as a result of acoustic survey activities is likely to be inconsequential when compared to natural mortality rates during non-upwelling conditions. On a precautionary basis, controls will be implemented to prevent interaction of survey vessels with upwellings; • Pelagic fish (not site attached) impacts as a result of the Duntroon survey are predicted to be localised, temporary and recoverable. The area affected by Duntroon survey is a small proportion of the SGS bioregion (~ 5.3%) with impacts to pelagic fish from sound (i.e. PTS and TTS) predicted on a worst case basis to be much smaller in area (~ 1.3%) over the survey period. For pelagic fish present in the Duntroon OA to have the potential to be affected by PTS, animals would need to be located on the continental shelf within 150 m of the operational array and for TTS the fish would need to remain within 4.97 km of the operational array for more than 24 hours. These impacts would only occur if an operating array was started at full power adjacent to these animals. In reality, with soft-start procedures adopted and fish mobility in the area, impacts are more likely to behavioural (localised avoidance) and is unlikley to have a substantial adverse effect on the population. Other higher trophic species which feed upon these prey are assessed in Section 6.2.3.4 (SBT, shark species), Section 6.2.3.5 (pinnipeds), Section 6.2.3.6 (Turtles), Section 6.2.3.7 (Avifauna) and Section 6.2.3.8 (cetaceans). With controls adopted for the survey activity, any impacts to biological resources within the Kangaroo Island Pool, Canyons and adjacent shelf-break & Eyre Peninsula upwelling KEF are expected to be localised, temporary and recoverable. On this basis, ecological integrity of these habitats and its functioning is not expected to be significantly affected by seismic operations as defined by the EPBC significant impact criteria.

KEF	Ecosystem Sensitivity	Threats	Actions having a risk of significant impact on the Commonwealth Marine Environment	Description of Impact
Mesoscale Eddies (pelagic KEF)	Mesoscale eddies are important transporters of nutrients and meso-zooplankton communities and become hot-spots for a complex range of higher trophic levels. These eddies play a critical role in determining species distribution and transport coastal phyto-plankton communities offshore and removing larval fish from the continental shelf offshore (decreasing fishery productivity). These KEFs are thought to attract a range of organisms ar higher trophic levels (marine mammlas, seabirds, SBT).	Potential pressures include changes in sea temperature, change in oceanography and ocean acidification as a result of climate change.	Generally, actions in or adjacent to the South-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the meso-scale eddies.	The Duntroon OA overlaps with the Eyre Peninsula meso-scale eddy KEF. This system is pelagic and is a physical forcing system which transports and distributed nutrients (not affected by Duntroon survey) and biological resources regionally. As such the Duntroon survey does not affect this KEF system, however on an indirect basis may affect the biological resources which are transported within the system. As per previous KEF entries, Duntroon survey activities have assessed impacts to biological resources within affected the Duntroon acoustic footprint. Acoustic impacts to plankton has been assessed in Section 6.2.3.2 and pelagic fish species assessed in Section 6.2.3.4. Other higher trophic species which feed upon these prey are assessed in Section 6.2.3.4 (SBT, shark species), Section 6.2.3.5 (pinnipeds), Section 6.2.3.6 (Turtles), Section 6.2.3.7 (Avifauna) and Section 6.2.3.8 (cetaceans). With controls adopted for the survey activity, any impacts to biological resources within the Western Eyre meso-scale eddy KEF are expected to be localised, temporary and recoverable. On this basis, ecological integrity withinthe KEF is not expected to be significantly affected by sesimic operations as defined by the EPBC significant impact criteria.

KEF	Ecosystem Sensitivity	Threats	Actions having a risk of significant impact on the Commonwealth Marine Environment	Description of Impact
Benthic Invertebrate community of the eastern GAB shelf (spatial boundary not defined)	Benthic invertebrate communities of the eastern GAB shelf are highly biodiverse, soft sediment ecosystems. Surface sediments are dominated by heterozoan carbonate fragments comprising bryozoans, porifera, rhodoliths and other invertebrates .	No pressures of concern. Pressures of potential concern include: • Changes in sea temperature • Changes in oceanography • Ocean acidification	Generally, most actions occurring in Benthic invertebrate communities of the eastern Great Australian Bight are unlikely to impact adversely on the biodiversity values of this key ecological feature.	The Duntroon OA may overlap the benthic invertebrate community of the eastern GAB shelf. This system consists of sessile benthic habitats (sponges, ascididans, bryozoans) and other invertebrates which rely on the habitat such as crustaceans. The Duntroon survey does not interact with the seabed and accordingly does not physically modify the KEF. An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. benthic habitats (sponges) and invertebrates) has been undertaken within this EP. Acoustic impacts to benthic receptors has been assessed in Section 6.2.3.3 (marine invertebrates including porifera, crustaceans and cephalopods). As identified in those sections: • Impacts to sessile invertebrates such as sponges, bryozoans and ascidians from acoustic sound source used in the Duntroon survey are not expected based upon available scientific literature and review of acoustic impacts to other sessile feeders such as corals. Ecological integrity of sponge habitats are not expected to be affected and its associated ecosystem functioning is not expected to be adversely affected. • For invertebrates such as crustaceans (lobsters, crab, prawns) sub-lethal physiological impacts may result from survey operations on a localised basis to a small proportion of the population. On a bioregional basis, the Duntroon OA spatially overlaps 5.4% of the SGS bioregion. The area affected by sound levels which may result in sub-lethal impacts is significantly less (~1.7%). On this basis, survey activities are not expected to result in a substantial adverse affect on a population of marine species . Ecosystem functioning is not expected to be adversely affected. • There is no spatial overlap with abalone habitats in the Duntroon OA. On this basis, ecological integrity of these habitats and its functioning is not expected to be significantly affected by sesimic operations as defined by the EPBC significant impact criteria.

KEF	Ecosystem Sensitivity	Threats	Actions having a risk of significant impact on the Commonwealth Marine Environment	Description of Impact
Small pelagic fish of the south-west region	Bioregion occurs in the GAB and the fisheries of the Gulf of St Vincent and Spencer Gulf. It refers to shoaling, epipelagic fish supported by summer upwelling events in the Eyre pelagic ecosystem. Fluctuations in abundance of small pelagic fish have serious implications for the functioning of pelagic ecosystems.	Pressures of concern are changes in sea temperature and oceanography. Pressures of potential concern include: Ocean acidification	Actions which have a real chance or possibility of introducing pathogens to the small pelagic fish of the South-west Marine Region have a high risk of significant impact on the Commonwealth marine environment	An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. zooplankton, small pelagic fish) has been undertaken in this EP. Acoustic impacts to plankton (feedstock for small pelagic fish, assessing impacts to fish/larvae from small pelagic fish) has been assessed in Section 6.3.3.1 and pelagic fish species assessed in Section 6.2.3.4. As identified in those sections: • Impacts to plankton (including krill) as a result of acoustic survey activities is likely to be localised, temporary and recoverable (incidental consequence) and inconsequential when compared to natural mortality rates during non-upwelling conditions. On a precautionary basis, temperal controls are implemented to prevent temproal and spatial overlap upwellings; • Pelagic fish impacts as a result of the Duntroon survey are predicted to be localised, temporary and recoverable. Information provided with respect to pelagic fish contained in the “Kangaroo Island Pool, canyons and adjacent shelf-break & Eyre Peninsula Upwelling” is relevant to the assessment of survey activities on the “small pelagic fish of the south-west region KEF” on a regional basis. However, in addition to this, the Duntroon OA spatially overlaps a small area (1274 km^2) of the outer area of the sardine fishery which is actively fished where there is recorded catch. This spatial overlap might affect 0.1% of the annual catch. This fishery is sustainable with a current exploitation rate of 18% of its biomass (Ward et al. 2012). On this basis, given the small proportion of fishery area affected and any expected impacts likely to be behavioural in pelagic fish, it is unlikely to have a substantial adverse effect on the population and the ecosystem integrity and functioning is not expected to be affected by the Duntroon survey activities. Other higher trophic species which feed upon pelagic fish are described in Section 6.2.3.4 (SBT, shark species), Section 6.2.3.5(pinnipeds), Section 6.2.3.6 (Turtles), Section 6.2.3.7 (Avifauna) and Section 6.2.3.8 (cetaceans). With controls adopted for the survey activity, any impacts to biological resources within this KEF are expected to be localised, temporary and recoverable. On this basis, ecological integrity of this KEF and its functioning is not expected to be significantly affected by seismic operations as defined by the EPBC significant impact criteria.

6.2.3.13 Impacts to Commonwealth and State Marine Parks

Commonwealth Marine Parks:

Commonwealth marine parks affected by acoustic sound are managed under the Australian Marine Parks – South-west Marine Parks Network Management Plan 2018 (DNP, 2018). An assessment of activities which are permissible under the zones within these CMPs is provided in Section 4

As part of this impact assessment, with controls adopted, any foraging and injury impacts to CMP conservation values (i.e. foraging and calving mammals, foraging sharks and bird species (identified conservation values) which may be present in the CMP have been shown to be localised, temporary and recoverable) (Consequence SLIGHT to MINOR). Further an assessment undertaken on ecosystem disturbance within these CMPs (refer previous section on KEFs) has also identified that impacts are localised, temporary and recoverable. This ensures that there is no disruption to the key ecological processes for key fauna conservation values within the CMPs nor ecosystem disturbance within the CMP fulfilling IUCN principles for each of the CMP zones and the South-west marine Parks Network Management Plan 2018.

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Table 6-58 demonstrates that the proposed Duntroon survey will be carried out in a manner which aligns and does not conflict with conservation values and IUCN principles for these CMPs.

<u>State Marine Parks</u>

The South Australian government has developed the South Australian Representative System of Marine Protective Areas "*to establish and manage a comprehensive, adequate and representative system of MPAs to contribute to the long-term ecological viability of marine and estuarine systems, to maintain ecological processes and systems, and to protect Australia's biological diversity at all levels*" (Bryars et al, 2016 p2).

These parks have been set aside to protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources (National Parks SA, 2016). An assessment of the environmental, economic and social values of these parks with respect to residual acoustic sound is provided in Table 6-59.

Acoustic modelling from the closest modelled site to the coast predicts sound levels in the nearest coastal areas to the Duntroon OA be 120-130 dB re 1µPa (SPL). Note that ambient sound levels in coastal areas along the southern margins of Australia have high ambient underwater spectral levels, with a mean of 110 dB re 1 μPa^2/Hz and peaks up to 161 dB re 1 μPa^2/Hz (McCauley & Gavrilov 2013).

Table 6-58 Conservation Values and Management Principles of CMP's affected by acoustic sound from the MC2D and MC3D Duntroon Survey

CMR	Zonation	SEL (dB re 1µPa^2.s) & SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Purpose of Zone	South-west marine Parks Management Plan 2018 - IUCN Management Objectives/ Principles	Values	Principle Attainment
Western Eyre CMR	Multiple Use Zone (IUCN VI) (15,900 km^2) OA: 8,200 km^2 (overlap)	-	Within Survey area	Provide for the ecologically sustainable use and the conservation of ecosystems, habitats and native species.	Zone should be managed for the sustainable use of natural ecosystems based upon the following principles: • Biological diversity and other natural values should be protected and maintained in the long-term; • Management practices applied to ensure the ecological sustainable use of the reserve or zone; • Management of the reserve or zone should contribute to regional and national development to the extent it is consistent with these principles.	Important foraging area for the: • Australian sea lion (refer **Section 6.2.3.5**) • Threatened white shark (refer **Section 6.2.3.4**) • Threatened blue and migratory sperm whale (refer **Section 6.2.3.8**) • Migratory short-tailed shearwater and caspian tern (refer **Section 6.2.3.7**) Important seasonal calving habitat for threatened southern right whale (refer **Section 6.2.3.8**) Examples of westernmost ecosystems of Spencer Gulf shelf Province and easternmost GAB shelf transition and Southern Province (refer all **Section 6.2**); Five KEFs (refer Table 6-57 for assessment of ecological integrity and assessment of adverse effects on populations): • Ancient coastline (90-120m); • Kangaroo Island Pool, canyon and adjacent shelf-break & Eyre Peninsula upwelling; • Meso-scale eddies; • Benthic invertebrates communities of the eastern GAB shelf; • Small Pelagic Fish of southwest marine region. Cultural: Sea country is valued for indigenous cultural identity, health and welll-being. Heritage: No listings in CMP Social and Economic Values: Commercial tourism, commercial fishing, recreation and mining are important in the CMP.	This impact assessment demonstrates the Duntroon survey, with control measures adopted, will protect the biological diversity of the CMP. All impacts assessed for the listed threatened and migratory species were assessed as having minor or incidental impacts to the species only (i.e. slight consequence and not significant). On this basis the management practices applied this ensures the protection of these natural values. An assessment of the survey activity on the ecological integrity of ecosystems (KEFs) present in the Duntroon OA has been undertaken in Table 6-57. On the basis of this assessment, the Duntroon activity should not result in modification, destruction, fragmentation, isolation or disturbance to an important or substantial area of habitat such that an adverse impact on the marine ecosystem functioning or integrity in the Commonwealth marine area; or have a substantial adverse effect on a population of marine species or cetacean including its lifecycle and spatial distribution. On this basis the biological diversity is protected, ecological sustainability of the area maintained, and with management measures adopted to avoid spatial conflicts with commercial fisheries, no significant impacts to social and economic values.
	Special Purpose Zone (IUCN VI) (24,371 km^2) OA: 1,620 km^2 (overlap)	-	Within Survey area	Provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species, while applying special purpose management arrangements for specific activities.	• Management practices applied to ensure the ecological sustainable use of the reserve or zone • Contribution to the regional and national development to the extent it is consistent with these principles		

CMR	Zonation	SEL (dB re 1µPa^2.s) & SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Purpose of Zone	South-west marine Parks Management Plan 2018 - IUCN Management Objectives/ Principles	Values	Principle Attainment
Western Eyre CMR (Con't)	Marine National Park (IUCN Category II) (17,437 km^2)	< 140 (SEL) < 150 (SPL)	27 km (nearest National Marine Park Zone) ~ 32 km[108] from nearest survey acqusition point)	Provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.	The zone should be protected and managed to conserve its natural condition according to the following: • Natural and scenic areas of national and international significance should be protected for spiritual, scientific, educational, recreational or tourism purposes;	Values are the same as Western Eyre CMR - Multiple Use and Special Purpose Zone (as above).	No impacts to natural and scenic areas of national and international significance expected from acoustic operations.
					• Examples of physiographic regions, biotic communities, genetic resources and native species should be perpetuated in as natural state as possible to provide ecological stability and diversity		Potential impacts to native species and biotic communities have been shown to have only incidental impacts to ecological stability and biodiversity withinthe survey area where the impacts are largest. Impacts to natural resources and biotic communities within the National Park are not expected to be affected by residual sound impacts (which will be localised and temporary). IUCN management principle is met.
					• Visitor use should be managed at a level which will maintain the zone in a natural or near natural state		N/A – covered by Park Management objectives and prescriptions.
					• Management should seek to ensure that exploitation or occupation inconsistent with these principles does not occur.		N/A – covered by Park Management objectives and prescriptions

[108] Assumes a 5 km run-in/run-out distance where the acoustic array is operating at full power within the OA. Net additional distance buffer between operational array and Marine Park is 8 km. This is applied to all distances to establish SEL and SPL values at the boundary of the marine parks in this table. Residual SPL and SELs are based on Line 2, Site 1 (continental shelf) results.

CMR	Zonation	SEL (dB re 1µPa^2.s) & SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Purpose of Zone	South-west marine Parks Management Plan 2018 - IUCN Management Objectives/ Principles	Values	Principle Attainment
Western Eyre CMP (Con't)	Marine National Park (IUCN Category II) (17,437 km^2)	< 140 (SEL) < 150 (SPL)	27km (nearest National Marine Park Zone) ~ 35 km from nearest survey acqusition point)	Provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.	• Respect maintained for the ecological, geomorphological, sacred and aesthetic attributes which the reserve or zone was assigned to this category.	Values are the same as Western Eyre CMR - Multiple Use and Special Purpose Zone (as above).	Survey activities within the Duntroon OA will not affect this value in the National Park Zone.
					• Needs of indigenous people should be taken into account including subsistance resource use to the extent that they do not conflict with these principles.		Consultation has occurred with all relevant Aboriginal stakeholders (refer **Section 9**). Survey activities within the Duntroon OA will not affect this value in the National Park Zone.
					• Aspirations of traditional owners of the land, continuing land management practices, protection and maintenance of cultural heritage and the benefits of traditional owner enterprises, established in the reserve or zone, consistent with these principles should be recognised and taken into account.		Consultation has occurred with all relevant Aboriginal stakeholders (refer **Section 9**). Survey activities within the Duntroon OA will not affect this value in the National Park Zone.
Western Kangaroo Island CMP	Special Purpose Zone (IUCN VI)	< 130 (SPL) (Site 1, Line 2 location)	47 km (nearest National Marine Park Zone) ~ 53 km from nearest survey acqusition point)	Provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species, while applying special purpose management arrangements for specific activities	As above for Western Eyre Special Purpose Zone	Note the conservation values for the Western Kangaroo Island CMP are a subset of the Western Eyre CMR (as follows): • Important foraging area for the: • Australian sea lion (refer **Section 6.2.3.5**) • Threatened white shark (refer **Section 6.2.3.4**) • Threatened blue and migratory sperm whale (refer **Section 6.2.3.8**) • Migratory short-tailed shearwater and caspian tern (refer **Section 6.2.3.7**)	Assessment is as per the Western Eyre Special Purpose Zone. Residual sound levels experienced in the CMP Special Purpose Zone is not expected to affect values given the impacts assessment impact identified for the Western Eyre CMP where the activity is planned to take place.

CMR	Zonation	SEL (dB re 1µPa².s) & SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Purpose of Zone	South-west marine Parks Management Plan 2018 - IUCN Management Objectives/ Principles	Values	Principle Attainment
Western Kangaroo Island CMP	Marine National Park (IUCN Category II)	< 130 (SPL) (Site 1, Line 2 location)	60 km (nearest National Marine Park Zone) ~ 68 km from nearest survey acqusition point)	Provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.	As above for Western Eyre National Park Section	Important seasonal calving habitat for threatened southern right whale (refer **Section 6.2.3.8**) Examples of westernmost ecosystems of Spencer Gulf shelf Province and Southern Province (refer all **Section 6.2**) Two KEFs (refer Table 6-57 for assessment of ecological integrity and assessment of adverse effects on populations): • Ancient coastline (90-120m) • Kangaroo Island Pool, canyon and adjacent shelf-break & Eyre Peninsula upwelling. Cultural: Sea country is valued for indigenous cultural identity, health and welll-being. Heritage: No listings in CMP Social and Economic Values: Commercial tourism, commercial fishing, recreation and mining are important in the CMP.	Assessment is as per the Western Eyre Marine National Park Zone. Residual sound levels experienced in the CMP Special Purpose Zone is not expected to affect values given the impacts assessment impact identified for the Western Eyre CMP where the activity is planned to take place.

Table 6-59 Environmental, Economic and Social Values of SA Marine Parks affected residual acoustic sound from the Duntroon survey (DEWNR, 2010; Bryars et al, 2016a, 2016b)

Marine Park	SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Management Objectives/ Principles	Values	Principle Attainment
Western Kangaroo Island Marine Park	< 130 dB re 1µPa (Site 1, Line 2 location)	60 km	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources.	*Ecological Value 1 (Habitat - Reef):* Subtidal reef occurs from Cape Forbin to Cape Bedout and around Cape Du Couedic which support fish and invertebrates and commercially fished species that use reef habitats (lobster, abalone, marine scalefish and charterboat fishery).	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these reef species is expected (refer **Section 6.2.3.4**). Value is not affected by Duntroon activities.
				Ecological Value 2 (Habitat - Seagrass): Seagrasses have been observed at a depths of 12 m at Harvey's Return.	Residual sounds from seismic activities are not expected to affect seagrass. Value is not affected by Duntroon activities.
				Ecological Value 3 (Habitat - Sand): Sand habitat is prevalent across the marine park with areas of beach and subtidal sandplains.	Residual sounds from seismic activities are not expected to affect sand areas. Value is not affected by Duntroon activities.
				Ecological Value 4 (Habitat - Mangrove): No mangroves are present in the WKIMP.	Not Applicable.
				Ecological Value 5 (Habitat - Saltmarsh): No saltmarsh systems are present in WKIMP.	Not applicable
				Ecological Value 6 (Species - sharks): The WKIMP is used by a number of shark species, including blue shark, dusky whaler, smooth hammerhead, school shark, white shark, shortfin mako and porbeagle.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these sharks is expected (refer **Section 6.2.3.4**). Value is not affected by Duntroon activities.
				Ecological Value 7 (Species – marine mammals): The WKIMP is used by a number of marine mammals including southern right whale, pygmy blue whale, sperm whale, pygmy sperm whale, dwarf sperm whale, pigmy right whale, beaked whale, short-finned pilot whale, false killer whale, Risso's dolphin, southern right whale dolphin, Australian sea lion, long-nosed fur seal (formerly New Zealand fur seal), Australian fur seal, common dolphin and bottlenose dolphin. Some of these species are resident while others are more transient, visiting to rest, breed and/or feed.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these marine mammals is expected (refer **Section 3.2.3.5** and **Section 3.2.3.8**). Value is not affected by Duntroon activities
				Ecological Value 8 (Species - seabirds): The WKIMP is used by a number of seabird species, including white-bellied seaeagle, osprey, crested tern, fairy tern and Pacific gull. Some of these species are resident while others are more transient, visiting the WKIMP to rest, breed and/or feed. Seabirds that breed in New Zealand or Antarctica, such as albatrosses, petrels and prions also occur in the WKIMP	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these seabirds is expected (refer **Section 3.2.3.7**). Value is not affected by Duntroon activities
				Ecological Value 9 (Species - shorebirds): The WKIMP is used by a number of shorebird species for feeding, including pied oystercatchers, red necked stint, grey plover, sharp-tailed sandpiper and hooded plover. Some of these species are resident while others are migratory from interstate or overseas.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these shorebirds is expected. Value is not affected by Duntroon activities.

Marine Park	SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Management Objectives/ Principles	Values	Principle Attainment
Western Kangaroo Island Marine Park (Con't)	< 120 dB re 1µPa (Site 1, Line 2 location)	60 km	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources.	*Socio-economic value 1 (Local Business and Community):* Local businesses and communities are predominantly based north east of the WKIMP within the vicinities of Parndana and Kingscote. A number of businesses, industries and jobs are reliant on the ecological values of the WKIMP, or use the WKIMP. These include tourism and commercial fishing.	Residual acoustic sound is not expected to affect this value (refer tourism and commercial fishing) expected (refer **Section 6.3.2.9**).
				Socio-economic value 2 (Coastal recreation): The WKIMP is used for a range of coastal recreation activities including fishing, boating and sightseeing.	The residual levels of acoustic sound at the WKIMP are not sufficient to affect fishing activities. Boating and sight-seeing in the parks are also not expected to be affected by the Duntroon survey activities. Value is not affected by Duntroon activities.
				Socio-economic value 3 (Tourism): Tourism is an important economic contributor to the region. Coastal and marine recreational opportunities include general recreation, recreational and charter fishing, and wildlife watching. Flinders Chase National Park is important for coastal sightseeing, wildlife watching and camping.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to recreational and charter fishing or wildlife watching. Value is not affected by Duntroon activities
				Socio-economic value 4 (Coastal Heritage): *Aboriginal:* The Ngarrindjeri and Kaurna Aboriginal people have traditional associations (which may include Aboriginal traditional fishing) with Kangaroo Island. *European:* The South Australian Heritage Register contains entries for the WKIMP including the lighthouses at Cape Borda and Cape du Couedic, the disused jetty near Weirs Cove, and Harveys Return. Commonwealth and state legislation has declared 13 historic shipwrecks in the WKIMP.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to traditional fishing. No impacts to European heritage is expected from residual sound levels. Value is not affected by Duntroon activities.
				Socio-economic value 5 (Transport & Infrastructure): The region is remote and exposed, and there is no coastal infrastructure within the WKIMP. There are no ports in the WKIMP, but the western end of Kangaroo Island is an important shipping route and ships pass within a few kilometres of the Kangaroo Island Upwelling.	Value is not applicable to Duntroon survey activities.
				Socio-economic value 6 (Aquaculture): There is no aquaculture in the WKIMP.	Not applicable.
				Socio-economic value 7 (Recreational Fishing): Recreational fishing has an important socio-economic value across South Australia including in the WKIMP. Recreational fishing is conducted in all habitat types except saltmarsh. Species targeted by recreational fishers in the WKIMP include King George whiting, Australian herring and Australian salmon.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to recreational fishing. Value is not affected by Duntroon activities.

Marine Park	SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Management Objectives/ Principles	Values	Principle Attainment
Western Kangaroo Island Marine Park (Con't)	< 120 dB re 1µPa (Site 1, Line 2 location)	60 km	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources.	*Socio-economic value 8 (Commercial Fishing):* There are a number of commercial fisheries operating in the WKIMP. This includes the NZRLF (rock lobsters) however the majority of vessels are located in Port Lincoln; abalone conducted on sub-tidal reef habitats; sardine fishery (including Australian anchovy) which is concentrated at the southern end of the Spencer Gulf but some fishing occurs near Western Eyre Peninsula, in Investigator Strait and to the west of Kangaroo Island; marine scalefish fishery targetting King George whiting, snapper, southern calamary and southern sea garfish (most fishing effort is concentrated in Spencer Gulf and Gulf St Vincent); and charter boat fishery.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to commercial fishing. Value is not affected by Duntroon activities.
Thorny Passage Marine Park	< 150 dB re 1µPa < 140 dB re 1µPa (SPL) < 130 dB re 1µPa (Based on Line 2, Site 1 footprint)	OA: 4 km; NA: 18km (Rocky (south) Is.) OA: 30 km ENE; NA: 46 km ENE (Whidbey Islands) OA: 36 km N; NA: 43 km N (Liguanea Island)	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources	*Ecological Value 1 (Habitat - Reef):* Reef (inter-tidal and sub-tidal) occurs in Coffin Bay and near Williams Island and Cape Catastrophe. Further offshore, Greenly and Rocky Islands and the Four Hummocks Island Group are fringed by reef. Communities contain fish, invertebrate and macroalgal diversity and abundance.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for reef species is expected (refer **Section 6.2.3.4**). Value is not affected by Duntroon activities.
				Ecological Value 2 (Habitat - Seagrass): The largest area of seagrass in the TPMP occurs in Coffin Bay.	Coffin Bay is protected from residual sound for Duntroon survey activities. No impacts from sound are expected in seagrass. Value is not affected by Duntroon activities.
				Ecological Value 3 (Habitat - Sand): Sand habitat is prevalent across the marine park with areas of beach, inter-tidal flats and and subtidal sandplains.	Residual sounds from seismic activities are not expected to affect sand areas. Value is not affected by Duntroon activities.
				Ecological Value 4 (Habitat - Mangrove): No mangroves are present in the TPMP.	Not Applicable.
				Ecological Value 5 (Habitat - Saltmarsh): The largest areas of saltmarsh in the TPMP occur in Yangie and Kellidie Bays, and along the eastern side of Horse Peninsula.	Value is not affected by Duntroon survey activities.
				Ecological Value 6 (Species - sharks): The TPMP is used by a number of shark species, including blue shark, dusky whaler, smooth hammerhead, school shark, white shark, shortfin mako and porbeagle. The northern part of the park overlaps a relatively productive area for gummy and whaler sharks in the South Australian Marine Scalefish Fishery.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these sharks is expected (refer **Section 6.2.3.4**). Value is not affected by Duntroon activities.
				Ecological Value 7 (Species – marine mammals): The TPMP is used by a number of marine mammals including southern right whale, humpback whale, minke whale, pygmy right whale, southern bottlenose whale, strap-toothed whale, long-finned pilot whale, sperm whale, pygmy sperm whale, killer whale, Australian sea lion, long-nosed fur seal (formerly New Zealand fur seal), Australian fur seal, common dolphin and bottlenose dolphin. Some of these species are resident while others are more transient, visiting to rest, breed and/or feed. Southern right whales migrate along this coastline between May and October towards calving and resting areas further west.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these marine mammals is expected expected (refer **Section 6.2.3.5** and **Section 6.2.3.8**). Residual sound impacts have been assessed at coastal areas and found not be be at levels which might disturb or prevent aggregating whales, sea lions or coastal migrations . Value is not affected by Duntroon activities.

Marine Park	SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Management Objectives/ Principles	Values	Principle Attainment
Thorny Passage Marine Park (Con't)	< 150 dB re 1µPa < 140 dB re 1µPa (SPL) < 130 dB re 1µPa	4 km (Rocky (south) Island) 28 km ENE (Whidbey Islands) 37 km north (Liguanea Island) [Taken to MP boundary]	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources	*Ecological Value 8 (Species - seabirds):* The TPMP is used by a number of seabird species, including white-bellied sea-eagle, osprey, Caspian tern, crested tern, fairy tern, little penguin, Pacific gull, short-tailed shear-water, silver gull and white-faced storm-petrel. Some of these species are resident while others are more transient, visiting the TPMP to rest, breed and/or feed. Most of the islands in the TPMP support seabird breeding colonies. Seabirds that breed in New Zealand or Antarctica, such as albatrosses, petrels and prions also occur in the TPMP.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these seabirds is expected (refer **Section 6.2.3.7**). Value is not affected by Duntroon activities
				Ecological Value 9 (Species - shorebirds): The TPMP is used by a number of shorebird species for breeding and feeding, including hooded and grey plovers, eastern reef egret, curlew sandpiper, sanderling, common greenshank, red-necked stint and pied and sooty oystercatchers. Some of these species are resident and others migrate to the TPMP from interstate or overseas.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these shorebirds is expected. Value is not affected by Duntroon activities.
				Socio-economic value 1 (Local Business and Community): Local businesses and communities are predominantly based north east of the TPMP within the vicinity of Port Lincoln, and most information in this section is reported for the Port Lincoln and Lower Eyre Peninsula Local Government Areas. A number of businesses, industries and jobs are reliant on the ecological values of the TPMP or use the TPMP. These include tourism, aquaculture and commercial fishing.	Residual acoustic sound is not expected to affect this value (refer tourism and commercial fishing).
				Socio-economic value 2 (Coastal recreation): The TPMP is used for a range of coastal recreation activities including fishing, boating, snorkelling, scuba diving, swimming, surfing, camping and sightseeing.	Residual sound impacts have been assessed at coastal areas and found not be be at levels which might disturb water-based recreational activities expected (refer **Section 6.2.3.9**). Value is not affected by Duntroon activities. Camping and sight-seeing is not applicable to Duntroon OA activities.
				Socio-economic value 3 (Tourism is an important economic contributor to the region. Coastal and marine recreational opportunities include general recreation, recreational and charter fishing, whale watching, scenic cruises and four-wheel driving.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to recreational and charter fishing or wildlife watching. Value is not affected by Duntroon activities
				Socio-economic value 4 (Coastal Heritage): *Aboriginal:* The Nauo-Barngarla Aboriginal people have traditional associations (which may include Aboriginal traditional fishing) with areas of the TPMP *European:* Entries in the SA Heritage Register for the TPMP includes a small tablet that Matthew Flinders left at Memory Cove to commemorate the loss of his crew, historical whaling sites at Fishery Bay and Coffin Bay (Point Sir Isaac), and a jetty at Mount Dutton Bay. There are 20 shipwrecks in the TPMP, most of which are fishing vessels.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to traditional fishing. No impacts to European heritage is expected from residual sound levels. Value is not affected by Duntroon activities.
				Socio-economic value 5 (Transport & Infrastructure): Transport and infrastructure provide socio-economic activity and value in this region (DENR 2010). Port Lincoln is important for the export of grain, vegetables, legumes and oilseeds. The port is not in the TPMP, but ships pass through it to access the port.	Not applicable to Duntroon survey activities.

Marine Park	SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Management Objectives/ Principles	Values	Principle Attainment
Thorny Passage Marine Park (Con't)	< 150 dB re 1µPa < 140 dB re 1µPa (SPL) < 130 dB re 1µPa	4 km (Rocky (south) Island) 28 km ENE (Whidbey Islands) 37 km north (Liguanea Island)	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources	*Socio-economic value 6 (Aquaculture):* The TPMP supports an aquaculture industry based mainly on intertidal Pacific oysters. In the TPMP there are 163 intertidal oyster leases, and 4 abalone licences. The majority of the oyster leases are in Coffin Bay.	Not applicable. Coffin Bay is protected from sound impacts.
				Socio-economic value 7 (Recreational Fishing): Recreational fishing has an important socio-economic value across South Australia including in the WKIMP. Recreational fishing is conducted in all habitat types except saltmarsh. Species targeted by recreational fishers in the TPMP include King George whiting, Australian herring and Australian salmon.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to recreational fishing. Value is not affected by Duntroon activities.
				Socio-economic value 8 (Commercial Fishing): There are a number of commercial fisheries operating in the TPMP. This includes the NZRLF (rock lobsters) with the majority of vessels are located in Port Lincoln; abalone conducted on sub-tidal reef habitats; prawn fishery (targets western king prawn using an otter trawl with fishing conducted on subtidal sand habitat; sardine fishery (including Australian anchovy) which is concentrated at the southern end of the Spencer Gulf but some fishing occurs near Western Eyre Peninsula, in Investigator Strait and to the west of Kangaroo Island; marine scalefish fishery targeting King George whiting, snapper, southern calamari and southern sea garfish (most fishing effort is concentrated in Spencer Gulf and Gulf St Vincent but for King George whiting, the TPMP contains the most productive areas (Denial Bay and Smoky Bay); and charter boat fishery (Between July 2009 and June 2012, 5 operators used Coffin Bay as their port of departure and 11 operators used Port Lincoln).	Given the distance from survey activities and the residual sound levels at the boundary of this state marine park, no impacts expected with regard to commercial fishing expected (refer **Section 6.2.3.4**). Value is not affected by Duntroon activities.
Neptune Island Group Marine Park	120 dB re 1µPa	OA: 42 km ENE	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources	*Environmental Values - Habitat:* Habitats include the exposed island environments above the reach of the tides, while at the shoreline, intertidal reefs extend down into deep water and sandy seafloor habitats. The slightly larger North Neptune Island has an area of surveyed platform reef adjacent to it, in some areas extending to depths greater than 50m.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these reef species is expected expected (refer **Section 6.2.3.4**). Value is not affected by Duntroon activities.
				Environmental Values - Marine Species: The Marine Park support a variety of marine and coastal species including fish (snapper, trevally, wrasse, Western Australian salmon, gummy shark, whaler shark and Australian herring), sharks (white shark (important feeding area), shortfin mako, porbeagle stingaree, whitespotted spurdog, spotted wobbygong, bronze whaler, blue shark, smooth hammerhead, school shark and dusky whaler), mammals (largest breeding colony of New Zealand fur seals in South Australia), birds (Caspian tern, crested tern, short-tailed shearwater (roost and nest on the Islands), cape barren goose, peregrine falcon (breed and nest on the islands), fairy tern breeds on South Neptune Island, rock parrot) and marine invertebrates (southern rock lobster, southern calamari, greenlip and blacklip abalone).	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to PTS, TTS or behaviour for these species is expected expected (refer **Section 6.2.3.4** (fish and sharks), **Section 6.2.3.5** (pinnipeds) and **Section 6.2.3.7** (Avifauna)). Value is not affected by Duntroon activities.

Marine Park	SPL (dB re 1µPa) at Boundary	Distance to Nearest OA Boundary	Management Objectives/ Principles	Values	Principle Attainment
Neptune Island Group Marine Park (Con't)	120 dB re 1µPa	48 km ENE	Protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources	*Economic Values – commercial fishing:* The commercial fisheries that operate in the Neptune Islands Group Marine Park are NZRLF, Sardine fishery, marine scalefish fishery and abalone fishery. The park is part of the Northern Zone Rock Lobster Fishery, which operates from November to May. The northern zone contributes around 20% of the $105m state-wide catch of southern rock lobster. The South Australian fishery for Australian sardine is the largest fishery by volume in Australia and is based out of Port Lincoln. Important waters include lower Eyre Peninsula and lower Spencer Gulf. The Marine Scalefish Fishery is a diverse multi-species, multi-gear fishery that operates across State waters. The key target species in this region are shark and leatherjacket. The Abalone Fishery targets greenlip and blacklip abalone. The park lies within the Western Zone Abalone Fishery, which produced about 64% of the State's abalone harvest in 2008/09. Fishing charters also operate in this region, based out of a variety of locations including Port Lincoln and Kangaroo Island	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to commercial fishing activities within the park is expected expected (refer **Section 6.2.3.4**). Value is not affected by Duntroon activities.
				Economic Values – transport and infrastructure: Transport and infrastructure provide an important economic contribution to the region, providing for maritime activities such as: shipping ports for import and export of goods; boat ramps for launching of recreational or commercial vessels; jetties for fishing; and breakwaters and groynes for coastal management.	Value is not affected by residual acoustic sound.
				Economic Values – Local Tourism: The regular presence of great white sharks in the area has led to a world-renown shark viewing industry, with two operators conducting cage diving tours, one based in Port Lincoln and one in Adelaide. Charter fishing is also conducted around the islands.	Given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to cage of charter fishing activities within the park is expected expected (refer **Section 6.2.3.9**). Value is not affected by Duntroon activities.
				Social Values – Aboriginal heritage: Little is known about the Aboriginal heritage for the Neptune Islands Group Marine Park. However the Government is aware that there may be confidential Aboriginal heritage sites in South Australia's coastal areas.	Value is not affected by residual acoustic sound.
				Social values – European heritage: A number of wrecks have occurred around the southern islands, including the *Frances* (1840) which is protected but not found, and the *Venus* (1946) and *Yandra* (1959) which are not protected.	Value is not affected by residual acoustic sound.
				Social values – Recreational activities: Due to the remoteness of this park, there are limited recreational activities undertaken here, other than white shark cage diving and charter fishing.	As above, given the distance and the residual sound levels at the boundary of this state marine park, no impacts with regard to cage of charter fishing activities is expected expected (refer **Section 6.2.3.9**). Value is not affected by Duntroon activities.

6.2.3.14 *Impacts from Vessel and Helicopter Sound*

Receptor Sensitivity: Activities generating underwater sound can affect marine fauna by interfering with aural communication, eliciting changes in behaviour, or in extreme cases, causing physiological impacts to auditory organs. The potential for noise from anthropogenic sources to impact fauna depends on a range of factors, including the intensity and frequencies of the noise, the prevailing background noise and the proximity of the noise sensitive species.

Hearing damage in marine mammals from shipping noise has not been widely reported (OSPAR, 2009). Observed marine mammal behaviour to vessel sound includes the following:

Sea lions (an otariid) in water tolerate close and frequent approaches by vessels and sometimes congregate around fishing vessels. However, the amount of evidence is slender, and it is not known whether these animals are affected or are stressed by these encounters (Peterson and Bartholomew, 1967; cited in Richardson et al, 1995).

Dolphins of many species tolerate or even approach vessels but sometimes members of the same species show avoidance. Reactions appear to be dependent on the dolphin's activity at the time - resting dolphins tend to avoid boats, foraging dolphins ignore and socialising dolphins may approach vessels (B. Wursig, pers.obs; cited in Richardson et al, 1995). Dolphins also reduce the energy costs of travel by riding the bow and stern waves of vessels (Williams et al, 1982; cited in Richardson et al, 1995).

Baleen whales seem to ignore weak vessel sounds and move away in response to strong or rapidly changing vessel noise. Avoidance was particularly strong when vessels approached directly (Watkins, 1986; cited in Richardson et al, 1995). Vessels operating in gray whale breeding lagoons caused short term escape reactions in the species particularly when the vessels are moving fast and erratically, however there is little response to slow-moving or anchored vessels (Reeves 1977; Swartz and Cummings, 1978; Swartz and Jones, 1978, 1981; cited in Richardson et al. 1995). Some whales are attracted to noise from idling outboard motors and are not seriously disturbed by small vessels however calling behaviour may change to reduce masking by boat noise. During migration, gray whales were observed to change course at 200-300 m in order to move around a vessel in their path (Wyrick, 1954; cited in Richardson et al, 1995).

There is no direct evidence of mortality or potential mortality to fish or sea turtles from ship sound (Popper are al., 2014). Popper et al. (2014) identifies that TTS impacts in turtles is moderate near the sound source (tens of meters) and masking risk is high at near and intermediate distances (hundreds of meters) from the sound source.

Popper et al. (2014) identify some evidence for auditory tissue effects or TTS caused by continuous sound on goldfish (*Carassius auratus*), an otophysan species that has specializations for enhanced sensitivity to sound pressure. Some recoverable loss of sensory hair cells occurred in the ear after 48 hours of exposure to white noise at 170 dB re 1 µPa SPL (Smith et al. 2006 in Popper at al., 2014). Recovery of TTS took seven days and full replacement of the sensory cells took eight days. Exposure to 158 dB re 1 µPa rms in another study also resulted in TTS in goldfish and the catfish *Pimelodus pictus* (Amoser and Ladich 2003 in Popper et al., 2014). Full recovery occurred after three days for the goldfish and after fourteen days for catfish.

Popper et al (2014) using a relative risk assessment process for continuous shipping sounds identifies that there is a low risk of mortality, potential mortality or recoverable injury for fish without swim bladders or fish with a swim bladder (not involved in hearing) exposed to continuous shipping sound. As above, the threshold for recoverable injury is 170 dB re 1µPa SPL (48 hrs exposure) for fish which have a swim bladder involved in hearing. Further for this grouping a threshold for TTS in hearing of 158 dB re 1µPa SPL (for 12 hours exposure) is identified. Masking risk in all fish types is high near the sound source (tens of meters) and at intermediate distances (hundreds of meters). At distances considered 'far' from the source (thousands of meters), masking risk is moderate for fish species without a swim bladder or where the swim bladder is not involved in hearing. The risk of masking remains high for fish species with a swim bladder involved in hearing at far distances from the sound source. Behavioural change in fish also is more likely near the vessel and at intermediate distances from the vessel.

The behavioural reaction of cetaceans to circling aircraft (fixed wing or helicopter) has been observed. Reactions are sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS, 2001; cited in Santos, 2004). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animal. The effects on whales seem transient, and occasional over-flights probably have no long-term consequences (NMFS, 2001; cited in Santos, 2004).

Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150 m. Leatherwood et al. (1982) observed that minke whales responded to helicopters at an altitude of 230 m by changing course or slowly diving.

Extent and duration of Exposure and Potential Impact:

For most of the survey the acoustic array will dominate marine sound. Underwater sound generated by the presence of the survey vessels may result in changes in behaviour of marine fauna such as disturbance, avoidance or attraction. However, underwater sound from the survey vessels is transient and typical of other underwater noise emitted by commercial shipping or fishing vessels which operate in the area.

Foraging BIAs are present within the Duntroon OA for pinnipeds and cetaceans. Spatial and temporal restrictions implemented on the operation of acoustic arrays will also guard against impacts to foraging marine fauna from the survey vessel. For support vessel operations, there is the potential for localised avoidance of marine species around the survey vessels when they are in proximity to marine species.

The Duntroon OA also overlaps a BIA for the white shark (foraging) with other fish and turtles potentially present. Based upon support vessel sound levels there could be temporary and localised behavioural disturbance to fish and turtles in the area.

Based upon the extremely short duration that helicopter noise is likely to be heard underwater and the low frequency of helicopter flights to the seismic vessel during the survey, impacts to fauna such as sharks, cetaceans and fish in the area would be localised and short term (seconds).

Summary:

Consequence Level (Inherent): If the activity results in disturbance to marine fauna from vessel sound, there is a potential for minor and temporary disruption to a small proportion of population with associated minor, temporary effects on critical habitats/activities (MODERATE consequence). Helicopter sound is considered incidental to the marine environmental setting (SLIGHT consequence).

Consequence Level (Residual): With controls adopted, disturbance to protected species is expected to be incidental within the local setting (SLIGHT consequence).

Controls Assessment:

Table 6-48 provides an assessment of possible controls to reduce impacts to marine fauna from support vessel and helicopter operations.

Table 6-60: Assessment of Potential Control Measures to reduce impacts from helicopters to marine fauna

Control Measure	Practicable	Will it be Implemented?	Justification
Implement EPBC Regulations 2000 (Part 8, Division 8.1) to manage vessel/helicopter operations in proximity to whales.	YES	YES	Regulatory requirement and good industry practice and will be adopted.

Control Measure	Practicable	Will it be Implemented?	Justification
Ensure propulsion and engine equipment is maintained to limit the amount of sound to the environment.	YES	YES	Good Industry practice – adopted.
Prevent temporal overlap with foraging activities in the BIA	Yes	Yes (for baleen whales)	PGS has structured surveys to limit temporal overlap with expected times of high foraging (refer temporal assessment section).
Adopt greater spatial buffers for vessel management as described in the EPBC Regulations (Part 8) to prevent disturbance in foraging BIAs.	No	No	Temporal overlap of activities and control measures implemented to prevent spatial overlap with foraging baleen whales preventing interference. MF whales, such as the sperm whale, does not have a significant overlap with vessel sound. Foraging impacts are not anticipated from vessel sound.
Adopt EPBC Regulations 2000 (Part 8) requirements for all protected species (sharks, birds, pinnipeds, cetaceans, turtles.)	No	No	Sighting of additional species such as sharks and turtles is not practicable from support vessels. Pinnipeds are considered to be practicable for observation purposes. Controls are not applicable to bird species present on the sea surface.
Eliminate support vessels from the survey.	No	No	Support vessels required to support the seismic vessel – but also to identify species and adopt spatial buffers around survey activity. Not acceptable to eliminate from survey.

6.2.4 *Impact assessment*

Table 6-61 provides the impact assessment for acoustic sound disturbance from the seismic survey activity.

Table 6-61: Acoustic sound disturbance from seismic survey EIA

Aspect	Seismic array acoustic disturbance in the marine environment.	
Impact Summary	Possible physiological or behavioural impacts to sound-sensitive species.	
Extent of Impact	High levels of sound localised around the moving operating array, with lower-level residual sound impacts on a regional basis.	
Duration of Impact	Temporary (duration of survey)	
Level of Certainty of Impact	MEDIUM. Impact of acoustic sound on species has been extensively studied for a number of species (e.g. whales, fish) with lesser studies on other species. PGS considered that there is sufficient literature available to assess impacts to species present and adjacent to the survey area.	
Values potentially affected within the survey environment	Whales (protected and listed), turtles (protected), pinnipeds (protected and listed), fish (pelagic, commercial), sharks (protected), marine invertebrates (lobster, deep sea crab, sponges, bryozoans, ascidians), plankton, tourism	
Impact decision framework.	**B** *(The activity is a standard operation and well understood, it is not new to the area and good practice is well defined. However acoustic modelling has been performed to assess potential impacts given the concern by some stakeholders with respect to impacts on marine fauna from acoustic sound and exploration activities leading to drilling and development.*	
POTENTIAL IMPACT	INHERENT CONSEQUENCE	RESIDUAL CONSEQUENCE
Acoustic Array Sound Impacts:		
Mortality (Zooplankton and fish/invertebrate eggs/larvae)	SLIGHT	SLIGHT
Filter Feeding Sessile Invertebrates (Recoverable Injury)	SLIGHT	SLIGHT
Abalone (Recoverable Injury)	SLIGHT	SLIGHT
Crustaceans (Sub-lethal impacts – Crab, Lobster)	SLIGHT	SLIGHT

Crustaceans (Catchability/Abundance –Crab, Lobster)	SLIGHT	SLIGHT
Cephalopods (Behavioural Impact)	MINOR	SLIGHT
Sharks (Mortality/Recoverable Injury)	SLIGHT	SLIGHT
Sharks (TTS)	MINOR	MINOR
Sharks (Behavioural –including Masking)	SLIGHT	SLIGHT
Pelagic Fish (Recoverable Injury)	SLIGHT	SLIGHT
Pelagic Fish (TTS)	SLIGHT	SLIGHT
Demersal Fish (Recoverable Injury)	MINOR	MINOR
Demersal Fish (TTS)	SLIGHT	SLIGHT
Fish (Behavioural including masking)	SLIGHT	SLIGHT
Fish (Catch abundance/ catchability)	SLIGHT	SLIGHT
Pinniped (Mortality/Recoverable Injury)	SLIGHT	SLIGHT
Pinnipeds (Behavioural)	MODERATE	SLIGHT
Pinnipeds (Masking)	SLIGHT	SLIGHT
Turtles (Mortality/Recoverable Injury)	MINOR	SLIGHT
LF Cetaceans (Mortality/Recoverable Injury)	MODERATE	SLIGHT
LF Cetaceans (Foraging - Behavioural)	MODERATE	SLIGHT
LF Cetaceans (Ocean Migrating - Behavioural)	SLIGHT	SLIGHT
Cetaceans (Behavioural - Coastal Aggregation)	SLIGHT	SLIGHT
Cetaceans (LF) (masking - oceanic)	MINOR	MINOR
Cetaceans (MF/HF) (masking)	SLIGHT	SLIGHT
Birds (Injury)	SLIGHT	SLIGHT
Birds (Foraging Displacement)	SLIGHT	SLIGHT
Vessel and Helicopter Sound Impacts		
Vessel Impacts to Marine Fauna	MODERATE	SLIGHT
Helicopter Impacts to Marine Fauna	SLIGHT	SLIGHT

Environmental Controls and Performance Measurement		
EPO	**EPS**	**Measurement Criteria**

EPO2: Survey is conducted in a manner that prevents physical injury (PTS/TTS) to marine fauna (whales, turtles, pinnipeds) from underwater sound.	**EPS4: Standard Management Procedures (EPBC 2.1 – Part A3 – applicable at all times)** – Survey operations conducted in accordance with all requirements of the EPBC Act Policy Statement 2.1 – Part A Standard Management Procedure. Information below is taken directly from policy documents and will be implemented for all surveys within the proposed OA: • A.3.1: Pre-start-up visual observation; • A.3.2: Soft start procedures; • A.3.3: Start-up delay Procedures; • A.3.4: Operations Procedures (shut-down on line turns); • A.3.5: Stop work procedure; • A.3.6: Night-time and low visibility procedures; • A4: Compliance and Sighting reports The following precaution zones will be implemented for whales (excluded dolphins) during all individual surveys within the OA (all measured as a horizontal radius from the operating array): • Observation Zone: 3+ km • Low power Zone: 2 km • Shutdown Zone: 500 m. To protect deep-diving species present in the survey area, pre-startup visual/PAM observation will include: • For water depths < 200m, observation period is 30 minutes; • For water depths > 200m, observation period is 60 minutes. Note: 1. Start-up will not commence if: a. Sperm whales are detected and are foraging within 13 km of the survey vessel location b. HF cetaceans (pygmy & dwarf sperm whales) at any distance detected. 2. Power-down will occur if sperm whales are detected within 13 km of the operational array. 3. Shut-down will occur for any HF cetacean at any distance detected. **For pinnipeds (additional requirements to Part A3):** If during pre-start observations (prior to the initiation of soft start procedures) a MFO detects a pinniped within 1000m of the source, start-up will be delayed until: • The MFO confirms the pinniped has moved to a point > 1000m from the source; or • Despite continuous observation, 10 minutes have passed since the last detection of a pinniped within 1000 m of the source and the mitigation zone remains clear. **For turtles (additional requirements to Part A3):** If during pre-start observations (prior to the initiation of soft start procedures) a MFO detects a turtle within 500 m of the source, start-up will be delayed until: • The MFO confirms the turtle has moved to a point > 500m from the source; or • Despite continuous observation, 30 minutes have passed since the last detection of a turtle within 500 m of the source and the mitigation zone remains clear. **Shutdown (Turtles and pinnipeds):** If during survey operations turtles are detected within 500m of the operating array, the source will be shut-down. For pinnipeds if detected in water depths < 200m shutdown will occur.	MFO reports show marine fauna interaction protocols are followed during survey including all required soft-start, shutdown and power-down activities. Responsibility: MFO Records of all marine fauna sightings including pinnipeds are recorded on MFO's and support vessel crew's marine fauna record sheets. Responsibility: MFO Vessel logs with records of all soft starts, shut down procedures and timing of acquisition. Responsibility: Vessel Master

EPO2: Survey is conducted in a manner that prevents physical injury (PTS/TTS) to marine fauna (whales, turtles, pinnipeds) from underwater sound.	**EPS5: Additional Management Procedures (EPBC 2.1 – Part B1 (MFOs) – applicable at all times**Operation of the seismic source within the proposed OA must at all times comply with the following EPBC 2.1 – Part B Additional Management Procedures (Survey Vessel): • Two dedicated trained and experienced MFOs will be available on the survey vessel to observe for marine fauna; • At least one MFO is on observation effort during daylight hours to advise on whale presence and shutdown/power down requirements. • An additional trained (but not experienced) MFO will be present onboard the survey vessel to assist with observations (for at least one swing). • An additional MFO will be present on each of the support vessels to assist with marine fauna identification/observation and implementation of adaptive management measures if 'high' whale densities are triggered within the survey period. All MFOs will be trained and experienced in whale identification and behaviour, distance estimation and capable of making accurate observations of whales in Australian waters	MFO training and experience resumes are assessed and on file prior to engagment. Responsibility: PGS Vessel Manager MFO shifts recorded in the MFO Report. Responsibility: MFOs
	EPS6: Standard Management Procedures (EPBC 2.1 – Part A2) The MFOs will induct survey and support vessel crews to ensure they are aware of the EPBC Policy Guideline 2.1 requirements and methodologies to undertake visual assessment for marine fauna species.	Induction records verify key crew members have participated in the induction. Responsibility: Survey Party Chief

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EPS7: Additional Management Procedures (EPBC 2.1 – Part B5 (PAM) – applicable all times) – During the Duntroon surveyoperations must at all times comply with the following EPBC 2.1 – Part B Additional Management Procedures:

A PAM system is installed on the survey vessel and is operational to detect odontocete whales (specifically sperm) meeting the specification requirements detailed in Section 7.4.;
PAM observations are undertaken on a 24-hr basis by two competent and experienced PAM Operators trained in the PAM system software used;
During daylight hours, PAM detections will be validated against MFO observations and ranges to determine the error (if any) in PAM detection distances;
Once PAM proves reliable in estimating distances, then PAM will be used to trigger (including at night and during periods of low visibility):

Power-down and shutdown for any odontocete [Note 1] detected in the shutdown (500m) or low-power (2000m) zone;
Power-down for sperm whales within 13 km of the operational array [Note 2];
Shutdown for the HF cetaceans [Note 3] at any distance of detection.

If PAM records are shown to be inaccurate in estimating distances, the seismic vessel will power-down in the event of a confirmed detection (comprising 3 or more detection records for a MF individual whale and any detection of a HF whale) and not power-up until 60 minutes have passed without detection.

Note:

Odontocete includes those whales which have detectable calls from Table 6-45 which are listed as having a possible presence in the survey area (excluding dolphin species).
If sperm whales are verified by support vessels as migrating and not foraging within canyon system, survey activities can recommence within this spatial buffer.
For HF cetaceans recorded as present in the survey area (pygmy sperm whale and dwarf sperm whale) any bioacoustic detection requires immediate shutdown of an active source.

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Records verify operational PAM system meets the requirements of Section 7.4.
Calibration records of PAM detections and visual observations during daylight hours.
<u>Responsibility</u>: PGS Vessel manager
Records (CV) verify the PAM operators are competent to a standard equivalent to those in 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations.
<u>Responsibility</u>: PGS Vessel Manager
PAM Master Observation Sheet provides acoustic detection record for the survey.
<u>Responsibility:</u> PAM Operator
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EPO2: Survey is conducted in a manner that prevents physical injury (PTS/TTS) to marine fauna (whales, turtles, pinnipeds) from underwater sound.	**EPS08: Additional Management Procedures (EPBC 2.1 – Part A3 (Low Visibility – applicable all times)** Within a location soft-starts and operations may proceed provided: • there has not been 3 or more whale instigated power-downs or shut-downs during the preceding 24 hours; or • Startup may also occur if operations have not been underway in the preceeding 24 hours and the vessel (& surveillance craft) have been in the vicinity (approximately 13 km) of the proposed start-up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period and no whales have been sighted. If 3 or more whale instigated shutdowns/powerdowns occur (i.e. high numbers of animals): • Soft starts will be undertaken at that particular location if good visibility conditions are present and PAM operator has confirmed no whales are not present in the low power/shutdown zones or sperm whales within 13 km of the array; and • Operations at night or in low visibility will not be undertaken at that particular location. In this instance adaptive management measures will be considered (refer *adaptive management – EPS09*).	MFO reports show marine fauna interaction protocols are followed during survey <u>Responsibility</u>: MFO
	EPS09: Additional Management Procedures (EPBC 2.1 – Part B6 (Adaptive Management – applicable all times to cetaceans) If there are 3 or more shut-down/power-downs due to whale presence in the preceding 24 hours; OR if there are three or more sightings of whales within the shut-down/power-down zones when the acoustic array is not operational in the preceding 24 hr period; the density of whales is deemed to be high and will cause the following measures to be implemented: • <u>Surveillance</u>: A support vessel will travel along the acquisition line to a distance or at least 13 km from the seismic array. If whales are observed within the distance of observation by the MFO on the support vessel, the survey vessel will undertake adaptive management (below). • <u>Relocation</u>: Survey vessel will relocate to another survey line > 13 km from the last confirmed whale sighting location where the support vessel has confirmed no whale presence. The survey vessel will not return to the original location within 24 hrs; OR • <u>Cessation</u>: If there are no options for the relocation (e.g. no other survey lines to acquire), all night time operations will cease at this location until 24 hours have passed with no whales observed. However at this decision point, if there have been less than 3 sightings within the power-down/ shutdown zone in the preceding 24 hours, night-time operations can re-commence in this location.	MFO reports show marine fauna interaction protocols are followed during survey including all required soft-start, shutdown and power-down activities to inform decision. <u>Responsibility</u>: MFO <u>Responsibility</u>: Party Chief (implementing adaptive management)

EPO2: Survey is conducted in a manner that prevents physical injury (PTS/TTS) to marine fauna (whales, turtles, pinnipeds) from underwater sound.	**EPS10: Additional Management Procedures (EPBC 2.1 – Part B3 (Spotter Vessel and Aircraft): Aerial Surveys during Operations (PGS)** The PGS Project Manager may implement additional aerial surveys to establish whale presence during operations if whale numbers are higher* than expected. The PGS Project Manager will decide on any additional surveys if spatial information is required to supplement vessel–based surveillance to obtain a regional context of whale presence. * Higher whale numbers defined as *3 or more shutdowns/power downs per day due to whales or 3 or more whale sightings recorded in the low-power/shut-down zone during shutdowns/ power downs.* The PGS Project Manager shall document the survey scope defining the aerial survey boundary and methodology to be utilised based upon Gill et al. (2011) but modified for conditions present in the Duntroon survey area. .	Records verify aerial surveys are undertaken as required by the Project Manager (weather permitting). Aerial survey report conforms to the documented methodology, survey boundaries and provides the required sighting data. Records (CVs) indicate that the aerial observers are trained and competent to undertake survey activities. <u>Responsibility</u>: PGS Vessel Manager
	Array Volume and Source Level **EPS11:** A seismic source of no greater than 3260 in^3 volume operating at 2000 psi will be used to meet the objectives for the Duntroon survey. **EPS12:** The airgun will have the following equivalent at source PK Pressure levels: • < 255.6 dB re 1µPa (PK) (Vertical plane) • < 249.5 dB re 1µPa (PK) (Horizontal plane – broadside) • < 246.5 dB re 1µPa (PK) (Horizontal plane – endfire) A SSV study will be undertaken duringthe Duntroon survey to reconfirm sound levels emitted. Data will be analysed at the completion of the survey.	Record of airgun configuration SSV Report <u>Responsibility</u>: PGS Vessel Manager
	Operational Area: **EPS13:** There will be no discharge of the acoustic source outside the Duntroon operational area.	Record of survey line acquisition within the Duntroon OA. Responsibility: Party Chief
	Line Turns **EPS14:** During line-turns the sound source will be shut down.	MFO Report verifies period of shutdown. Responsibility: MFO
EP03: Survey is conducted in a manner that prevents behavioural impact to foraging blue whales and prevents blue whale displacement from foraging grounds.	**Temporal Separation** **EPS15**: The Duntroon survey will be undertaken in the period September 1 to November 30, 2019 or 2020 and will have a maximum duration of 91 days per season.	MFO Report verifies period of acquisition. Responsibility: MFO

EP03: Survey is conducted in a manner that prevents behavioural impact to foraging blue whales and prevents blue whale displacement from foraging grounds	**Upwelling 'Parameter' Monitoring** **EPS16:** PGS will engage an independent third party to monitor environmental parameters for upwelling conditions and suitable conditions for blue whale foraging within the blue whale foraging BIA during November. This shall include: • Wind direction and speed (wind stress from south-east > 0.03 Pa) at Neptune Islands; • Sea bottoms temperature within the upwelling/coraging BIA; • Sea surface temperatures in the foraging BIA (19.2ºC ± 0.77 ºC) (Gill et al, 2011). If SE winds at sufficient wind stress are present at Neptune Island and the sea bottoms temperature and/or sea surface temperature environmental parameters are triggered, PGS will initiate daily aerial surveillance to detect blue whale presence or migration into the survey area.	Daily upwelling Reports from independent third-party. Responsibility: PGS Vessel Manager
	Aerial Surveillance (Blue Whale Migration into the High Abundant Food Source Foraging BIA). **EPS17:** Daily aerial surveillance would be undertaken by qualified observers utilising recognised surveillance techniques should upwelling/foraging environmental conditions are triggered. The surveillance area will focus on the area west/south of the EPP-41/42 MC3D survey area extending 100 km[109] from the survey boundary or high abundant food source foraging BIA to detect any migrating blue whales within 24hrs of the survey area. If blue whales are detected within this zone, PGS will assume that foraging within the BIA is possible and halt the Duntroon survey for the season. The aircraft will be in constant communication with the survey vessel. If blue whales are not detected, daily aerial surveillance will continue over this area until either blue whales are detected or until November 30, the last day of acquisition for the season.	Daily aerial surveillance reports. Responsibility: PGS Vessel Manager
	Acquisition Pattern: **EPS22:** The EPP-41/42 MC3D survey will sequence acquisition of the inshore racetrack over the continental shelf area (i.e. higher productivity areas during upwellings) before the deeper water racetrack (i.e. off-continental shelf) to avoid spatial overlap with high productivity areas if upwellings occur in November.	Record of survey line acquisitions Responsibility: Survey Chief

[109] Distance is based upon the largest mean distance per day travelled by tagged pygmy blue whales (89.66 km) as per Double et al, (2014).

EP04: Survey is conducted in a manner that prevents behavioural impacts to foraging sperm whales	**Additional Management Procedures (EPBC 2.1 – Part B3 (Spotter Vessel and Aircraft) Pre-mobilisation MC3D Aerial Survey:** **EPS18**: Prior to MC3D survey commencement (up to 3 days prior), an aerial survey will establish the presence of whales within the survey area to inform the start-up location of survey activities (weather -permitting). Survey effort will focus on the canyon areas and sperm whale foraging BIA within the MC3D survey area. The PGS Project Manager shall document the survey scope defining the aerial survey boundary and methodology to be utilised based upon Gill et al. (2011) modified for conditions present in the Duntroon survey area. Two trained and experienced MMOs will be engaged to record sighting and effort data during the aerial survey. *If an aerial survey is not possible due to weather conditions, a support vessel will be pre-deployed to the MC3D area to undertake the survey and inform start location.*	Records verify an aerial survey was undertaken up 3 days prior to survey commencement (weather permitting). Aerial survey report conforms to the documented methodology, survey boundaries and provides the required sighting data. Records (CVs) indicate that the aerial observers are trained and competent to undertake survey activities. <u>Responsibility</u>: PGS Vessel Manager
	Additional Management Procedures - spatial buffer to sperm whale foraging areas **EPS19:** Duntroon survey operations will maintain a spatial buffer of 13 km to foraging sperm whales located within the sperm whale foraging BIA. Sperm whale detection will be via PAM detection with power-down initiated by the PAM operator if sperm whales are detected within 13 km of the operating array. During daylight hours, sperm whales detected by PAM will be validated by support vessels and foraging activity confirmed. If: • Foraging is confirmed, survey operations will maintain a 13 km spatial buffer around the foraging whales: and • Migrating, survey operations will resume.	PAM Master Observation Sheet provides acoustic detection record for the survey. <u>Responsibility:</u> PAM Operator
	Additional Management Procedures – Sperm Whale Foraging BIA Specific Measures: **EPS20:** Operation of the seismic source when foraging sperm whales have been confirmed in the area, must comply with the following EPBC 2.1 – Part B Additional Management requirements: During the four hours prior to darkness, a vessel will scout the area scheduled to be traversed during the night to confirm the presence of whales in the night acquisition area. If foraging whales are encountered in the night acquisition area, then adaptive management measures will be applied (refer to EPS09).	Support vessel fauna observation records verify surveillance activities during periods where foraging sperm whales have been observed. <u>Responsibility</u>: Support Vessel Masters
EPO05: Undertake seismic acquisition in a manner that noise above levels	**Array Size** **EPS11:** A seismic source of no greater than 3260 in^3 volume operating at 2000 psi will be used to meet the objectives for the Duntroon survey.	Record of airgun configuration Responsibility: PGS Vessel Manager

which causes behavioural disturbance is not received in coastal habitat critical to aggregating SRWs.	**Operational Area:** **EPS13:** There will be no discharge of the acoustic source outside the Duntroon operational area.	Record of survey line acquisition within the Duntroon OA. Responsibility: Party Chief
EPO06: Undertake seismic acquisition in a manner that prevents serious or irreversible impacts to plankton or fauna dependent on plankton as a food source (i.e. ecosystem disruption)	**Array Size & Volume:** **EPS11:** A seismic source of no greater than 3260 in^3 volume operating at 2000 psi will be used to meet the objectives for the Duntroon survey.	Record of airgun configuration Responsibility: PGS Vessel Manager
	Operational Area: **EPS13:** There will be no discharge of the acoustic source outside the Duntroon operational area.	Record of survey line acquisition within the Duntroon OA. Responsibility: Party Chief
	Survey Duration: **EPS16:** The survey will be undertaken between September 1 and November 30, 2019 or 2020. Survey activities in November will be curtailed if environmental upwelling parameters are triggered and aerial surveillance detects blue whales within 100 km of the MC3D survey boundary (as appropriate).	Environmental upwelling parameter reports. Aerial Surveillance Records <u>Responsibility</u>: PGS Vessel Manager MFO Survey Report <u>Responsibility</u>: MFO
	Acquisition Pattern: **EPS21:** Maintain survey orientation in the current (partial) cross prevailing current direction to reduce the likelihood of plankton being impacted multiple times by the seismic source. **EPS22:** The EPP-41/42 MC3D survey will sequence acquisition of the inshore racetrack over the continental shelf area (i.e. higher productivity areas during upwellings) before the deeper water racetrack (i.e. off-continental shelf) to avoid spatial overlap with high productivity areas if upwellings occur in November.	Record of survey line acquisitions Responsibility: Survey Chief
EPO07: Undertake seismic acquisition in a manner that prevents ambient noise levels in the female sea lion foraging BIA resulting in site avoidance or other behavioural responses.	**Spatial Buffer** **EPS23:** A spatial buffer to 10 km shall be maintained between the operational source and the boundary of the male and female sea lion foraging BIA. **EPS24:** The vessel master will be supplied with all maps and GPS for exclusion zones that will be implemented during the survey, including the details of seasonal restrictions.	Record of survey line acquisition. Responsibility: Survey Chief Copies of maps and GPS coordinates provided to vessel master. <u>Responsibility</u>: PGS Vessel Manager
	Array Size & Volume: **EPS11:** A seismic source of no greater than 3260 in^3 volume operating at 2000 psi will be used to meet the objectives for the Duntroon survey.	Record of airgun configuration Responsibility: PGS Vessel Manager

	Sound Source Verification: **EPS25:** PGS to undertake at least one verification activity of sound source (via streamers) in accordance with process detailed in Appendix L**.** Data will be post processed for use in future survey modelling activities.	SSV Report <u>Responsibility</u>: PGS Vessel Manager
EPO08: Undertake seismic acquisition in a manner that prevents injury to invertebrates and fish and impacts as a result of the survey are localised, temporary and recoverable	**Array Volume and Source Level** **EPS11:** A seismic source of no greater than 3260 in^3 volume operating at 2000 psi will be used to meet the objectives for the Duntroon survey. **EPS12:** The airgun will have the following equivalent at source PK Pressure levels: • < 255.6 dB re 1µPa (PK) (Vertical plane) • < 249.5 dB re 1µPa (PK) (Horizontal plane – broadside) • < 246.5 dB re 1µPa (PK) (Horizontal plane – endfire). A SSV study will be undertaken duringthe Duntroon survey to reconfirm sound levels emitted. Data will be analysed at the completion of the survey.	Record of airgun configuration SSV Report <u>Responsibility</u>: PGS Vessel Manager
	Spatial Separation – Ancient Coastline KEF **EPS25:** No MC2D acquisition will be undertaken within 150 m of the 120m depth contour defining the Ancient coastline.	Record of survey line acquisition. Responsibility: Survey Chief
	Spatial Separation – Gulper Shark Breeding Closure Area **EPS26:** The following spatial controls will be observed during the Duntroon Survey (all areas): • MC2D survey limits survey lines to those perpendicular with the gulper shark closure area. No MC2D acquisition within closure area from survey lines parallel to the slope. • No MC3D acquisition within the 30nm gulper shark breeding closure area;	Records verify spatial buffers are maintained during survey operations. <u>Responsibility</u>: Vessel Master
	Source Operation: **EPS27:** Soft start procedures will be conducted in accordance with Part A of the EPBC Policy Statement 2.1 requirements. **EPS13:** There will be no discharge of the acoustic source outside the Duntroon operational area.	MFO report verifies survey controls are implemented Responsibility: MFO
	Adjacent Line Spatial and Temporal separation **EPS28:** A period of no less than 18 hours must have elapsed before any adjacent lines are acquired compared with the previous line to prevent TTS impacts to fish species.	MFO report verifies survey controls are implemented Responsibility: MFO
EPO09: Undertake seismic acquisition in a manner to prevent behavioural	**Array Size & Volume:** **EPS11:** A seismic source of no greater than 3260 in^3 volume operating at 2000 psi will be used to meet the objectives for the Duntroon survey.	Record of airgun configuration Responsibility: PGS Vessel Manager

disturbance to seabird populations foraging in upwelling related BIAs during upwelling events	**Operational Area:** **EPS13:** There will be no discharge of the acoustic source outside the Duntroon operational area.	Record of survey line acquisition within the Duntroon OA. Responsibility: Party Chief
	Survey Duration: **EPS29:** The survey will be undertaken between September 1 and November 30, 2019 or 2020. Survey activities in November will be curtailed if environmental upwelling parameters are triggered and aerial surveillance detects blue whales within 100 km of the MC3D survey boundary (as appropriate).	Environmental upwelling parameter reports. Aerial Surveillance Records Responsibility: PGS Vessel Manager MFO Survey Report Responsibility: MFO
EPO10: Undertake seismic acquisition in a manner that prevents disruption to fishery surveys which determine TACCs	**Temporal Separation** **EPS15:** The Duntroon survey will be undertaken in the period September 1 to November 30, 2019 or 2020 and will have a maximum duration of 91 days per season.	MFO report verifies survey timeframe Responsibility: MFO
EPO11: Undertake seismic acquisition in a manner where interference with fishing is to no greater extent than necessary than to acquire seismic	**Array Size & Volume:** **EPS11:** A seismic source of no greater than 3260 in^3 volume operating at 2000 psi will be used to meet the objectives for the Duntroon survey.	Record of airgun configuration Responsibility: PGS Vessel Manager
	Operational Area: **EPS13:** There will be no discharge of the acoustic source outside the Duntroon operational area.	Record of survey line acquisition within the Duntroon OA. Responsibility: Party Chief
	Survey Duration: **EPS29:** The survey will be undertaken between September 1 and November 30, 2019 or 2020. Survey activities in November will be curtailed if environmental upwelling parameters are triggered and aerial surveillance detects blue whales within 100 km of the MC3D survey boundary (as appropriate).	Environmental upwelling parameter reports. Aerial Surveillance Records Responsibility: PGS Vessel Manager MFO Survey Report Responsibility: MFO
	Notification – *refer to Section 6.9 for spatical conflict prevention controls.*	
EPO12: Undertake seismic acquisition in a manner that prevents migratory barriers to baleen whales during simultaneous seismic survey by third party	**EPS30: Simultaneous Seismic Surveys (Planning) –** PGS will monitor the NOPSEMA website for potential simultaneous surveys within proximity to the Duntroon OA and consult with titleholders on spatial and temporal overlap identifying measures to prevent possible cumulative impacts.	Records verify surveillance of the NOPSEMA website and communication with relevant titleholders (as required). Responsibility: PGS Vessel Manager

EPO12: Undertake seismic acquisition in a manner that prevents migratory barriers to baleen whales during simultaneous seismic survey by third party	**EPS31: Simultaneous Seismic Surveys (Operations) -** Communications with other seismic survey vessels that may be operating in the vicinity ensures that a minimum agreed distance between operating arrays such that a 10 km corridor with sound levels < 140 dB re 1µPa (SPL) is maintained between seismic survey vessels during seismic data acquisition: • Stakeholder notification prior to survey commencement • SIMOPS Procedure developed and adhered to during survey (as required); • Provision of MFO monitoring data to third party survey vessel to inform on cetacean distribution and assist with operational decision making on a daily basis.	Records verify that: • Communications between PGS and other seismic operators have been undertaken. • SIMOPS Procedure is in place. • Vessel track plots indicate distances from vessels comply with separation distances. • Daily MFO report to third party survey vessel Responsibility: Vessel Master/ MFO
EPO13: Vessels and helicopters operate to the prevent disturbance to marine fauna during acquisition activities	**EPS32:** Vessels will meet the requirements of Part 8 of the EPBC Regulations specifically: • Travel at less than 6 knots when in the caution zone of a cetacean (150 m radius for dolphins and pinnipeds and 300 m for whales) • Do not approach closer than the caution zones for dolphins and whales. Dolphin caution zone adopted for pinnipeds. • If cetacean or pinniped shows signs of disturbance move away at a constant speed of less than 6 knots. Note if foraging fauna are identified the caution zone is extended to 1000m.	MFO records verify requirements met. Responsibility: MFO
	EPS33: Helicopters will meet the requirements of Part 8 of the EPBC Regulations specifically (unless in an emergency): • Must not operate at a height lower than 1650 ft within a horizontal radius of 500m from a cetacean or pinniped.	MFO records verify requirements met. Responsibility: MFO
	EPS34: Noise radiates from vessels is reduced to as low as reasonably practicable by ensuring engines and propulsion systems are maintained in accordance with manufacturers specifications.	PMS records verify that engines and propulsion system maintenance meet this standard. Responsibility: PGS Vessel Manager

Demonstration of ALARP - PLANKTON	
Hazard Consequence Criteria	A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.

Hierarchy of Controls	Eliminate: • Survey window avoids 'peak' seasonal timeframes where upwelling conditions are present (December to March) for MC3D surveys on the continental shelf. • Survey timing/location does not overlap any location-specific spawning grounds . Substitute: • Acoustic source selected such that it is the smallest source to achieve the survey objectives Engineer: • Alignment of survey lines as far as possible with cross and prevailing conditions to avoid cumulative impacts. Isolate: • If upwelling environmental indicators are triggered, surveillance for whales entering the area to forage on plankton will be a trigger for halting survey activities for the season. This isolates area high density krill areas from high areas of noise. • Survey commences during down-welling September and October over the nearer shore MC3D racetrack areas, moving offshore in the later months to areas which are off the continental shelf reducing spatial overlaps with the Kangaroo Island Pool • Most of survey is undertaken off the continental shelf areas where plankton stocks are low, and impacts are reduced in absolute terms. Administrative: • None identified
Compliance with International Conventions, Legislative Codes and Standards	International Conventions: • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) Legislation: • Environment Protection and Biodiversity Conservation Act 1999 • EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8) Legislated Standards: • EPBC Policy Statement 2.1: Industry – Interaction between offshore seismic surveys and whales (Part A: Standard Management and Part B: Adaptive Management). • EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).
Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
Professional Judgement:	Alternate controls have been identified, assessed and implemented where practicable. Controls adopted cover multiple levels on the control hierarchy. *This is a common criterion for all acoustic impacts and will not be repeated in subsequent tables.*
Engineering Risk Assessment:	Modelling of acoustic footprint has been undertaken to assist in establishing possible impacts to receptors in the marine environment. Most conservative distance adopted for impact assessment which still identifies that impacts are locatised, temporary and recoverable. This information has been shared with stakeholders who have expressed an interest in the modelling output. *This is a common criterion for all acoustic impacts and will not be repeated in subsequent tables.*
Demonstration of Acceptability - PLANKTON	

Plankton Impact Summary: Survey area overlaps portion of Kangaroo Island pool upwelling (seasonally variable November to April) and upwelling-related BIAs such as with blue whale BIA (abundant food source) linked to upwelling system. Survey does not overlap any specific spawning or aggregation areas areas for fish and invertebrate species. All species spawning in the survey period have widespread spawning characteristics. Survey area overlaps the Western Eyre CMP. Predicted impacts to plankton are assessed as localised to within and immediate around the survey area, temporary and recoverable (SLIGHT Consequence). Upwelling Conditions: Without controls, impact to plankton may lead to foraging related impacts on the Blue Whale BIA – minor disruption to a small portion of the population. No threats to population viability (MODERATE consequence). Other foraging and ecosystem processes may also be compromised. With controls adopted (no overlap with key upwelling period, halting survey activity prior to foraging-related activity to prevent impacts to higher productivity waters, commencing survey arears of higher upwelling potential in downwelling month)) residual impact is SLIGHT.	
Policy compliance	The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Commonwealth and State Legislative Criteria	This assessment meets the requirements of the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (and associated legislation and guidelines).
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	*The Duntroon OA overlaps a portion of the Western Eyre CMP.* An assessment of plankton impacts against accepted scientific literature associated with the survey activity identifies impacts to be below natural mortality rates for plankton species (impacts localised, temporary and recoverable). Assessment against relent scientific literature identifies that the impacts was localised within the survey area, temporary and shoret-term and recoverable. On the basis of this assessment, conservation values (foraging species), ecosystem functioning and KEF functioning within the CMP are not significantly affected (values retained). Plankton impacts do not conflict with the South-west Marine Parks Network Management Plan 2018 prescriptions or IUCN Objectives. Refer to Table 6-57 (CMP Conservation values assessment) and Table 6-58 (Acoustic impact assessment to KEFs). *The Duntroon OA overlaps critical habitat for the pygmy blue whale* (as defined in the Conservation Management Plan for the Blue Whale). Conservation Management Plan for the Blue Whale has been considered as any plankton impacts may *directly impact* on foraging areas. Measures have been adopted which prevent impacts and acoustic sound displacement from foraging areas (also protects plankton abundance) meet requirements of Conservation Plan. *BIAs are also present for the Australian sea lion, seabirds, the sperm whale and the great white shark, however these species do not feed on plankton and are not considered in this plankton assessment.* *Impacts are therefore acceptable against marine reserve, bioregional plans species recovery and conservation advices.*

External Context: Stakeholder Engagement	During external consultation the following stakeholder expressed concern with respect to plankton impacts, particularly in light of the McCauley et al, 2017 paper: KI Dolphin Watch **[Stakeholder Record 32],** ASBTIA [**Stakeholder Record 6**] • Stakeholders have been provided with an assessment of the paper and its application to the Duntroon area, together with an assessment of plankton impacts as a result of the Duntroon survey activity. No feedback has been obtained from this information with the exception of KI Dolphin Watch **[Stakeholder Record 32]** who identified that a ‘no impact’ approach was appropriate, however agreed that impacts to plankton should not be substantial. *Copies of the Duntroon EP have been and continue to be provided to these stakeholders to review assessment.* • The Wilderness Society [**Stakeholder Record 42**] and ASBTIA [**Stakeholder Record 6**] have expressed concerns regarding detrimental impacts to plankton and the associated impact on ecosystem values including cetaceans and commercial fisheries. Both requested additional modelling to be undertaken to establish impacts within the GAB similar to the CSIRO study on the NWS. PGS considers that the NWS study should be considered as a screening study to identify the magnitude of impacts associated with recent plankton mortality findings by McCauley et al. (2017). This study showed that impacts were still localised, temporary and recoverable. A similar screening study in the GAB (non-upwelling conditions) would be expected to show similar outcomes (localised, temporary and recoverable) however biomass reduction may be less due to more dynamic oceanic conditions in the GAB with a greater recovery time due to cooler water temperatures. The importance of the screening study was to provide design parameters to reduce impacts to zooplankton. PGS has adopted these controls to prevent impacts during upwelling periods with reduced survey timeframes (September to November), undertaking MC3D areas where there is spatial overlap with the the Kangaroo island Pool prior to November to avoid overlap with upwelling conditions and foraging displacement*Ecosystem impacts can still be assessed utilising recognised impact thresholds to plankton. PGS does not believe a screening study would add additional value in reducing impacts to plankton with a priority placed upon replicating the results of the McCauley et al, 2017 research. .Given the altered timframe a CSIRO-equivalent ‘upwelling’ simulation is therefore not appropriate to the conditions which will be present in the Duntroon OA during acquisition activities*. *Copies of the Duntroon EP have been and continue to be provided to these stakeholders to review assessment.* • SASIA (**Stakeholder No: 8 Records**) expressed concerns associated with the overlap of the survey area and impacts to sardine egg counts which affect stock assessment particularly during February/March. PGS assessed and responded to SASIA on the possible spatial overlap of the survey with areas of high egg density and seismic impacts to fish eggs (localized) and predicted impacts to be very slight. No overlap to sardine egg spawning grounds or egg survey will occur due to the temporal separation adopted for the survey (September to November).. • AIASA (**Stakeholder Record 54**) expressed concerns associated with the temporal overlap of the abalone spawning period with survey activities. Abalone are nearshore, shallow depth species with localised distribution of fertilised eggs. Survey activities are too distant from these areas to cause impact to egg species. *Impacts are therefore acceptable against stakeholder concerns*.

External Context: Environmental	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* Plankton is not considered as a **threatened/migratory species** however plankton supports the ecosystem for these species. Threatened and migratory species present in the Duntroon OA include the blue, sperm, sei and fin whales (all foragers), the Australian sea lion (forager), albatross and petrel bird species (foragers), turtles (transient) and other migratory whale species. As the survey predominantly overlaps non-upwelling periods with controls to prevent spatial and temporal overlap with upwelling periods, survey impacts to plankton (& upwwellings) is expected to be slight. Utilising accepted scientific literature associated with sound impacts to seismic, impacts are predicted to be lower than natural mortality rates. Utilising more conservative recent scientific studies, impacts are, localised and recoverable in non-upwelling periods and these species are protected from indirect impact (i.e. no significant impacts). No triggers for significance under the EPBC Policy Statement 1.1 (MNES) trigger criteria. *The Duntroon OA as part of the marine environment contained key ecological features.* Plankton supports species within some of these KEFS. As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. The KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to establish any impacts to ecosystem functioning in Table 6-57. These KEFs are widely represented in the SGS and Southern Province bioregions. KEFs assessed which may be directly affected by plankton impacts are the Kangaroo Island Pool, Canyons and adjacent shelf-break & Eyre Peninsula Upwelling (note Duntroon OA does not overlap the shallower Eyre Peninsula upwelling); mesoscale eddies (transporting and distributing plankton); and the small pelagic fish of the south-west region. Table 6-57 establishes that these KEFs are not significantly impacted by localised and temporary reductions in plankton levels. On this basis, significance criteria for the Commonwealth marine environment are not triggered. *Impacts to environmental context are therefore acceptable*.
Impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damaged to plankton or fauna dependent on plankton as a food source will occur with the implementation of controls within this EP. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity have been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has been used to understand the most suitable and effective controls to active environmental outcomes.

Acceptability statement:	Impacts, with controls adopted, to plankton are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMP are not impacted (*legislation*); • No displacement of blue whales from foraging BIA as a result of plankton impacts (*legislation*). • Fish spawning and fish stock survey are not affected by survey activity (*stakeholder*); • Threatened and migratory species are not injured and disturbance in foraging areas is prevented (*external environment; conservation plans*); • The impact does not significantly modify, destroy, fragment, isolate or disturb an important habitat (i.e. KEF) or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results (*external environment and stakeholder*). *Based upon the evaluation made within this table (& supporting assessments) the impact to plankton is considered acceptable.*
DEMONSTRATION OF ALARP – INVERTEBRATES	
Hazard Consequence Criteria	A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
Hierarchy of Controls	Eliminate: • Acoustic source does not have sufficient sound level to cause mortality to crustaceans, abalone, sponges, ascidians. Substitute: • Acoustic source selected such that it is the smallest source to achieve the survey objectives Engineer: • *None Identified*. Isolate: • Water depths within the Duntroon OA are at least 100 m. As invertebrates appear to be primarily affected by particle motion (near-field effects) impacts are reduced. • Duntroon OA does not overlap commercial lobster or abalone fishing areas. Administrative: • Soft-start procedures in accordance with EPBC Policy Guideline 2.1 will be adopted to mitigate effects to invertebrates such as cephalopods which may be close to the operating array.
Compliance with International Conventions, Legislative Codes and Standards	International Conventions: • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) Legislation: • Environment Protection and Biodiversity Conservation Act 1999 • EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8) • Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights. Legislated Standards: • EPBC Policy Statement 2.1: Industry – Interaction between offshore seismic surveys and whales (Part A: Standard Management and Part B: Adaptive Management). • EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).
Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to cetaceans and other marine life to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
Demonstration of Acceptability - INVERTEBRATES	

<table>
<tr><td colspan="2">Invertebrate Impact Summary:
Survey area overlaps portion of the sperm whale BIA (foraging), Australian sea lion BIA (foraging), seabirds (foraging), white shark (foraging).
Survey area overlaps the Western Eyre CMR.
Impacts assessed as follows (refer Section 6.2.3.3):
• No predicted impacts to bryozoans, ascidians, or porifora. No mortality impacts predicted to crustaceans or abalone (physiological only to a small proportion of the population) (SLIGHT Consequence).
• Cephalopod impacts are expected to be localised, temporary and recoverable (SLIGHT consequence).
Indirect Impacts: Survey area overlaps low effort catch in the Giant Crab Fishery and there is no overlap with the NZRLF or abalone fisheries. Impact assessment identified no impacts to the sustainability of the fishery. There are no cephalopod fisheries (calamari) within the OA.</td></tr>
<tr><td>Policy compliance</td><td>The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.</td></tr>
<tr><td>PGS HSE Management System</td><td>Section 7 demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.</td></tr>
<tr><td>External Context: Commonwealth and State Legislative Criteria</td><td>This assessment meets the requirements of the Commonwealth Environment Protection & Biodiversity Conservation Act 1999 (and associated legislation and guidelines) and the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights.</td></tr>
<tr><td>External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices</td><td>The Duntroon OA overlaps a portion of the Western Eyre CMP.

An assessment of invertebrate impacts associated with the survey activity identifies impacts to be (conservatively) sub-lethal for invertebrate species (sessile fauna and crustaceans) with possible displacement by cephalopods (impacts localised, temporary and recoverable). On the basis of this assessment, conservation values (foraging species), ecosystem functioning and KEF functioning within the CMP are not significantly affected. Impacts to cephalopods may create localised and temporary displacement to the sperm whale, the male Australian sea lion and white shark however this displacement is temporary and recoverable and does not conflict with the South-west Marine Parks Network Management Plan 2018 prescriptions or IUCN Objectives. Refer to Table 6-58 (CMP Conservation values assessment) and Table 6-57 (Acoustic impact assessment to KEFs).

Invertebrates are not listed as a threatened/migratory species.

South-west Marine Bioregional Plan:

Benthic invertebrate communities of the eastern GAB: Pressures of potential concern on this feature include changes in sea temperature and oceanography and ocean acidification as a result of climate change and physical habitat modification (such as caused by damage to benthic communities from bottom trawling) (Not applicable to Duntroon). No impacts are predicted from sound on these species.

An assessment into the impacts of acoustic sound on sessile benthic structures identified little to no impact (refer also to Table 6-57). The SW Bioregional Plan notes - generally, most actions occurring in Benthic invertebrate communities of the eastern Great Australian Bight are unlikely to impact adversely on the biodiversity values of this key ecological feature.

Impacts are therefore acceptable against marine reserve, bioregional plans, species recovery plans and conservation advices.</td></tr>
</table>

External Context: Stakeholder Engagement	During external consultation the following stakeholder expressed concern with respect to survey impacts to invertebrates: • SA Rock Lobster Fishing Industry Association (SARLAC) (**Stakeholder No: 4 Records**) expressed concern at the recent Day et al. (2016) study relating to lobsters. PGS responded identifying some limitations of the study, and while relevant and important to shallow water surveys, the study conditions are not completely replicated in the Duntroon survey. Additional correspondence was provided by SARLAC which indicated that damage, permanent or otherwise, to Southern Rock Lobsters in SA, or any other jurisdiction, because of seismic survey work which may impact on reproductive capacity is likely to impact across the stock. This was of great concern to the industry. Further SARLAC's view was the survey work should not proceed until suitable controls could be identified and implemented to address concerns. SARLAC advised that they were not aware of any suitable and proven / demonstrated controls. Further SARLAC correspondence identified that a compensation arrangement like arrangements made for the Otway Basin should be arranged prior to the survey proceeding. PGS meetings held to identify and resolve the issue identified that a forward action to avoid displacement and / or economic loss was through mutual planning, however certainty and surety for the industry would only be provided by proceeding with an appropriate and agreed framework for compensation in place. SARLAC's position is that no party should suffer a detrimental economic impact because of these activities and in the medium to long term, if it is demonstrated that seismic survey activity has caused or contributed to any actual impact on rock lobster abundance, recruitment or catchability, fishers will be compensated for any resulting economic loss. PGS obtained fishing data from SARDI for both the Rock Lobster and Giant Crab Fishery. This information confirms that there is no spatial overlap of the Duntroon OA with active rock lobster fishing grounds and low levels of giant crab fishing have been identified as possible in the Duntroon OA ('confidential' or < 5 Licencees per annum). An assessment of possible impacts to the fishery has been provided to SARLAC identifying that any impacts to the fishery, which has been conservative assessed, will not be significant at a fishery biomass level. Additional information provided to SARLAC included an assessment of the McCauley et al., 2017 paper on plankton (including eggs and larvae). This identified reproductive and sustainability impacts to the fishery are not expected. Additional consultation has occurred with new survey timeframe identified. *No feedback has yet been provided*. • Andrew Fergusson **[Stakeholder Record 44],** a lobster and deep-sea crab fisherman also expressed concerns for the sustainability of the fisheries with respect to survey sound. A response was provided to Andrew with the SARLAC information attached. Additional consultation has occurred with new survey timeframe identified *No subsequent feedback has been provided.* • The Wilderness Society [**Stakeholder Record 42**] requested information regarding the impacts on commercial species (e.g. scallops or lobsters) and the assessment of impacts on these classes of species within the ecosystem and food chains of the GAB. The invertebrate section of the updated EP was provided to the wilderness society to fulfil this request. Additional consultation has occurred with new survey timeframe identified No further feedback on this issue has been provided by TWS. • A giant crab fisherman (**Stakeholder Record 72**) has advised there may be a spatial conflict between Duntroon survey activities in April and his fishing grounds. Arrangements were made during the March to May period for the fisherman to enter the area before survey commencement, however with the new timeframe (Spetember to November) there is little temporal overlap with the fishing season and this measure now offers no benefit. No feedback has been provided on this new timeframe. • AIASA (**Stakeholder Record 54**) expressed concerns associated with survey activities close to near-shore coastal reefs and requires an indemnity to protect abalone stock against damage from seismic. There is no spatial overlap with the fishery and survey activity is distant from fishing grounds. Assessment information has been provided to the AIASA to show that impacts to albalone stock are not predicted and an indemnity is not required. Stakeholder has not yet responded. An assessment into the Abalone, Lobster and Giant Crab Fishery is provided in Section 6.2.3.3. This assessment demonstrates that seismic operations will not cause sustainability issues with the abaolone, lobster or giant crab fishery. Lobster fisheries will not be displaced due to survey activities. *Impacts are therefore acceptable against stakeholder concerns.*

External Context: Environmental	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* Invertebrates are not considered as a threatened/migratory species however may provide prey for these species. Threatened and migratory species present in the Duntroon OA which foraging which might be impacted by invertebrate impacts include the sperm whale (cephalopod and crustacean forager), the Australian sea lion (forager) and possibly the white shark (forager). As no mortality impacts are predicted to crustaceans and displacement effects only expected for cephalopods, prey abundance is not reduced. Localised and temporary displacement effects may be experienced only. Given the large foraging areas for these species (i.e. impacted area represents 0.5% of sperm whale BIA or 0.04% of the male sea lion foraging impact) no significant impacts are predicted for population level impacts (i.e. no triggers for significance under the EPBC Policy Statement 1.1 (MNES)). Impacts to threatened and migratory species are therefore acceptable. *The Duntroon OA as part of the marine environment contains key ecological features based upon significance criteria.* Invertebrates support species and the functioning of the ecosystem within some of these KEFS. As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to establish any impacts to ecosystem functioning in Table 6-57. These KEFs are widely represented in the SGS and Southern Province bioregions. KEFs assessed which may be directly affected by invertebrate impacts are the Ancient Coastline (benthic habitats supporting demersal fish communities) and benthic communities of the eastern GAB shelf. No impacts to sessile invertebrates are predicted and mortality impacts to gastropods, decapods are not predicted. Table 6-57 establishes that these KEFs, as a result of these impacts, are not significantly impacted by sound and at worst may suffer only localised and temporary impacts. On this basis, significance criteria for the Commonwealth marine environment are not triggered. *Impacts to environmental context are therefore acceptable*.
Impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damaged to invertebrates or fauna dependent on invertebrates as a food source will occur with the implementation of controls within this EP. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity haves been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has been used to understand the most suitable and effective controls to active environmental outcomes.

Acceptability Criteria	Impacts, with controls adopted, to invertebrates are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMP are not impacted (*legislation*); • Fishermen are not significantly displaced from a fishing area where they have exclusive rights to fish (*stakeholder*); • The activity will not significantly impact on rock lobster or giant crab abundance, recruitment or catchability (*stakeholder*) or an adverse substantial impact on a population of marine species (*external environment*). • Threatened and migratory species are not significantly impacted (*external environment*); • Impacts do not significantly modify, destroy, fragment, isolate or disturb an important habitat (i.e. KEF) or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results (*external environment*). *Based upon the evaluation made within this table (& supporting assessments) the impacts to invertebrates from seismic sound are considered acceptable.*
DEMONSTRATION OF ALARP – FISH (excludes Elasmobranchs)	
Hazard Consequence Criteria	A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
Hierarchy of Controls	<u>Eliminate:</u> • Survey will be undertaken during September to November (predominantly downwelling favourable with controls to prevent spatial overlap with upwelling areas). Survey period is not significant for fish foraging or abundance.. • No temporal overlap with fishery survey activities (i.e. GABIA FIS, SBT surveys or sardine egg surveys).. • SBT stock are not present in the eastern GAB during the September to November period. • No acquisition within 150 m of the Ancient Coastline to protect demersal fish stock. <u>Substitute:</u> • Acoustic source selected such that it is the smallest source to achieve the survey objectives <u>Engineer:</u> • *None Identified*. <u>Isolate:</u> • Temporal isolation to high productivity periods for fish production. <u>Administrative:</u> • Soft-start procedures in accordance with EPBC Policy Guideline 2.1 will be adopted to mitigate effects to fish which may be close to the operating array.
Compliance with International Conventions, Legislative Codes and Standards	International Conventions: • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) Legislation: • Environment Protection and Biodiversity Conservation Act 1999 • EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8) • Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights. Legislated Standards: • EPBC Policy Statement 2.1: Industry – Interaction between offshore seismic surveys and whales (Part A: Standard Management and Part B: Adaptive Management). • EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).

<table>
<tr><td>Good Industry Practice:</td><td>APPEA Code of Environmental Practice (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to cetaceans and other marine life to a level which is ALARP and acceptable by demonstrating:
• The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
• Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts.
IAGC: Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).</td></tr>
<tr><td colspan="2">Demonstration of Acceptability - – FISH (excludes Elasmobranchs)</td></tr>
<tr><td colspan="2">Fish (excluding Elasmobranchs) Impact Summary:
Survey area includes conservation-dependent species such as SBT. OA also overlaps the small pelagic fish of south-west region KEF
Survey area overlaps the Western Eyre CMP.
Impacts assessed as follows (refer Section 6.2.3.4):
• Mortality/recoverable injury impacts to pelagic/demersal fish are present only on the continental shelf and are considered unlikely based upon scientific literature. Any recoverable injuries are localised and temporary (SLIGHT consequence).
• TTS impacts not expected given the constant movement to both fish (SLIGHT Consequence);
• Behavioural/masking impacts to fish greater closer to the array and diminishing at further distances from the array (kms) (SLIGHT consequence).
Indirect Impacts: Survey area overlaps low effort catch for the gillnet hook and trap, great Australian Bight trawl sector, the marine scalefish fishery (King George Whiting and Snapper), sardine fishery, SBT fishery (note juvenile SBT stock not present during survey period) and Charter boat fishery. An assessment of seismic survey impacts to fish biomass has identified that the incremental stock affected by the seismic survey does not exceed fishery TACs or compromise fishing management KPIs such that harvest arrangements need to be reassessed. No impact to fish resource sustainability is predicted.
Fish catch and Abundance Impacts: Low level fishing present – no significant impacts (SLIGHT Consequence)</td></tr>
<tr><td>Policy compliance</td><td>The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.</td></tr>
<tr><td>PGS HSE Management System</td><td>Section 7 demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.</td></tr>
<tr><td>External Context: Commonwealth and State Legislative Criteria</td><td>This assessment meets the requirements of the Commonwealth Environment Protection & Biodiversity Conservation Act 1999 (and associated legislation and guidelines) and Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights.</td></tr>
</table>

External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	*The Duntroon OA overlaps a portion of the Western Eyre CMP*. An assessment of fish impacts associated with the survey activity identifies only localised and temporary impacts to individual fish species with possible localised and temporary displacement by individual fish species. On the basis of this assessment, conservation values (foraging species), ecosystem functioning and KEF functioning within the CMP are not significantly affected. Displacement impacts may create localised and temporary displacement to the male Australian sea lion and white shark however this displacement is temporary (and recoverable) given the constant movement of the vessel. This does not conflict with the South-west Marine Parks Network Management Plan 2018 prescriptions or IUCN Objectives. Refer to Table 6-58 (CMP Conservation values assessment) and Table 6-57 (Acoustic impact assessment to KEFs). *SBT Conservation Advice* Information contained within this advice is fishing-related and nothing pertains to sound impacts. *South-west Marine Bioregional Plan:* • *Small Pelagic Fish of the South West Marine Region*: Actions which have a real chance or possibility of introducing pathogens to the small pelagic fish of the South-west Marine Region have a high risk of significant impact on the Commonwealth marine environment (not triggered for Duntroon activities). *No matters relating to sound impacts* • *SBT*: SBT was listed in 2010 as conservation dependent under the EPBC Act. BIA is yet to be defined for this species. The species is highly migratory, generally accepted to be a single population, with juveniles in their first year of life moving into the South-west marine Region. Extraction of living resources is of concern to the SBT. The fishery is managed globally by the international Commission for the Conservation of Southern Bluefin Tuna, which has already established measures to ensure rebuilding of the spawning stock. The Commission will continue to assess the effectiveness of its management measures and implement further measures as required. Noise pollution is of potential concern for southern bluefin tuna as are changes in sea temperature and oceanography. No specific action with respect to noise pollution is identified. *Impacts are therefore acceptable against marine reserve and species conservation advice requirements.*

External Context: Stakeholder Engagement	During external consultation the following stakeholders expressed concerns with respect to survey impacts to fish: • SASIA (**Stakeholder No: 8 Records**) expressed concerns associated with the overlap of the survey area and impacts to sardine egg counts/surveys which affect stock assessment particularly during February/March. PGS assessed and responded to SASIA on the possible spatial overlap of the survey with areas of high egg density and seismic impacts to fish eggs (localized) with predicted slight impacts. Additional information was provided to SASIA in August on the spatial overlap of the fishery with the Duntroon OA and spatial overlap of the with plankton and sardine egg count areas. In addition, PGS provided an assessment of impacts on plankton expected from the Duntroon survey and an assessment of the recent study by McCauley et al., 2017. *Survey design now eliminates overlap of Duntroon survey activities with shelf spawning of sardines (September to November) and egg count surveys. Issue resolved.* • ASBTIA **[Stakeholder Record 6]** has expressed concerns with respect to the timing of survey activities prior to 31 March due to interference with SBT fishing activities. Information and control measures adopted, to prevent interference with SBT fishing activities have been proposed to ASBTIA based upon Bight Petroleum EP. PGS provided an assessment of impacts on plankton expected from the Duntroon survey and an assessment of the recent study by McCauley et al., 2017. Feedback identified that any activity prior to April 1 is unacceptable as sound can create avoidance behavior in SBT for hundreds of kilometers and any seismic vessel operating closer than this to a pontoon under tow poses unacceptable risk. ASBTIA also identifies that the conditions negotiated with Bight Petroleum are now outdated and no longer relevant. Feedback was provided to ASBTIA identifying that survey activity in deeper waters do not have significant sound ingress onto the continental shelf, maintaining that the Bight Petroleum EP conditions are relevant based upon scientific data available for fish disturbance. PGS has requested the literature quoted by ASBTIA to inform these control measures. *PGS has now modified survey design such that acquisition is undertaken during the period September to November which eliminates temporal overlap with juvenile SBT in the eastern GAB. ASTBIA now have concerns around the 'dead zones' caused by seismic activity and cannot agree to seismic within the GAB. Information has been provided to ASTBIA to support that seismic creating 'dead zones' does not hold merit. PGS has not received a reply from PGS correspondence dated 3rd October 2018 to ASBTIA..* • GABIA **[Stakeholder Record 3]** has expressed concerns associated with a FIS survey to be undertaken in the February to April period which may affect quota numbers. PGS has provided an assessment which demonstrated that Duntroon survey activities should not affect FIS activities given the spatial buffer (86 km). *Survey timeframe has been modified to September to November 2019/20. No FIS are planned during that timeframe. Issue resolved.* • SSIA [**Stakeholder Record 60**] and SPFIA [**Stakeholder Record 61**] have advised that there is essentially no SPF fishing in the area and shark hook fishermen may fish in the area. No issues or concerns have been raised. • CSIRO **[Stakeholder Record 13]** expressed concerns with the potential risk of seismic survey operations affecting SBT behaviours in turn affecting CSIRO survey programs (independent aerial surveys, gene-tagging abundance estimates, ability to find/tag fish); and disrupting purse seine fishing operations affecting the 'fishery dependent' index of abundance from commercial spotters and sampling operations for gene-tagging study. PGS in response to this concern committed to not undertake any seismic survey activities prior to March 1. PGS has now altered timeframe to prevent temporal overlap with survey activities. This information has been provided to CSIRO. *PGS has not received a reply from PGS correspondence dated 17th July 2018 to CSIRO. No response has been provided to date.* Feedback has been requested from the Marine Fishers Association of SA **[Stakeholder Record 1],** SARFAC (now RECFish SA) [**Stakeholder Record 57],** CFA [**Stakeholder Record 11],** Sustainable Shark Fishing Association **[Stakeholder Record 20]** and Recreational Charter Boat Fishery **[Stakeholder Record 55**] however no feedback has been provided by these groups. *Impacts are therefore acceptable against stakeholder concerns.*

External Context: Environmental	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* SBT are a species listed under the EPBC Act as conservation dependent due to overfishing. The Duntroon survey period does not temporally overlap periods when juvenile SBT are present in the eastern GAB and no stock impacts are predicted. The Conservation advice does not identify and sound related conditions for this species. The Duntroon OA may contain syngnathid species however this listed species is not considered a significant site-attached fish species within the OA given the water depths of the survey (100m⁺) and lack of recorded species in SA waters. If present it is expected to be widespread throughout the bioregion at this depth range. No impacts at a population level expected. *Indirect Impacts*: Higher level threatened and migratory species utilising fish as a feedstock forage within the Duntroon OA (e.g. sperm whale BIA, the male Australian sea lion BIA, white shark BIA and seabird BIA). Given the very low predicted impacts to fish located on the continental shelf (1.3% SGS impact), no significant flow-on impacts to populations (i.e. significantly affecting critical habitat) are expected given the sustainability of fish species present and observed natural mortality rates (SBT). Localised and temporary displacement effects may be experienced however given the large foraging areas for these species no significant impacts are predicted (i.e. no triggers for significance at a population level under the EPBC Policy Statement 1.1 (MNES)). *Impacts to threatened and migratory species are therefore acceptable based upon significance criteria.* *The Duntroon OA as part of the marine environment which contains KEFs and marine species populations.* Fish support species and the functioning of the ecosystem within some of these KEFS. As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to ecosystem functioning in Table 6-57. These KEFs are widely represented in the SGS and Southern Province bioregions. KEFs assessed which may be directly affected by fish impacts are the Ancient Coastline (benthic habitats supporting demersal fish communities); Kangaroo Island Pool, canyons and adjacent shelf-break (high productivity utilised by small pelagic fish) and small pelagic fish of the SW region. Any impact to fish species is small compare with fishery biomass and observed natural mortality rates (SBT). Table 6-57 establishes that these KEFs, as a result of these fish impacts are not significantly impacted by sound. On this basis, significance criteria for the Commonwealth marine environment are not triggered. *Impacts to environmental context are therefore acceptable*.
Impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damage to fish or fauna dependent on fish as a food source have been identified. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity have been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has been used to understand the most suitable and effective controls to active environmental outcomes.

Acceptability Criteria	Impacts, with controls adopted, to fish are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMP are not impacted (*legislation*); • Survey sound impacts to SBT operations are eliminated due to temporal isolation from SBT juveniles being present in the eastern GAB during Duntroon survey activities (*stakeholder*); • Survey sound impacts form survey activities do not affect fish stock survey activities leading to reduced quotas (*stakeholder*); • Fish stock affected does not compromise resource sustainability (measured through TACs and fishery management KPIs (*external environment*); • No injury impacts to threatened and migratory species (*external environment*); • No injury or TTS impacts to demersal fish located in the Ancient coastline KEF (IUCN VI Principles); • Impacts do not significantly modify, destroy, fragment, isolate or disturb an important habitat (e.g. KEF) or substantial area of habitat such that an adverse impact on Commonwealth marine ecosystem functioning or integrity; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution (i.e. fish biomass) (*external environment*). *Based upon the evaluation made within this table (& supporting assessments) the impacts to fish (pelagic and demersal) from seismic sound are considered acceptable.*
DEMONSTRATION OF ALARP –Elasmobranchs	
Elasmobranchs Impact Summary: Survey area includes conservation-dependent species such as the Gulper Shark and School Shark. OA also overlaps a small portion of the white shark BIA (0.3%). Conservation advices and recovery plan does not identify sound as a threat to species recovery. Survey area overlaps the Western Eyre CMP. Impacts assessed as follows (refer **Section 6.2.3.4**): • Mortality/recoverable injury impacts to sharks are present only on the continental shelf based on modelling and not expected given the anatomy of the species and its known response to sudden increases in sound (SLIGHT consequence). • TTS impacts not expected given the constant movement of vessel (SLIGHT Consequence); • Behavioural/masking impacts to fish and shark greater closer to the array and diminishing at further distances from the array (kms) (SLIGHT consequence). The available evidence indicates sharks will generally avoid seismic sources, so the likely impacts on sharks are expected to be limited to short-term behavioural responses, such as avoidance of waters around the operating seismic array (Carroll et al, 2017). *Indirect Impacts:* Fishery-related impacts have been assessed under 'Fish' acceptability criteria.	
Hazard Consequence Criteria	A SLIGHT consequence (*all other elasmobranch impacts*) is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
Hierarchy of Controls	Eliminate: • MC2D survey lines have been removed from the gulper shark closure area (central 30nm zone) to eliminate unnecessary sound exposure (possible abandonment or breeding issue in the area). Substitute: • Acoustic source selected such that it is the smallest source to achieve the survey objectives Engineer: • *None Identified*. Isolate: • *None identified.* Administrative: • Soft-start procedures in accordance with EPBC Policy Guideline 2.1 will be adopted to mitigate effects to sharks which may be close to the operating array.

Compliance with International Conventions, Legislative Codes and Standards	International Conventions: • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) Legislation: • Environment Protection and Biodiversity Conservation Act 1999 • EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8) • Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights. Legislated Standards: • EPBC Policy Statement 2.1: Industry – Interaction between offshore seismic surveys and whales (Part A: Standard Management and Part B: Adaptive Management). • EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).
Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to cetaceans and other marine life to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
Demonstration of Acceptability - – Elasmobranchs	
Policy compliance	The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Commonwealth and State Legislative Criteria	This assessment meets the requirements of the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (and associated legislation and guidelines) and *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (S280) – *Interference with Other Rights.* .

<table>
<tr><td>External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices</td><td>
The Duntroon OA overlaps a portion of the Western Eyre CMP.
An assessment of modelling related to shark impacts associated with the survey activity identifies the potential for mortality/recoverable injury impacts only within shallow waters (< 160 m). For the deeper waters coincident with the CMP, localised, temporary and recoverable impacts are expected which may result in possible localised displacement. Based on this assessment, conservation values within the CMP (foraging species), ecosystem functioning and KEF functioning within the CMP are not significantly affected. For example, behavioural impacts leading to localised and temporary displacement within the white shark BIA (BIA is located at the northern edge of the OA) is not expected to affect foraging activities given the distance of the boundary from the nearest pinniped colony and the depth of water which Is at the normal 'limit' range of the shark (100m+).
Localised displacement of shark species is not expected to significantly affect other species present in the CMP. One this basis, the activity does not conflict with the South-west Marine Parks Network Management Plan 2018 prescriptions or IUCN Conservation Objectives. Refer to Table 6-58 (CMP conservation values assessment) and Table 6-57 (Acoustic impact assessment to KEFs).
Recovery Plan for the White Shark (SEWPC, 2013):
Actions contained within this plan does not relate to marine noise exposure.
Conservation Advice for the Southern Dogfish (TSSC, 2013):
Actions contained within this advice does not relate to marine noise exposure.
South-west Marine Bioregional Plan:
White Sharks: People planning to undertake actions in BIAs for white sharks must consider the potential for their action to have a significant impact on the species. For actions proposed outside a BIA for white shark (most of Duntroon survey), the risk of significant impact on the species is lower. Actions with a high risk of significant impact on the white shark include:

Actions which have a real chance or possibility of increasing human disturbance in BIA e.g. tourism activities (Not applicable to Duntroon)
Actions which have a real chance or possibility of increasing entanglement in important ('foraging' and 'distribution (high density)') areas (Not applicable to Duntroon).

Impacts are therefore acceptable against marine reserve, marine bioregional plans, recovery plans and species conservation advice requirements.
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<tr><td>External Context: Stakeholder Engagement</td><td>
During external consultation the following stakeholders provided the following feedback:

SSIA [Stakeholder Record 61] have advised that shark hook fishermen may fish in the area. No issues or concerns have been raised.
SPFIA [Stakeholder Record 60] have advised that there is essentially no SPF fishing in the area. No issues or concerns have been raised.
Feedback has been requested from the Marine Fishers Association of SA [Stakeholder Record 1], SARFAC (now RECFish SA) [Stakeholder Record 57], CFA [Stakeholder Record 11], Sustainable Shark Fishing Association [Stakeholder Record 20] and Recreational Charter Boat Fishery [Stakeholder Record 55] however no feedback has been provided by these groups.
AFMA [Stakeholder Record 2] were requested to provide comment to PGS for controls adopted to prevent behavioural disturbance to the Gulper Shark. AFMA responded by statingthe information and analysis contained in the correspondence was well considered and thorough, however they cannot comment on the likely effectiveness or otherwise of the proposed control measures in minimizing impacts on gulper sharks.

Based upon this feedback, PGS considers it has satisfactorily met stakeholder requirements.
Impacts are therefore acceptable against stakeholder concerns.
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External Context: Environmental	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* White sharks are a threatened species within the Duntroon OA together with migratory species such as the shortfin mako and the porbeagle shark. The OA also holds habitat for the conservation dependent Gulper shark and school shark. Assessment of survey activities for PTS, TTS, behavioural/masking impacts have been undertaken. With controls implemented and known responses to sudden sounds (Myrberg, 2001) behavioural impacts are expected which are temporary, localised and recoverable. As such, localised displacement effects may be experienced are not expected to have significant impacts to populations (i.e. no triggers for significance at a population level under the EPBC Policy Statement 1.1 (MNES)). *Indirect Impacts*: As sharks are an apex predator, indirect impacts from any localised and temporary displacement is not expected to affect other protected species. Impacts to threatened and migratory species are therefore acceptable based upon significance criteria. *The Duntroon OA as part of the marine environment which contains KEFs and marine species populations.* As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to ecosystem functioning in Table 6-57. These KEFs are widely represented in the SGS and Southern Province bioregions. Sharks, as apex predators, with behavioural impacts from survey activities (predicted to be temporary and localised) are unlikely to significant impacts on KEF functioning and adverse impacts to their population are not expected. On this basis, significance criteria for the Commonwealth marine environment are not triggered and are therefore acceptable. *Impacts to environmental context are therefore acceptable*.
Impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damage to elasmobranchs have been identified. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity have been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has been used to understand the most suitable and effective controls to active environmental outcomes.

Acceptability Criteria	Impacts, with controls adopted, to elasmobranchs are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMP are not impacted by the Duntroon survey (*legislation*); • No injuries expected to threatened and migratory species and sharks within foraging BIAs (i.e. white shark) given the small overlap in area at the OA boundary behavioural disturbances within the BIA at foraging locations (i.e. Rocky Island Sth) are not expected (*external environment*); • Impacts do not significantly modify, destroy, fragment, isolate or disturb an important habitat (e.g. KEF) or substantial area of habitat such that an adverse impact on Commonwealth marine ecosystem functioning or integrity; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution (i.e. fish biomass) (*external environment*). *Based upon the evaluation made within this table (& supporting assessments) the impacts to sharks from seismic sound are considered acceptable.*
DEMONSTRATION OF ALARP – Turtles	
Hazard Consequence Criteria	A SLIGHT consequence is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
Hierarchy of Controls	<u>Eliminate:</u> • *None identified.* <u>Substitute:</u> • Acoustic source selected such that it is the smallest source to achieve the survey objectives <u>Engineer:</u> • *None Identified*. <u>Isolate:</u> • *None identified.* <u>Administrative:</u> • Soft-start procedures and shutdown zones in accordance with EPBC Policy Guideline 2.1 will be adopted to mitigate effects to turtles which may be close to the operating array.
Compliance with International Conventions, Legislative Codes and Standards	International Conventions: • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) Legislation: • Environment Protection and Biodiversity Conservation Act 1999 • EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8) Legislated Standards: • EPBC Policy Statement 2.1: Industry – Interaction between offshore seismic surveys and whales (Part A: Standard Management and Part B: Adaptive Management). • EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).
Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
Demonstration of Acceptability - – Turtles	

Turtle Impact Summary: Survey area overlaps the Western Eyre CMP. No BIA is present for marine turtles in the OA. Impacts assessed as follows (refer Section 6.2.3.6): • PTS/TTS impacts are only realised close to the operational array. Individuals affected only no population level impacts (SLIGHT consequence). • Behavioural Impacts are localised temporary and recoverable (SLIGHT Consequence); *Indirect Impacts:* None identified.	
Policy compliance	The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Commonwealth and State Legislative Criteria	This assessment meets the requirements of the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (and associated legislation and guidelines).
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	*The Duntroon OA overlaps a portion of the Western Eyre CMP*. Marine turtles are not identified as a conservation value with the Western Eyre CMP. Conservation values are met, and ecosystem/KEF functioning are not significantly affected. The activity does not conflict with the South-west Marine Parks Network Management Plan 2018 prescriptions or IUCN Objectives. *Recovery Plan for the Marine Turtle (2017-2027) (DoEE, 2017):* Noise interference as a general threat to sea turtles within Australian waters with a requirement for, in accordance with the EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines, all seismic survey vessels operating in Australian waters must undertake a soft start during surveys irrespective of location and time of year of the survey. *South-west Marine Bioregional Plan:* No specific requirements for marine turtles in the bioregional plan. *Impacts are therefore acceptable against marine reserve, marine bioregional plans, recovery plans and species conservation advice requirements.*
External Context: Stakeholder Engagement	External consultation did not raise any issues relating to marine turtles. *This is taken as acceptance that stakeholder concerns have been met.*

External Context: Environmental	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* Marine turtles are threatened/migratory species. Assessment of survey activities for PTS/TTS and behavioural impacts have identified, with controls implemented, that impacts are temporary, localised and recoverable. Localised and temporary displacement effects may be experienced however given the range of these species no significant impacts to populations are predicted (i.e. no triggers for significance at a population level under the EPBC Policy Statement 1.1 (MNES)). *Indirect Impacts*: No indirect impacts as a result of impacts to turtles are identified. Impacts to threatened and migratory species are therefore acceptable based upon significance criteria. *The Duntroon OA as part of the marine environment which contains KEFs and marine species populations.* As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to ecosystem functioning in Table 6-57. These KEFs are widely represented in the SGS and Southern Province bioregions. Turtle impacts are not expected to impact upon KEF areas and impacts which are predicted to be temporary and localised are unlikely to have significant adverse impacts to their population. On this basis, significance criteria for the Commonwealth marine environment are not triggered and are therefore acceptable. *Impacts to environmental context are therefore acceptable*.
Impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damage to turtles are identified. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity have been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has been used to understand the most suitable and effective controls to active environmental outcomes.
Acceptability Criteria	Impacts, with controls adopted, to turtles are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMP are not impacted (*legislation*); • Injury impacts to a threatened and migratory species are not expected (*external environment*); • EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines are adopted (*legislative*); • Impacts do not significantly modify, destroy, fragment, isolate or disturb an important habitat (e.g. KEF) or substantial area of habitat such that an adverse impact on Commonwealth marine ecosystem functioning or integrity; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution (*external environment*). *Based upon the evaluation made within this table (& supporting assessments) the impacts to sharks from seismic sound are considered acceptable.*
DEMONSTRATION OF ALARP – Marine Mammals (Pinnipeds and Cetaceans)	

<table>
<tr><td>Hazard Consequence Criteria</td><td>A SLIGHT consequence is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.

A MINOR consequence (foraging) is considered broadly acceptable. If the control measures are consistent with applicable standards, then no action is required to reduce the impact further unless a reasonably practicable measure is available. The impact shall be managed in accordance with good industry practice.</td></tr>
<tr><td>Hierarchy of Controls</td><td><u>Eliminate:</u>
• Temporal exclusion during periods of upwelling (foraging blue whales).
<u>Substitute:</u>
• Acoustic source selected is the smallest source to achieve the survey objectives
<u>Engineer:</u>
• Adoption of PAM to detect odontocetes.
• Sound source verification to verify acoustic modelling
<u>Isolate:</u>
• Spatial buffer between SRW calving BIA and survey activities between September and November.
• Spatial buffer of 10 km between acoustic source and male and female sea lion foraging BIA.
• Spatial buffer of 13 km between acoustic source and foraging baleen or sperm whales.
• Spatial buffer between PGS and third-party acquisition vessel during planning to provide a migratory corridor < 140 dB re 1µPa if simultaneous surveys undertaken.
<u>Administrative:</u>
• Implement EPBC Policy Statement 2.1 – Standard Management Procedures (Part A) & (Part B)
• Support vessels to monitor and detect cetaceans during foraging.
• Adaptive management measures if cetacean presence is high or increasing;
• MC3D Pre-survey aerial survey (weather permitting) to establish presence of whales with possible aerial surveys during operations as requires.
• Monitoring if upwelling parameters are triggered to monitor for high productivity.
• MFOs present on all vessels.
• Crew induction to ensure awareness of EPBC Policy 2.1 and visual observation techniques</td></tr>
<tr><td>Compliance with International Conventions, Legislative Codes and Standards</td><td>International Conventions:
• Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)
Legislation:
• Environment Protection and Biodiversity Conservation Act 1999
• EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8)
Legislated Standards:
• EPBC Policy Statement 2.1: Industry – Interaction between offshore seismic surveys and whales (Part A: Standard Management and Part B: Adaptive Management).
• EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).</td></tr>
<tr><td>Good Industry Practice:</td><td>APPEA Code of Environmental Practice (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating:
• The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
• Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts.
IAGC: Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
JNCC (2017) Guidelines for marine seismic surveys (increase observation time sin deeper waters for odontocetes).
DoC (2013) Code of Codenuct form Minimising disturbance to marine Mammals from seismic survey operations (Controls for pinniped – startup procedures)</td></tr>
<tr><td colspan="2">Demonstration of Acceptability - Marine Mammals (Pinniped and Cetaceans)</td></tr>
</table>

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Marine Mammal Impact Summary:

Survey area includes BIA for blue and sperm whales (foraging), male Australia sea lion BIA (foraging) and lies adjacent to coastal areas for the southern right whale (calving and calving buffer).

Survey area overlaps the Western Eyre CMP.

Impacts assessed as follows with controls adopted (refer **Section 6.2.3.5** and **Section 6.2.3.8**):

- Pinnipeds (Otariids):
  - PTS/TTS impacts only experienced at the acoustic array (< 20m). With controls adopted no predicted impacts (SLIGHT consequence).
  - Foraging – no impacts to the male and female BIA (spatial buffer), small overlap with male BIA (0.04% impact at any time). Foraging impacts localised, transient and recoverable (SLIGHT Consequence).
  - Colonies – sound levels fall below 160 dB re 1µPa (SPL). No avoidance behaviour predicted (SLIGHT Consequence)
  - Acoustic/Sensory Masking: Localised, temporary and recoverable (SLIGHT Consequence)
- Whales:
  - PTS/TTS impacts with controls adopted are not expected to be significant to the species (SLIGHT Consequence);
  - Behavioural (coastal migration/calving): Sound impacts at adjacent shoreline fall below thresholds for behavioural disturbance (i.e. avoidance) – no impacts expected to coastal migrations or calving activities (SLIGHT Consequence);
  - Behavioural (Sperm BIA foraging): Spatial and temporal controls will limit coincident survey and foraging activities. Spatial buffer of 13 km between operating array and foraging pods to prevent displacement and disturbance (SLIGHT Consequence);
  - Behavioural (oceanic migration): Sound impact lead to minor deviations incidental to migration route to very small percentage of SRW population (SLIGHT Consequence);
  - Behavioural (Masking – LF cetacean): Minor and temporary disruption of a small proportion of the population (MINOR consequence);
  - Behavioural (Masking – MF/HF cetacean): Possible incidental effects (SLIGHT consequence);

Indirect Impacts: No Indirect impacts identified.

</td></tr>
<tr><td>Policy compliance</td><td>The management strategy for acoustic sound disturbance reflects PGS’s Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.</td></tr>
<tr><td>PGS HSE Management System</td><td>Section 7 demonstrates PGS’s HSEQ Management System is capable of meeting environmental management requirements for this survey.</td></tr>
<tr><td>External Context: Commonwealth & State Legislation</td><td>This assessment meets the requirements of the Commonwealth Environment Protection & Biodiversity Conservation Act 1999 (and associated legislation and guidelines).</td></tr>
</table>

External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	*The Duntroon OA overlaps a portion of the Western Eyre CMP*. An assessment of marine mammal impacts associated with the survey activity identifies the potential for injury impacts only within close proximity to the operating acoustic array. With controls adopted and impacts are expected to be incidental to the behaviour of the species. Based on this assessment, conservation values within the CMP (foraging species), ecosystem functioning and KEF functioning within the CMP are not significantly affected. One this basis, the activity does not conflict the South-west Marine Parks Network Management Plan 2018 prescriptions or IUCN Objectives. Refer to Table 6-58 (CMP Conservation Values assessment. *Conservation Management Plan for the Blue Whale (DoE, 2015).* Duntroon OA located in high abundance foraging BIA for the pygmy blue whale. Anthropogenic threats must be demonstrably minimised. Temporal controls adopted to prevent this threat. Action: Improved management and understanding of what impacts anthropogenic noise may have on blue whales by: 1. Investigating the baseline acoustic behaviour of blue whales; 2. Assessing the effect of anthropogenic noise on blue whale behaviour; 3. Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area; 4. EPBC Act Policy Statement 2.1—Interaction between offshore seismic exploration and whales is applied to all seismic surveys. *Conservation Management Plan for the Southern Right Whale (SEWPC, 2012).* Duntroon OA located adjacent to coastal calving and calving buffer BIA. Duntroon activity will overlap timeframe when whale is present in coastal waters (September-November). Improve the understanding of what impact anthropogenic noise may have on southern right whale populations by: a) assessing anthropogenic noise in key calving areas b) assessing responses of southern right whales to anthropogenic noise c) if necessary, developing further mitigation measures for noise impacts. *Recovery Plan for the Australian Sea Lion (SEWPC, 2013):* Duntroon OA located in a BIA for male Sea Lion foraging and adjacent to the male and female foraging BIA. No sound related actions present in recovery plan. *Conservation Advice (Sei Whale) (TSSC, 2015) & Fin Whale (TSSC, 2015*): No BIAs has been defined for these cetaceans (however they are known for foraging with pygmy blue whales). Actions include assessing and addressing anthropogenic noise • Once the spatial and temporal distribution (including BIA) of sei/fin whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys) should be undertaken on this species. • If required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei/fin whales. *Conservation Advice (Humpback whale) (TSSC, 2015) & Fin Whale (TSSC, 2015*): Duntroon OA is not in a BIA for the humpback whale. Actions include assessing and addressing anthropogenic noise include: • All seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. Should a survey be undertaken in or near a calving, resting, foraging area, or a confined migratory pathway then Part B. Additional Management Procedures must also be applied (not relevant for humpbacks at Duntroon). • For actions involving acoustic impacts (example pile driving, explosives) on humpback whale calving, resting, feeding areas, or confined migratory pathways site specific acoustic modelling should be undertaken (including cumulative noise impacts) (not relevant for humpbacks at Duntroon). • Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified a noise management plan should be developed. This can include: the use of shutdown and caution zones; pre and post activity observations; the use of marine mammal observers and / or Passive Acoustic Monitoring (PAM); and Implementation of an adaptive management program following verification of the noise levels produced from the action (i.e. if the noise levels created exceed original expectations).

External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices (Con't)	*Southwest Bioregional Plan has the following requirements for marine mammals:* *Whales:* People planning to undertake actions in BIAs for **sperm, southern right and blue whales,** if in undertaking seismic surveys, the potential for their action has a high risk of significant impact on the species is if there is a real chance or possibility of increasing noise above ambient levels within BIAs when the species is present. When the actions are undertaken in accordance with Part A and, where relevant, Part B of EPBC Act Policy Statement 2.1: Industry—interaction between offshore seismic surveys and whales, the risk of a significant impact to the species is low. *Pinnipeds:* People planning to undertake actions in proximity of breeding colonies and haul-out sites and within the foraging range of female sea lions should consider the potential of the action to have a significant impact on the species. Actions with a real chance or possibility of increasing the ambient noise levels within female Australian sea lion foraging areas to a level that might result in site avoidance or other physiological or behavioural responses.

External Context: Stakeholder Engagement	External consultation has raised the following issues and concerns associated with acoustic impacts to marine mammals:
	• Natural Resources Kangaroo Island (**Stakeholder No: 43 Records**) expressed concern with survey activity undertaken in May due to the likely presence of southern right whales. Feedback was provided to Natural Resources Kangaroo Island on measures adopted to minimize impacts on the southern right whale. Further update on the revised survey timeframe (September to November) and the sensitivities considered in its design together with potential impacts on the SRW has been provided to Natural Resources Kangaroo Island. *No further feedback provided to date*.
	• Kangaroo Island Council (**Stakeholder No: 22 Records**) raised concerns relating to seismic impacts on marine mammals and was also aware of the recent FRDC report on lobsters and scallops. PGS advised that controls such as MFOs, PAM and other control mitigations would be contained within the EP. A copy of the EP was sent to Kangaroo Island Council as it is submitted to NOPSEMA. Further update on the structure of the surveys and the sensitivities considered in its design has been provided to Kangaroo Island Council throughout the survey design. *No further feedback provided to date*.
	• WML **(Consultation Record 35)** expressed concerns regarding impact to foraging sea lions within proximity to the Duntroon OA, particularly lactating females. WML also expressed concern with the inadequacy of the modelling performed for the Duntroon survey as it was not on a frequency weighted basis and did not consider the most recent NMFS (2016) threshold criteria. PGS has had additional acoustic modelling undertaken. This information has been incorporated into the EP impact assessment and both the assessment and modelling report provided to WML for their review. WML has advised they are satisfied with the assessment and controls adopted (i.e. spatial buffers adapted to male and female foraging BIA). PGS has also advised then of source shutdown protocols adopted for pinnipeds in water depths < 200m.
	• Kangaroo Island Eco-action **(Stakeholder Record 33)** is against exploration in the GAB as they do not consider it an appropriate environment. KI Ecoaction wants strict adherence to the shutdown standards. PGS has provided feedback on the adoption of EPBC Policy Statement 2.1 requirements which are being incorporated into survey design
	• DEW (**Stakeholder No: 14 Records**) encouraged PGS to complete survey by May due to southern right whale presence and to adopt EPBC Policy Statement 2.1 requirements. Response and update has been provided demonstrating that expected sound impacts at the coast is not expected to cause behavioral responses; and impacts to migrating whales are not expected to be significant (minor increase in distance, no barriers caused by the survey to the coast). DEW provided feedback that they were satisfied with the response. *Issue resolved*.
	• Kangaroo Island Dolphin Watch **(Stakeholder Record 32)** wanted assurance over the standards to be adopted on the survey (PAM, controls to mitigate sound). PGS to provide transparency will utilize a trained local representative as MFO on the vessel. Further update has been provided to KI Dolphin Watch on the plans for the survey between September – November. *No concerns have been raised to date.*
	• The Wilderness Society **[Stakeholder Record 42]**, a recipient of all revisions of the Duntroon EP has expressed the following concerns:
	  ○ While preferred timeframes for the surveys 'nominally' avoid the main periods of significant whale activity, whales are known to be present in the Great Australian Bight (**GAB**) survey area outside these periods. *This is acknowledged within the current version of the EP. TWS will be advised of the revised survey timeframe.*
	  ○ In the original timeframe (March to May) the Duntroon Survey coincided with blue whale foraging but TWS advises to reduce the survey impact to ALARP timeframes should not extend into May 2018. The survey timeframe and controls adopted ensure that the temporal overlap with blue whale foraging does not occur however does occur when SRW are present on the coastline and migrating from the coast. *The impact assessment and modelling undertaken into southern right whale impacts has been provided to show impacts are not significant and align with conservation plan requirements*.
	  ○ Mitigation measures within the EP are not adequate to protect listed species to ALARP. *All controls have been reassessed within the current version of the EP.*

External Context: Stakeholder Engagement (con't)	• The Wilderness Society **[Stakeholder Record 42]**, a recipient of all revisions of the Duntroon EP has expressed concerns about the: o Two MFOs on board the survey vessel is not adequate to observe fauna and implement shutdown procedures. *This has been reassessed within Revision 2 of the EP and MFOs will be present on all vessels*. o Concern that no shutdown provisions for pinnipeds had been adopted within the survey. *This has been reassessed within this EP and shutdowns will be applied. This information has been provided to TWS..* o Concern that no monitoring of the sea lion habitat is proposed. *PGS does not propose, based on acoustic modelling undertaken, to monitor sea lion activity or sound intensities within the Australia sea lion habitat. Modelling identified that even on the closest acquisition line to the BIA, TTS thresholds were not reached with a substantial buffer between modelled value and threshold. PGS will undertake SSV using MCS methodology to verify the sound source which is expected to be quite accurate as thresholds of relevance (160 dB re 1µPa SPL) for behavioural impacts in the BIA are close to the acoustic source. In addition, the adopted threshold for disturbance is considered very conservative given the observed behaviours of pinnipeds during seismic surveys (Harris et al, 2001).* o Concern that PGS does not intend to undertake any additional baseline surveys to establish the presence of blue pygmy whales in the operational area during January to May nor to record this data during the period of the survey, notwithstanding the fact that '*surveys have shown that relative abundance in this area is highly variable both between and within season* '(EP p.71, DoE 2015). PGS has adopted temporal and spatial controls to prevent overlap with blue whales in the eastern GAB. Blue whale presence has been established based upon available publically available observation data. *PGS does not consider that additional baseline will serve to define the temporal movements of the pygmy blue whale which will respond in most part to the irregular upwellings which occurs along the SA coastline. PGS has designed the survey to account for blue whale presence which is prudent and adopted controls to prevent spatial overlap with foraging activities if there is uncertainty or significant variation in their movement patterns. Cetacean monitoring during the survey will be operationally focussed to minimise impacts to transiting cetaceans only.* o TWS SA previously raised concerns in regard to the reliance by PGS on the Bight Petroleum Lightning 3D MSS EP (21/3/14). *PGS has substantially re-written the Duntroon EP to align with more recent NOPSEMA standards on EP requirements. The acoustic section has been peer-reviewed by JASCO Applied Sciences. Copy provided to TWS.* o Requirements of The *South West Marine Bioregional Plans* direct that "*actions with a real chance or possibility of increasing the ambient noise levels within female [Australian sea lion] foraging areas to a level that might result in site avoidance or other physiological or behavioural responses*" have a high risk of a significant impact on this species. Accordingly, the survey should be restricted to avoid the male and female foraging BIA, particularly waters surrounding breeding colonies and foraging areas of the Australian sea lion. *PGS has included in the design of the survey a spatial buffer to prevent disturbance to foraging within the male and female foraging BIA to prevent displacement of female sea lions. The survey is located too far from breeding colonies to have behavioural impacts at those locations.* o Concern a holistic ecosystem approach was not taken to assess survey impacts on the environmental sensitivities of the GAB, nor the long-term or cumulative impacts of the ongoing and numerous surveys in proximity to the operational area had been undertaken. *This has been updated in the most current version of the EP*. The updated Duntroon EP will be sent to this stakeholder on submission to NOPSEMA.

External Context: Environmental (KEF)	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* The Duntroon OA contains BIAs (foraging) for the pygmy blue and sperm whales and the male Australian sea Lion. Other threatened whale species (fin, sei and humpback whale) and whale migratory species have habitat within the survey area. Assessment of survey activities for PTS/TTS, behavioural/masking impacts have identified with controls implemented that impacts to threatened species is not significant and are temporary, localised and recoverable. Controls adopted ensure the pygmy blue whale is not displaced from foraging activities and residual sound in coastal habitats will not affect the behaviours of southern right whales within their BIA. Controls adopted for the sperm whale (including PAM) protects against sperm whale foraging displacement if the species is present in the area and a spatial buffer between the array and the male and female Australian sea lion foraging BIA protects foraging male and female sea lions. For sea lions within the male BIA - given the localised and transient nature of the area affected; the low numbers of sea lions present in these water depths and the small observed reaction of phocid pinnipeds (more sensitive to sound than otariids) to seismic activities (Harris et al, 2001); and foraging responses to prey (cephalopod, pelagic fish) availability, behavioural impacts to foraging male sea lions would be incidental (*i.e. no observed foraging-related behaviour displacement*). On the basis of these controls, long-term decreases in the population, a reduction in occupancy, fragmentation of populations or adverse effects on habitat critical to the survival of the species is not expected (i.e. no triggers for significance at a population level under the EPBC Policy Statement 1.1 (MNES)). Impacts to threatened and migratory species are therefore acceptable based upon significance criteria. *The Duntroon OA as part of the marine environment which contains KEFs and marine species populations.* As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to ecosystem functioning in Table 6-57. Marine mammals as apex predators are not expected to have a significant impact upon the functioning of the KEFs present in the Duntroon OA. The survey activity will also not have an adverse impact to a marine population. On this basis, significance criteria for the Commonwealth marine environment are not triggered and are therefore acceptable. *Impacts to environmental context are therefore acceptable*.
ALARP Demonstration	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damage to marine mammals are identified with the implementation of controls within this EP. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity have been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has been used to understand the most suitable and effective controls to achieve environmental outcomes.

Acceptability Criteria	Impacts, with controls adopted to marine mammals are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMP are not impacted (i.e. behavioural disturbance requirements to foraging and coastal migrations, aggregations or calving activities are met) (*legislation*); • No injury impacts to threatened and migratory species (*external environment*); • EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines are adopted (*legislation and stakeholder*); • Anthropogenic noise in blue whale BIAs are managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area (l*egislation and stakeholder*); • Ambient noise levels within female Australian sea lion foraging areas are maintained to a level which does not result in site avoidance or other physiological or behavioural responses (*legislation and stakeholder*); • Anthropogenic noise in southern right whale key calving areas does not cause disturbance (*legislation & stakeholder*); • Impacts do not significantly modify, destroy, fragment, isolate or disturb an important habitat (e.g. KEF) or substantial area of habitat such that an adverse impact on Commonwealth marine ecosystem functioning or integrity; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution (*external environment & stakeholder*). *Based upon the evaluation made within this table (& supporting assessments) the impacts to sharks from seismic sound are considered acceptable.*
DEMONSTRATION OF ALARP – Avifauna	
Hazard Consequence Criteria	A SLIGHT consequence is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
Hierarchy of Controls	<u>Eliminate:</u> • Temporal exclusion to shelf (KEF) areas during period of potential upwelling during September to November. <u>Substitute:</u> • *None Identified* <u>Engineer:</u> • *None identified*. <u>Isolate:</u> • If environmental conditions leading to upwelling are triggered, PGS will undertake surveillance activity and if upwelling conditions are detected via blue whale migration into the area, survey activitos will be halted. <u>Administrative:</u> • Soft-start procedures in accordance with EPBC Policy Guideline 2.1 will be adopted to displace avifauna prey close to the operating array • Onshelf (higher productivity areas) acquisition will be undertaken during early in the survey period during down-welling periods to prevent spatial overlap with timeframes which have a greater likelihood of upwelling.
Compliance with International Conventions, Legislative Codes and Standards	International Conventions: • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) Legislation: • Environment Protection and Biodiversity Conservation Act 1999 • EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8) Legislated Standards: • EPBC Policy Statement 2.1: Industry – Interaction between offshore seismic surveys and whales (Part A: Standard Management and Part B: Adaptive Management). • EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).

Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
Demonstration of Acceptability - Avifauna	
Avifauna Impact Summary: Survey area includes foraging BIAs for seabirds. Survey area overlaps the Western Eyre CMP. Impacts assessed as follows (refer **Section 6.2.3.7**): • For non-upwelling conditions: Injury, displacement or foraging effects to avifauna present in the survey area may affect individual birds, however impacts from vessel/equipment operation and underwater sound at a population level are considered incidental (SLIGHT consequence). *Indirect Impacts:* Fishery-related displacement from sound may also result in foraging bird displacement.	
Policy compliance	The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Commonwealth & State Legislation	This assessment meets the requirements of the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (and associated legislation and guidelines).

<table>
<tr><td>External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices</td><td>
The Duntroon OA overlaps a portion of the Western Eyre CMP.
For non-upwelling conditions, an assessment of acoustic impacts to birds in the survey activity identifies exposure is limited to individual birds foraging beneath the water surface in proximity to the operating array. Individual birds may be affected but vessel movement will create only localised and temporary impacts at any one location. Penguin species present during the survey timeframe will be locate close to colonies due to brreding activities and have a very low likelihood of presence in the survey area. Bird species are wide-ranging and fish displacement may also serve to temporarily displace bird species from the immediate vicinity of the operating array.
For upwelling conditions, bird aggregations are possible with higher impact levels possible. These impacts will be prevented through temporal selection of the survey period (September to November) with monitoring identifying the presence of upwellings. Design of the MC3D survey so areas subject to high productivity are completed in the down-welling months has also been adopted. On the basis of this assessment, conservation values within the CMP (foraging species), ecosystem functioning and KEF functioning within the CMP are not significantly affected by survey operations. On this basis, the activity does not conflict with the South-west Marine Parks Network Management Plan (2018)/IUCN Objectives. Refer to Table 6-58 (CMR Conservation values assessment).
Recovery plan for Albatross and Giant Petrels (2011-2016):
No actions relating to sound impacts listed.
Conservation Advices:

Conservation Advice – Curlew Sandpiper (TSSC, 2015). No actions relating to sound.
Conservation Advice – Great Knot (TSSC, 2016a). No actions relating to sound.
Conservation Advice – Eastern Curlew (TSSC, 2016b). No actions relating to sound.
Conservation Advice – Red Knot (TSSC, 2016c). No actions relating to sound
Conservation Advice – Lesser sand Plover (TSSC, 2016d). No actions relating to sound

South-west Marine Bioregional Plan:
Key considerations in relation to significant impacts into seabird species – no actions/constraints relating to sound impacts.
Impacts are therefore acceptable against marine reserve, marine bioregional plans, recovery plans and species conservation advice requirements
</td></tr>
<tr><td>External Context: Stakeholder Engagement</td><td>
External consultation did not raise any issues relating to avifauna.
This is taken as acceptance that stakeholder concerns have been met.
</td></tr>
</table>

External Context: Environmental	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* The OA contains BIAs for threatened and migratory seabirds. Assessment of survey activities for injury and behavioural impacts has identified temporary, localised and recoverable impacts to these species during non-upwelling periods. Controls adopted for upwelling conditions will prevent impacts to higher bird population levels. With these controls implemented, individual birds may be affected however no significant impacts to populations are predicted (i.e. no triggers for significance at a population level under the EPBC Policy Statement 1.1 (MNES)). *Indirect Impacts*: None identified. Impacts to threatened and migratory species are therefore acceptable based upon significance criteria. *The Duntroon OA as part of the marine environment which contains KEFs and marine species populations.* As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to ecosystem functioning in Table 6-57. These KEFs are widely represented in the SGS and Southern Province bioregions. Bird interaction with demersal KEFs is not possible. Interaction with pelagic KEFs such as the small pelagic fishery is possible; however, birds are not expected to significantly alter the ecosystem functioning of these areas. No adverse impacts are expected. On this basis, significance criteria for the Commonwealth marine environment are not triggered and are therefore acceptable. *Impacts to environmental context are therefore acceptable*.
ALARP Demonstration	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damage to avifauna have been identified. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity have been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has not been undertaken on this impact as limited options to control impacts exist.
Acceptability Criteria	Impacts, with controls adopted, to seabirds are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMR are not impacted (i.e. seabird foraging in up-welling related BIAs) (*legislation*); • Threatened and migratory species are not significantly impacted (*external environment*); • Impacts do not significantly modify, destroy, fragment, isolate or disturb an important habitat (e.g. KEF) or substantial area of habitat such that an adverse impact on Commonwealth marine ecosystem functioning or integrity; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution (*external environment*). *Based upon the evaluation made within this table (& supporting assessments) the impacts to sharks from seismic sound are considered acceptable.*
DEMONSTRATION OF ALARP – Water-based Recreation/Diving/Tourism	
Hazard Consequence Criteria	A SLIGHT consequence is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.

Hierarchy of Controls	Eliminate: • Temporal exclusion to shelf (KEF) areas during period of potential upwelling. Substitute: • *None Identified* Engineer: • *None identified*. Isolate: • Spatial buffer of at least 36 km to the nearest abalone diving area from Duntroon OA boundary. Administrative: • *None Identified*
Compliance with International Conventions, Legislative Codes and Standards	Compliance with: • Offshore Petroleum & Greenhouse Gas Storage Act 2006 • Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (R13 – Environmental Risk Assessment)
Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to planning and design and assessment of environmental risk. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning).
Demonstration of Acceptability - **Water-based Recreation/Diving/Tourism**	
Impact Summary: Sound levels at adjacent coastlines where diving and recreational water sports are taking place are not expected to exceed protective thresholds.	
Policy compliance	The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Commonwealth & State Legislation	There is no specific legal and other industry best practice guidance to manage impacts to abalone divers and recreational water users. However, the UK Diving Medical Advisory Committee (DMAC) guidance note "Safe Diving Distances from Seismic Surveying Operations" can be used as a guide to acceptable practice.
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	This assessment considers social value impacts against the following criteria: • Thorny Passage Marine Park Environmental, Economic and Social Values (refer Table 6-59); and • Neptune Island Group Park Environmental, Economic and Social Values (refer Table 6-59). Review of these values against residual sound criteria has determined that values will still be attained during survey activity (refer Table 6-59) *External context (Marine Park Conservation Value) requirements have been assessed no values are compromised by survey activities. Impacts are therefore acceptable against these requirements.*
External Context: Stakeholder Engagement	External consultation did not raise any issues relating to diving Impacts. *This is taken as acceptance that stakeholder concerns have been met.*
External Context: Environmental	As described in **Section 6.2.3.9** (Water-sports/tourism/diving) the closest diving area (abalone harvesting) is located approximately 60 km from the nearest *acquisition point* at Four Hummocks Island. For locations on the continental shelf (Line2, Site 1) SPL thresholds fall below 140 dB re 1µPa approximately 41 km from the source locations and on this basis, environmental conditions are expected to be suitable for commercial fishing/recreational diving activities. *Impacts to the external (environmental) context are therefore acceptable*.
ALARP Demonstration	The residual impact meets ALARP criteria.

ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damage to divers or recreational water activities are expected from the Duntroon survey activities. Impacts will be temporary and while survey activities are located on the shelf environment. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity and ecological integrity are not relevant to diving and recreational water use. (e) Cost benefit analysis has not been used in this assessment.
DEMONSTRATION OF ALARP – Vessel and Helicopter Sound	
Hazard Consequence Criteria	A SLIGHT consequence is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
Hierarchy of Controls	Eliminate: • Temporal exclusion to shelf (KEF) areas during period of potential upwelling. Substitute: • *None Identified* Engineer: • Propulsion and engines will be maintained to engineering specifications. Isolate: • Adoption of EPBC Regulation (Part 8) requirements for spatial separation. Caution zone will be increased for support vessels to 1000m in the event of foraging cetaceans. • Adoption of spatial buffers for helicopters as per EPBC Regulation 2000 (Part 8) requirements will limit impacts to foraging marine mammals. Administrative: • Adoption of EPBC Regulation (Part 8) requirements provides for vessel management around marine fauna.
Compliance with International Conventions, Legislative Codes and Standards	International Conventions: • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) Legislation: • Environment Protection and Biodiversity Conservation Act 1999 • EPBC Regulations 2000 (Part 8) Legislated Standards: • EPBC Significant Impact Guidelines 1.1 for Matters of National Environmental Significance (i.e. Commonwealth marine environment, threatened and migratory species).
Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
Demonstration of Acceptability - Vessel and Helicopter Sound	

Impacts Summary:

The Duntroon OA overlaps a CMP and is a BIA for the Australian sea lion, blue and pygmy whales in addition to seabird species.

Impacts assessed as follows (refer **Section 6.2.3.14**):

- Behavioural effects to marine fauna present in the survey area may affect individual species, however impacts from vessel/equipment operation and underwater sound at a population level are considered incidental (SLIGHT consequence).

Indirect Impacts: No indirect impacts identified.

Policy compliance	The management strategy for acoustic sound disturbance reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Commonwealth & State Legislation	This assessment meets the requirements of the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (and associated legislation and guidelines). Control measures adopted to reduce impacts from vessels and helicopter noise are compliant with relevant legislation and conventions including the requirements of the EPBC Regulations 2000.
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	The Duntroon OA overlaps the Western Eyre CMP. Control measures adopted to reduce impacts from vessels and helicopter noise protect the conservation values within the CMR and are consistent and do not conflict with the management objectives within the CMR. The controls adopted also are consistent with the following: • Western Eyre Marine Reserve South-west Marine Parks Network Management Plan 2018 Conservation Values. With controls adopted impact are minor, temporary & recoverable to a small proportion of the population and does not conflict with the IUCN principles for the CMP (refer Table 6-58). • Conservation management plan for blue whales (DoE, 2015). Requirements are detailed in Table 3-9 and anthropogenic impacts have been assessed to prevent impacts. These have been adopted within this EP. • Conservation management plan for southern right whale (SEWPC, 2012). Requirements are detailed in Table 3-10 and actions to prevent anthropogenic impacts from vessel sound have been adopted within this EP. • Conservation advice for The Humpback Whale (TSSC, 2015c) – requirements are detailed in Table 3-8. Required actions to prevent anthropogenic impacts from vessel sound have been adopted within this EP. • Conservation advice for the sei whale (TSSC, 2015e) – requirements are detailed in Table 3-12. Required actions to prevent anthropogenic impacts from vessel sound have been adopted within this EP. • Conservation advice for the fin whale (TSSC, 2015d) – requirements are detailed in **Table 3-11.** Required actions to prevent anthropogenic impacts from vessel sound have been adopted within this EP. • Recovery plan for the Australian sea lion (SEWPC, 2013) - requirements are detailed in Table 3-14. No actions relating to sound impacts listed. • Recovery Plan for the White Shark (SEWPC, 2013) – No actions relating to vessel noise. *External context (Marine Reserve, management plans, conservation advice) requirements have been assessed and adopted as required. Impact is therefore acceptable against these requirements.*
External Context: Stakeholder Engagement	External consultation did not raise any issues relating to vessel or helicopter sound impacts. *This is taken as acceptance that stakeholder concerns have been met and the environmental impacts and risk are acceptable.*

External Context: Environmental	*The Duntroon OA overlaps marine areas which contains threatened and migratory species.* The OA contains BIAs for threatened and migratory seabirds. Assessment of helicopter and vessel activities for behavioural impacts has identified temporary, localised and recoverable impacts to these species. Individual animals may be affected however no significant impacts to populations are predicted (i.e. no triggers for significance at a population level under the EPBC Policy Statement 1.1 (MNES)). *Indirect Impacts*: None identified. Impacts to threatened and migratory species are therefore acceptable based upon significance criteria. *The Duntroon OA as part of the marine environment which contains KEFs and marine species populations.* As part of the **Commonwealth marine environment (**EPBC Policy Statement 1.1 – as relevant to the marine environment and KEF functioning) impacts must not *significantly modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results; or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution*. KEF systems present in the Duntroon OA have been assessed for potential impacts from sound to ecosystem functioning in Table 6-57 from seismic operations and found not to be significantly affected. Given the lower level sound impacts associated with vessel and helicopters there is no threat to KEF functioning. No adverse or significant impacts are expected. On this basis, significance criteria for the Commonwealth marine environment are not triggered and are therefore acceptable. *Impacts to environmental context are therefore acceptable*
ALARP Demonstration	The residual impact meets ALARP criteria.
ESD principles	(a) Decision making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. *This EP has considered all these factors when designing the Duntroon survey program to meet stakeholder requirements, prevent environmental impacts and effectively acquire the seismic date required*. (b) No threats of serious or irreversible environmental damage to marine fauna are identified with the implementation of controls within this EP. (c) The principle of inter-generational equity is not compromised as potential disturbance impacts are localised, temporary and recoverable. (d) Conservation and biological diversity have been considered in decision making to ensure that impacts to marine species/marine environment are considered acceptable. (e) Cost benefit analysis has been used to understand the most suitable and effective controls to achieve environmental outcomes.
Acceptability Criteria	Impacts, with controls adopted, to marine fauna are acceptable based upon the following criteria: • Conservation values and management objectives of the Western Eyre CMP are not impacted (*legislation*); • Threatened and migratory species are not significantly impacted (*external environment*); • Requirements of the EPBC Regulations 2000 (Part 8) are adopted (*legislation*); • Impacts do not significantly modify, destroy, fragment, isolate or disturb an important habitat (e.g. KEF); or have a substantial adverse impact on a population of marine species or cetacean including its lifecycle and spatial distribution (*external environment*). *Based upon the evaluation made within this table (& supporting assessments) the impacts to sharks from seismic sound are considered acceptable.*
Environmental Monitoring	

Survey MFO megafauna observations
Survey PAM Detections
Pre-survey (& operational/upwelling) Aerial Survey Observations
Survey – SSV Assessment
Record Keeping
MFO, PAM and aerial observer CVs PAM Calibration Records Key vessel crew induction records POB Records (survey and support) MFO/PAM datasheet records MFO End of survey report SSV Report SIMOPs Procedures/Consultation Records Aerial Surveillance Reports Geophysical Acquisition Report Sound Source Modelling Report PMS Records – Vessel (Propulsion and Engines) PAM specifications (& calibration/assessment verification Record) SIMOPS Communications records SIMOPS Procedure Policy 2.1 Procedures for marine fauna protection (acoustic operations)

6.3 Impact: Treated bilge water discharges (vessels)

6.3.1 Hazard

Routine oily water discharges from the vessel's bilge water treatment system to marine waters is expected during survey activities. Bilge water consists of deck drainage that has been captured in a closed loop system (i.e., bunded oil-collection systems) and contains water, oil, and other chemicals/contaminants.

Any treated bilge water discharged will have an oil-in-water (OIW) content of less than 15 ppm in accordance with the Commonwealth *Navigation Act 2012*, *Protection of the Seas (Prevention of Pollution from Ships) Act 1983* and Marine Order Part 91 (Marine Pollution Prevention - Oil).

6.3.2 Known and potential impacts

The known and potential environmental impacts of treated bilge water discharges are:

- Temporary and localised reduction in water quality (organics and toxics) around the discharge location;
- Visual amenity impacts of visible oil sheens; and
- Possible ingestion by marine species.

6.3.3 Evaluation of environmental impacts

Routine oily water discharges from the vessel's bilge water treatment system to marine waters is expected during survey activities. Bilge water consists of deck drainage that has been captured in a closed loop system (i.e., bunded oil-collection systems).

If treated bilge water is discharged, the treatment controls in place ensures that only trace quantities of oil are contained in the discharge. This is predicted to rapidly dilute and disperse, especially with the vessels in constant motion. Given the small volumes released, the high rates of dilution and dispersion in the open ocean environment, the constant movement and temporary presence of the vessels in any one location, acute or chronic toxicity impacts to marine fauna is not expected. Any impacts to plankton species would be extremely localised around the vessel discharge (i.e., a SLIGHT consequence).

Commonwealth Recovery Plans:

A review of the management actions and objectives listed in threatened species conservation/recovery plans that may be present in the survey area and applicable to the threats posed by the survey activity have been assessed in Section 3.7. No management actions, as contained in the recovery/management plans, are considered relevant to treated bilge water discharge impacts except the Recovery Plan for Marine Turtles 2017-1027 (DoEE, 2017) which ensure that response strategies and programs adequately include management for marine turtles and their habitat (particularly slow to recover habitats – not present in the Duntroon OA). Containment of spills from bilge system spills are addressed in the vessel's SOPEP. PGS has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement.

Marine Reserves (Conservation Values and Management Principles):

PGS has undertaken an assessment of localised treated bilge water discharge impacts against the South-west Marine Parkes Network Management Plan (DNP, 2018), Western Eyre CMP conservation values and IUCN management principles (Special Use/Multiple Use Zone (IUCN VI)) (refer Table 6-62). Treated bilge water discharge is permissible in accordance with the Management Plan in these zones if discharged in accordance with MARPOL requirements. During the Duntroon survey treated bilge water discharges will not be released within the CMP. This action protects conservation values and is consistent with the management principles for sustainable long-term use of the area. ALARP and acceptability is demonstrated in Table 6-62.

6.3.4 Impact assessment

Table 6-62 provides the impact assessment for vessel treated oil/water discharges.

Table 6-62: Treated oil/water discharge EIA

Aspect	Discharge of treated bilge to marine environment.		
Impact Summary	Discharge of intermittent trace volumes of hydrocarbons to the marine environment.		
Extent of Impact	LOW - Localised and intermittent around vessel discharge (expected to rapidly dilute and dissipate in open ocean environment while vessels are moving).		
Duration of Impact	Temporary (duration of survey) and recoverable		
Level of Certainty of Impact	HIGH. Impacts from treated bilge discharges to the marine environment (i.e. <15ppm oil-in water), in accordance with MARPOL requirements prevents excessive oil loadings within the marine environment while vessels are *en route*.		
Species affected within survey environment	Marine species (fish, plankton) are widely distributed and only a small portion of the population is potentially affected.		
Impact Decision Framework Context	A *(nothing new or unusual, represents business as usual, well understood activity, good practice is well defined).* Impact assessment decision making based upon LCS, GIP and PJ.		
Impact with controls failure (Inherent)			
MINOR			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Comply with the Protection of the Seas (Prevention of Pollution by Ships) Act 1983 and Marine Order 91 (Marine Pollution Prevention –Oil).	Administrative	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry
Contain and treat bilge water to an oil-in-water content < 15 ppm prior to marine discharge.	Engineer	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry

Systems for treating bilge water are maintained and measurement equipment calibrated to ensure discharge concentrations are met	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
Treated bilge water discharged outside of Western Eyre CMP	Eliminate	YES	Best practice to eliminate impacts to CMR.
Alternate Control: Survey and support vessel discharge treated bilge or all contaminated bilge to onshore facilities for treatment and disposal	Eliminate	NO	Substantial additional cost due to onshore treatment and disposal, acquisition downtime, increase in survey duration, increased fuel consumption given the additional transits required by support vessel. Risk of spills and leaks during transfer operations and additional safety risks to personnel during vessel transfer activities. No net benefit observed if treated bilge can be discharged.
Impact consequence with controls (residual)			
SLIGHT			

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	EPS	MEASUREMENT CRITERIA
EPO14: Treated bilge water discharge meets MARPOL Annex I requirements. **MC:** Records verify discharge of treated bilge water meets MARPOL Annex I requirements.	**EPS35:** Bilge water discharges must comply with the requirements MARPOL Annex I requirements reflected in: • *Protection of the Seas (Prevention of Pollution from Ships) Act 1983* (Section 9) • Navigation Act 2012 (Chapter 4, Parts 3 & 4) • Marine Order 91 (Marine Pollution Prevention – Oil)	Records confirm that the vessel has a MARPOL approved/compliant oily-water separator via an IOPP certification or equivalent documentation appropriate to vessel class. <u>Responsibility</u>: Vessel Master
	EPS36: Treated bilge water discharges occur outside the Western Eyre CMR if: • Treatment is via a MARPOL compliant oily water separator; • The vessel is proceeding en-route; • The oil content is less than 15 ppm; and • Oil discharge monitoring and control equipment are operating. If the above is not met the oil residue must be retained in on-board storage tanks for onshore disposal or further treatment.	Oil record book verifies bilge discharges were compliant with these requirements and is monitored through regular inspection review of the oil record book. <u>Responsibility</u>: Chief Engineer
	EPS37: Treatment and detection equipment is maintained to manufacturer's specifications and oil detection equipment calibrated to ensure reliable discharge concentrations are achieved.	PMS records verify that the Oil Treatment System is being maintained and oil detection meter calibrated. <u>Responsibility</u>: Chief Engineer
EPO15: No treated bilge water discharge in West Eyre CMP.	**EPS38:** Treated bilge water will not be discharged within the Western Eyre Commonwealth Marine Reserve.	Oil record book verifies bilge discharge location. <u>Responsibility</u>: Vessel Master
Demonstration of ALARP		

<table>
<tr><td>Hazard Consequence Criteria</td><td>A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.</td></tr>
<tr><td>Hierarchy of Controls</td><td><u>Eliminate</u>:
• For vessels without MARPOL treatment systems, bilge waste is held on-board for onshore treatment and disposal and has tankage to contain waste. This limits endurance times.
• The elimination of oils, fuels and lubricants etc. is not possible due the need to maintain safe operations. However, the volume stored on board is managed to minimum levels to meet acquisition demands.
• Discharge of treated bilge within CMR is eliminated.
<u>Substitute:</u> None identified.
<u>Engineer:</u>
• For vessels with engineered treatment systems – systems treatto an oil-in-water content of 15ppm, with calibrated Oil Detection Monitoring Equipment (ODME) to monitor and verify discharge quality.
<u>Isolate:</u>
• Engineered systems redirect treated bilge water back into vessel tankage if off-specification bilge is detected by the ODME.
<u>Administrative:</u>
• Equipment is routinely maintained.
• Oil Record book documents oil discharges from vessel (verification mechanism).
• Discharge conditions (i.e. proceeding en-route) observed.</td></tr>
<tr><td>Compliance with International Conventions, Legislation Codes and Standards</td><td>Compliance with:
• International Conventions
    ○ International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78) – Annex I
• Legislation (Commonwealth)
    ○ Navigation Act 2012 (Chapter 4 (Prevention of Pollution): Part 3 – Vessels Polluting or Damaging the Australian Marine Environment & Part 4 – Directions Relating to Foreign Vessels)
    ○ Protection of the Seas (Prevention of Pollution by Ships) Act 1983 (Section 9 - Prohibition of Discharge of oil or oily mixture into Sea)
    ○ Marine Order Part 91 (Marine Pollution Prevention - Oil).
    ○ EPBC Regulations 2000 (IUCN principles of Schedule 8)</td></tr>
<tr><td>Good Industry Practice:</td><td>APPEA Code of Environmental Practice (2008) objectives met for offshore seismic surveys with respect to reducing the impacts other marine life to a level which is ALARP and acceptable including:
• The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
• Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the treated bilge will discharge and assess potential impacts.
IAGC: Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management).</td></tr>
<tr><td>Professional Judgement:</td><td>Alternate controls identified with practicable controls implemented. Controls adopted cover multiple levels on the control hierarchy.</td></tr>
<tr><td>Engineering Risk Assessment</td><td>Not Applicable – ‘Risk Decision Framework Context’ is Category A.</td></tr>
<tr><td>Cost Benefit Analysis</td><td>Not Applicable – ‘Risk Decision Framework Context’ is Category A.</td></tr>
<tr><td colspan="2">Demonstration of Acceptability</td></tr>
<tr><td>Policy compliance</td><td>The risk management strategy for treated bilge water impacts reflects PGS’s Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.</td></tr>
<tr><td>PGS HSE Management System</td><td>Section 7 demonstrates PGS’s HSE&Q Management System is capable of meeting environmental management requirements for this survey.</td></tr>
</table>

External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised about the discharge of treated bilge water.
External Context: Environment	Survey is in deep offshore waters which are highly dispersive. Discharge affects marine component (upper water column) only on an intermittent basis for a short duration. Discharge is biodegradable. Species present in upper water column are widespread and no discharge will occur in the CMR.
Legislative criteria & standards	Legislation: • *Navigation Act 2012* • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* • Marine Order Part 91 (Marine Pollution Prevention - Oil). • EPBC Regulations 2000 (IUCN principles of Schedule 8) Industry Practice: • APPEA CoEP • IAGC Environment Manual
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	Western Eyre CMP: Treated bilge water impacts will be contained (locally) when discharged and will not be discharged within the Western Eyre CMP. This exceeds the requirements of the Management plan and does not conflict with, and meets the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*discharge does not compromise diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Species Recovery Plans/Conservation Advice: Review and assessment of threatened species recovery plans and conservation advice identified for marine turtles in Australia, a requirement Recovery Plan for Marine Turtles 2017-1027 (DoEE, 2017) which ensure that response strategies and programs adequately include management for marine turtles and their habitat (particularly slow to recover habitats – not present in the Duntroon OA). Containment of spills from bilge system spills are addressed in the vessel's SOPEP. PGS has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement.
Environmental impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
ODME monitors the Oil-in-Water content of treated bilge water	
Record Keeping	
IOPP PMS Records (Bilge Treatment System) ODME calibration records Oil Record Book.	

6.4 Impact: Sewage/grey water discharges (vessels)

6.4.1 Hazard

Sewage and grey water (comprising laundry, shower and sink water) discharges from vessel to marine waters is expected on an intermittent basis during survey activities.

All vessels engaged on the Duntroon multi-client survey will have sewerage treatment systems compliant to MARPOL 73/78 Annex IV requirements or comply with sewage discharge requirements of the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983.*

6.4.2 *Known and potential impacts*

The known and potential environmental impacts of sewage discharges are:

- Temporary and localised reduction in water quality (organics and bacteria) around the discharge location;
- Increased biological oxygen demand;
- Visual amenity impacts; and
- Possible ingestion/health risk to marine species.

6.4.3 *Evaluation of environmental impacts*

Intermittent release of sewage and greywater will cause localised nutrient enrichment of the water column. Sewage can also contain hazardous pathogens (including faecal coliform bacteria), intestinal parasites, viral agents that, if released untreated to the marine environment, may cause. Grey water can contain a wide variety of pollutant substances at different strengths, including oil and some organic compounds, hydrocarbons, detergents and grease, metals, suspended solids, chemical nutrients, and coliform bacteria.

The effects of sewage and sullage discharges on the water quality at Scott Reef were monitored for a drill rig operating near the edge of the deep-water lagoon area at South Reef. Monitoring at stations 50, 100 and 200 m downstream of the platform and at five different water depths, confirmed that the discharges were rapidly diluted in the upper 10 m water layer and no elevations in water quality monitoring parameters (e.g. total nitrogen, total phosphorous and selected metals) were recorded above background levels at any station (Woodside, 2011). Conditions associated with this example at Scott Reef are considered much less dispersive than vessels which are in constant movement in the Southern Ocean.

The biological oxygen demand of the treated effluent is unlikely to lead to oxygen depletion of the receiving waters (Black *et al.*, 1994), as it will be treated prior to release. Surface currents will also assist with oxygenation of the discharge once it is released.

Given the rapid rate of mixing and the absence of nearby sensitive environments or biological communities, there will be a negligible impact on the marine environment from sewage and grey water discharge.

<u>Commonwealth Recovery Plans:</u>

A review of the management actions and objectives listed in threatened species conservation/recovery plans that may be present in the survey area and applicable to the threats posed by the survey activity have been assessed in Section 3.7. No management actions, as contained in the recovery/management plans, are considered relevant to sewage discharge impacts. PGS has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement.

<u>Marine Reserves (Conservation Values and Management Principles)</u>:

PGS has undertaken and an assessment of localised sewage discharge impacts against the South-west Marine Parks Network Management Plan 2018, Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-63). While the Management plan allows for treated sewage discharge in the CMP in accordnacce with MARPOL requirements, for the Duntroon survey sewage will not be released within the CMP. This action protects conservation values and is consistent with the management principles for sustainable long-term use of the area. ALARP and acceptability is demonstrated in Table 6-63.

6.4.4 *Impact assessment*

Table 6-63 provides the impact assessment for vessel sewage discharges.

Table 6-63: Sewage and grey water discharge EIA

Aspect	Discharge of sewage and grey water to marine environment.
Impact Summary	Discharge of intermittent volumes of nutrients and pathogens to the marine environment
Extent of Impact	LOW - Localised around vessel discharge (< 50 m radius and <10 m water depth, expected to rapidly dilute and dissipate in open ocean environment while vessels are moving).
Duration of Impact	Temporary (duration of survey) and recoverable
Level of certainty of Impact	HIGH. Impacts from sewage discharges to the marine environment in accordance with MARPOL Annex IV requirements, prevents excessive nutrient loadings within the marine environment.
Species affected within survey environment	Marine species (fish, plankton) are widely distributed and only a small proportion of the population are potentially affected.
Impact Decision Framework Context	A (*Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined)*. Impact assessment decision making based upon LCS, GIP and PJ.

Impact with Controls failure (Inherent)			
MINOR			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICIATION
Comply with the Protection of the Seas (Prevention of Pollution by Ships) Act 1983 and Marine Order 96 (Marine Pollution Prevention – Sewage)	Administrative	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry.
Sewage treated as per MARPOL Annex IV requirements prior to marine discharge.	Engineer	YES	Good Practice – well defined and established treatment requirements adopted by offshore petroleum and shipping industry.
Systems for treating sewage are routinely maintained to ensure discharge concentrations are met	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
Vessel waste log maintained to record waste management practices	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
Vessel masters ensure that the POB does not exceed stated maximum carrying capacity for treatment equipment.	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
Treated sewage discharged outside of Western Eyre CMP	Eliminate	YES	Best practice to eliminate impacts to CMR.
Untreated sewage stored and transferred to shore for treatment and disposal.	Eliminate	NO	Substantial additional cost due to onshore treatment and disposal, acquisition downtime, increase in survey duration, increased fuel consumption given the additional transits required by support vessel. Risk of spills and leaks during transfer operations and additional safety and health risks to personnel during vessel transfer activities. **Little net benefit observed if sewage can be discharged.**
Impact Consequence with controls (residual)			

<table>
<tr><th colspan="3">SLIGHT</th></tr>
<tr><th colspan="3">ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS</th></tr>
<tr><th>EPO</th><th>EPS</th><th>MEASUREMENT CRITERIA</th></tr>
<tr><td>EPO16: Sewage discharge from survey vessels during survey activities meets MARPOL Annex IV requirements.</td><td>EPS39: Sewage discharges from vessels must comply with the requirements of:
• MARPOL Annex IV –sewage
• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 – Section 26D
• Navigation Act 2012 (Chapter 4, Parts 3 & 4)
• Marine Order 96 (Marine pollution prevention – Sewage)</td><td>Records confirm the vessel has MARPOL approved/compliant sewage treatment equipment via an ISPP certificate or equivalent documentation appropriate to vessel class.</td></tr>
<tr><td rowspan="3">MC: Vessel records verify sewage discharge complies with MARPOL Annex IV standards.</td><td>EPS40: Sewage discharge occurs outside the Western Eyre CMR if:
• Sewage is treated in an IMO approved/ MARPOL compliant sewage treatment plant and does not cause visible floating solids or discolouration;
• Sewage is comminuted and disinfected when:
o Vessel is >3nm from nearest land; and
o Sewage originating in holding tanks is discharged at a moderate rate (as defined by Marine Order 96) while the vessel is proceeding en-route as a speed not less than 4 knots;
• Sewage not comminuted or disinfected when:
o The vessel is >12nm from the nearest land;
o Sewage originating in holding tanks is discharged at a moderate rate (as defined by Marine Order 96) while the vessel is proceeding en-route as a speed not less than 4 knots.
If the above is not met the sewage must be retained in on-board storage tanks for onshore disposal or further treatment.</td><td>Vessel waste log verifies sewage discharges were compliant with these requirements and is monitored through regular inspection review of the discharge records.

<u>Responsibility</u>: Chief Engineer</td></tr>
<tr><td>EPS41: Equipment is routinely maintained, and system elements calibrated to ensure reliable discharge concentrations are being met.</td><td>PMS records verify that sewage treatment equipment is being maintained to schedule.

<u>Responsibility</u>: Chief Engineer</td></tr>
<tr><td>EPS42: Vessel masters ensure that the POB does not exceed stated maximum carrying capacity for treatment equipment</td><td>Records verify that POB has not exceeded treatment equipment carrying capacity.

<u>Responsibility</u>: Vessel Master</td></tr>
<tr><td>EPO17: No discharge of sewage within the West Eyre CMP.</td><td>EPS43: Sewage will not be discharged within the Western Eyre Commonwealth Marine Reserve.</td><td>Discharge records verify sewage has not been discharge within the Western Eyre Commonwealth Marine Reserve.

<u>Responsibility</u>: Vessel Master</td></tr>
</table>

Demonstration of ALARP	
Hazard Consequence Criteria	A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.

Hierarchy of Controls	Eliminate: • The generation of sewage and grey water by crew cannot be eliminated. However, for Vessels with STPs, effluent is treated to neutralise bacteria prior to discharge. • No discharge within the Western Eyre CMR. Substitute: • No practicable controls identified. Engineer: • For vessels with treatment systems – treatment systems treat sewage to lower the BOD or increase surface area (i.e. maceration) to enhance organic degradation. Equipment meets legislated requirements. • POB design limits of treatment systems are observed. Isolate: • Untreated sewage wastes not discharged within 12nm of land • Comminuted and disinfected sewage wastes not discharged within 3 nm of land. Administrative: • Sewage treatment equipment is routinely maintained • Vessel waste log verifies conditions of sewage discharge • Discharge conditions (i.e. proceeding en-route) observed.

Compliance with International Conventions, Legislative Codes and standards:	Compliance with:
	• International Conventions
	  ○ International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78) – Annex IV
	• Legislation (Commonwealth)
	  ○ Navigation Act 2012 (Chapter 4 (Prevention of Pollution): Part 3 – *Vessels Polluting or Damaging the Australian Marine Environment* & Part 4 – *Directions Relating to Foreign Vessels*)
	  ○ Protection of the Seas (Prevention of Pollution by Ships) Act 1983 ((Section 26D - *Prohibition of Discharge of sewage into the sea*))
	  ○ Marine Order Part 96 (Marine Pollution Prevention - Sewage).
	  ○ EPBC Regulations 2000 (IUCN principles of Schedule 8)

Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the impacts other marine life to a level which is ALARP and acceptable including: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the sewage will discharge and assess potential impacts. **IAGC Practice** is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management).
Professional judgement:	Alternate controls identified with practicable controls implemented. Controls adopted over multiple levels on the control hierarchy.
Engineering Risk Assessment:	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis:	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The risk management strategy for sewage discharge impacts reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised with to sewage discharges.
External Context: Environment	Survey is in deep offshore waters which are highly dispersive. Discharge affects marine component (upper water column) only on an intermittent basis for a short duration. Discharge is biodegradable. Species present in upper water column are widespread.

Legislative criteria & standards	Legislation: o *Navigation Act 2012* o *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* o Marine Order Part 96 (Marine Pollution Prevention - Sewage) o EPBC Regulations 2000 (IUCN principles of Schedule 8) Industry Practice: o APPEA CoEP o IAGC Environment Manual
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	Western Eyre CMP: Sewage discharge impacts will be contained (locally) within the survey area and will not be discharged within the Western Eyre CMP. This meets the prescriptions within the Management Plan, meets the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*discharge does not compromise diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Species Recovery Plans/Conservation Advice: Review and assessment of threatened species recovery plans and conservation advice identified no requirements for sewage discharge. PGS has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement.
Environmental impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Nil	
Record Keeping	
ISPP PMS Records (Sewage System) Vessel Waste Log POB Listing	

6.5 Impact: Food-scrap/putrescible discharge (vessels)

6.5.1 Hazard

Food-scrap/putrescible discharges from vessel to marine waters are expected during survey activities. Food scraps and putrescibles will be generated through cooking and food consumption, with wastes macerated and discharged overboard. It is expected that the average volume of putrescible waste discharged overboard is ~1 litre/person/day (Woodside, 2011).

All vessels engaged on the Duntroon multi-client survey will dispose of food-scraps/putrescibles in accordance with MARPOL 73/78 Annex V and Section 26F of the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983.*

6.5.2 Known and potential impacts

The known and potential environmental impacts of food-scrap/putrescible discharges are:

- Temporary and localised reduction in water quality (nutrients) around the discharge location;
- Increased biological oxygen demand; and
- Increase in scavenging behaviour of marine fauna and seabirds.

6.5.3 Evaluation of environmental impacts

Impacts to the marine environment from the disposal of macerated food wastes/putrescibles are expected to be negligible. Accumulation of nutrients in surrounding waters is not expected due to the minor quantities generated each day, the assimilative capacity of open waters and the high biodegradability/low persistence of the wastes disposed.

The potential for opportunistic fish and oceanic seabirds being attracted to the discharge of food scraps either directly, in response to increased food availability or on a secondary basis from prey species being attracted to the vessel, is expected to be low, given the small quantities and intermittent nature of disposal. No dependencies on the discharge are expected.

Commonwealth Recovery Plans:

A review of the management actions and objectives listed in threatened species conservation/recovery plans that may be present in the survey area and their applicability to the threats posed by the survey activity have been assessed in Section 3.7. No management actions, as contained in the recovery/management plans, are considered relevant to food-scrap discharge impacts. PGS has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement.

Marine Reserves (Conservation Values and Management Principles):

PGS has undertaken and an assessment of localised food-scrap discharge impacts against the requirements of the South-west Marine Parks Networks Management Plan 2018 (DNP, 2018), the Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-64). Food-scraps will not be released within the CMP. This action meets prescriptions within the Management Plan, protects conservation values and is consistent with the management principles for sustainable long-term use of the area. ALARP and acceptability is demonstrated in Table 6-64.

6.5.4 Impact assessment

Table 6-64 provides the impact assessment for vessel food-scrap/putrescible discharges.

Table 6-64: Food-scrap/putrescible discharge EIA

Aspect	Discharge of food-scraps/putrescible wastes to the marine environment.
Impact Summary	Localised increase in content of nutrients in surrounding surface waters
Extent of Impact	LOW - Localised around vessel discharge (expected to rapidly dilute and dissipate in open ocean environment while vessels are moving).
Duration of Impact	Temporary (duration of survey) and recoverable
Level of certainty of impact	HIGH. Impacts for food-scrap discharges to the marine environment in accordance with MARPOL Annex V requirements, prevents excessive nutrient loadings within the marine environment.
Species affected within survey environment	**Marine species (fish, plankton)** are widely distributed and only a small proportion of the species potentially affected. **Marine seabirds** which are protected, widely distributed and only a small proportion of the species potentially affected.
Impact Decision Framework Context	A (*Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined)*. Impact assessment decision making based upon LCS, GIP and PJ.
Impact with controls failure (inherent)	

SLIGHT			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Comply with the Protection of the Seas (Prevention of Pollution by Ships) Act 1983 and Marine Order 95 (Marine Pollution Prevention – Garbage)	Administrative	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry.
Food-scraps & putrescibles treated as per MARPOL Annex V requirements prior to marine discharge.	Substitute	YES	Good Practice – well defined and established treatment requirements adopted by offshore petroleum and shipping industry.
Equipment used in macerating food-scraps is routinely maintained to ensure performance requirements are met.	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
All discharges are recorded in vessel garbage record book	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
Vessel masters ensure that the POB does not exceed stated maximum carrying capacity for treatment equipment.	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
Shipboard personnel are aware of the restrictions around overboard discharges of waste materials.	Administrative	YES	Good practice – well defined and adopted by offshore petroleum sector.
Food-scraps/putrescibles discharged outside of Western Eyre CMP	Eliminate	YES	Best practice to eliminate impacts to CMR.
Food-scraps and putrescibles stored and transferred to shore for treatment and disposal.	Eliminate	NO	Substantial additional cost due to onshore treatment and disposal, increased fuel consumption given the additional transits required by support vessel. Risk of spills during transfer operations and additional safety and health risks to personnel during vessel transfer activities. Alternate storage on board vessel may lead to health issues and if refrigerated, may lead to less endurance time given a limitation on food storage space availability. **Little net benefit observed if food-scraps can be discharged.**
Impact consequence with controls (residual)			
SLIGHT			
ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS			
EPO	EPS	MEASUREMENT CRIERIA	

EPO18: Food scrap discharge from survey vessels during survey activities meets MARPOL Annex V requirements.	**EPS44:** Food-scrap discharges from vessels must comply with the requirements of: • MARPOL Annex V – garbage • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 – Section 26F • Navigation Act 2012 (Chapter 4, Parts 3 & 4) • Marine Order 95 (Marine pollution prevention – Garbage)	Records confirm the vessel has MARPOL approved/compliant equipment for maceration of food-scraps in accordance with the Vessel Garbage Management Plan (or equivalent document appropriate to vessel class). <u>Responsibility</u>: PGS Vessel Manager

MC: Garbage record book verifies food scrap discharge complies with MARPOL Annex V standards.	**EPS45**: Food-scrap discharge occurs outside the Western Eyre CMP if:
	• If food-scraps are comminuted to a particle size > 25mm:
	  ○ Vessel is en-route;
	  ○ Vessel is moving more than 4 knots; and
	  ○ The discharge takes place as far as practicable from the nearest land, but in any case>3nm from the nearest land.
	• If food-scraps are not comminuted:
	  ○ The vessel is en-route; and
	  ○ The discharge takes place as far as practicable from the nearest land, but in any case>12 nm from the nearest land.
	If the above is not met the food-scraps must be retained on-board for onshore disposal or incinerated in the vessel's incinerator.
		Vessel garbage record book verifies food-scrap discharges were compliant with these requirements and is monitored through regular inspection review of the discharge records.
		
		<u>Responsibility</u>: Chief Officer

	EPS46: Equipment is routinely maintained and system elements calibrated to ensure reliable discharge concentrations are being met.	PMS records verify that macerators are maintained to schedule. <u>Responsibility</u>: Chief Engineer
	EPS47: All vessel personnel are aware of the vessel garbage management arrangements through the information provided in the vessel survey induction.	Induction records verify crew have completed the vessel induction which include garbage management plan arrangements. <u>Responsibility</u>: Vessel Master
EPO19: No discharge of food scraps within the West Eyre CMP.	**EPS48:** Food scraps will not be discharged within the Western Eyre Commonwealth Marine Reserve.	Discharge records verify food scraps have not been discharged within the Western Eyre Commonwealth Marine Reserve. <u>Responsibility</u>: Vessel Master

Demonstration of ALARP	
Hazard Consequence Criteria	A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.

Hierarchy of Controls	Eliminate: • The generation of food-scraps/putrescible waste by crew cannot be eliminated. *No elimination controls identified which are practicable.* • No discharge in Western Eyre CMP. Substitute: • *No substitution controls identified which are practicable.* Engineer: • Survey vessel equipped with grinder/macerator meeting 25mm maximum particle size for putrescible wastes Isolate: • Untreated putrescible wastes not discharged within 12nm of land • Treated putrescible wastes not discharged within 3 nm of land. Administrative: • All crew members inducted into the vessel Garbage management plan requirements. • Maceration equipment routinely maintained. • All garbage disposal from vessel is documented.

Compliance with International Conventions, Legislation Codes and Standards	Compliance with:
	• International Conventions:
	  ○ International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78) – Annex V
	• Legislation (Commonwealth):
	  ○ *Navigation Act 2012* (Chapter 4 (Prevention of Pollution): Part 3 – *Vessels Polluting or Damaging the Australian Marine Environment* & Part 4 – *Directions Relating to Foreign Vessels*)
	  ○ Compliant with the Commonwealth *Navigation Act 2012* and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Section 26F - *Prohibition of discharge of garbage into the sea*)
	  ○ Marine Order Part 95 (Marine Pollution Prevention - garbage).
	  ○ EPBC Regulations 2000 (IUCN principles of Schedule 8)

Good Industry Practice	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the impacts other marine life to a level which is ALARP and acceptable including: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which foodscraps will discharge and assess potential impacts. **IAGC Practice** is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management).
Professional Judgement:	Alternate controls identified with practicable controls implemented. Controls cover multiple levels of the control hierarchy.
Engineering Risk Assessment:	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The management strategy for food-scrap/putrescible discharge impacts reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised about food-scrap/putrescible discharges.
External Context: Environment	Survey is in deep offshore waters which are highly dispersive. Discharge affects marine component (upper water column) only on an intermittent basis for a short duration. Discharge is biodegradable. Species present are widespread.

Legislative Criteria and Standards	Legislation: ○ *Navigation Act 2012* ○ *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* ○ Marine Order Part 95 (Marine Pollution Prevention - Garbage) ○ EPBC Regulations 2000 (IUCN principles of Schedule 8) Industry Practice: ○ APPEA CoEP ○ IAGC Environment Manual
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advice	Western Eyre CMR: Food scrap discharge impacts will be contained (locally) within survey area and will not be discharged within the Western Eyre CMP. This meets with Management Plan prescriptions, and discharge impacts do not conflict with, and meet the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*discharge does not compromise diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Species Recovery Plans/Conservation Advice: Review and assessment of threatened species recovery plans and conservation advice identified no management actions, as contained in the recovery/management plans, are considered relevant to food-scrap discharge impacts. PGS has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement.
Environmental impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Nil	
Record Keeping	
Garbage Management Plan Garbage Record Book Macerator Specifications PMS Records (Maceration Equipment) Vessel Induction Attendance Sheets	

6.6 Impact: Air emissions (vessel)

6.6.1 Hazard

The following activities during the survey will generate atmospheric emissions:

- Vessel combustion of marine diesel for propulsion and power generation (continuous) and within mobile deck equipment (intermittent);
- Use of aviation fuel for transport of personnel using helicopters (intermittent); and
- Liquid and solid waste combustion within the vessel's incinerator (intermittent).

6.6.2 Known and potential impacts

The known and potential environmental impacts associated with atmospheric emissions are:

- Localised and temporary decrease in air quality due to combustion gases and particulate matter emitted from diesel combustion; and

- Contribution to the global greenhouse gas (GHG) effect.

6.6.3 *Evaluation of environmental impacts*

The use of fuel to propulsion engines, generators, fixed plant (e.g., ROV) and any incineration of wastes will result in gaseous emissions of GHG such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), along with non-GHG particulate emissions such as sulphur oxides (SO_X) and nitrous oxides (NO_X).

The emissions generated from the vessel add to the GHG load in the atmosphere increasing global warming (albeit very minor). The fuel sources used for combustion purposes will be Marine Gas Oil (MGO) or Marine Diesel Oil (MDO) with anticipated consumption of the seismic vessel in the order of 45m^3 per day during MSS activities. For a 91 day survey program this results in a total GHG contribution of 10,985 tonnes $CO_{2\text{-}eq}$[110] (a negligible contribution to GHG emissions).

The emission of non-GHG particulate matter, such as NO_X and SO_X, can lead to a reduction in local air quality on a health-risk basis. The combustion of fuels and wastes, in such a remote location, is not expected to impact on the health or amenity of nearby human settlements located over 51 km away, as offshore winds will rapidly disperse and diffuse gaseous and emissions.

<u>Commonwealth Recovery Plans:</u>

A review of the management actions and objectives listed in threatened species conservation/recovery plans that may be present in the survey area and applicable to the threats posed by the survey activity have been assessed in Section 3.7. No management actions, as contained in the recovery/management plans, are considered relevant to air discharge impacts.

<u>Marine Reserves (Conservation Values and Management Principles)</u>:

PGS has undertaken and an assessment of localised air emission impacts against the South-west Marine Parks Network Management Plan 2018 (DNP, 2018), the Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-65). Impacts to CMP conservation values are slight, recoverable and consistent with the management principles for sustainable long-term use of the area. There is no conflict with prescriptions contained in the Management Plan. ALARP and acceptability is demonstrated in Table 6-65.

6.6.4 *Impact assessment*

Table 6-65 provides the impact assessment for air emissions.

Table 6-65: Air emissions discharge EIA

Aspect	Discharge of air emissions to the marine environment.
Impact Summary	Localised reduction in air quality and minor contribution to GHG effects.
Extent of Impact	LOW - Localised around vessel discharge (expected to rapidly dilute and dissipate in open ocean environment while vessels are moving).
Duration of Impact	Temporary (duration of survey) and recoverable.
Level of Certainty of Impact	HIGH. Impacts from air emissions to the marine environment, in accordance with MARPOL requirements, prevent excessive oil loadings within the marine environment.
Species affected within survey environment	Air-breathing species in very close proximity to exhaust points (e.g. birds – potentially protected). Note that impacts to bird species are considered non-credible due to the constant movement of the vessels and the animal's aversion to high temperature emissions.
Impact Decision Framework	A (*Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined)*. Impact assessment decision making based upon LCS, GIP and PJ.
Impacts with Controls failure (Inherent)	

[110] This amount is 0.0006% of Australia's GHG emissions for 2012 (DoE, 2014ah)

MINOR			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Compliance with Protection of the Sea (Prevention of Pollution from Ships) Act 1982 and marine Order Part 97 (Marine Pollution Prevention – Air Pollution)	Administrative	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector.
Monitor and optimise fuel use to increase efficiency and minimise emissions	Administrative	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector.
Use of low sulphur diesel fuel when it is available to reduce sulphur emissions (SOx) from vessel combustion.	Substitute	YES	The survey and support vessels will use Marine Gas Oil (MGO) or Marine Diesel Oil (MDO) to power engines (rather than Intermediate Fuel Oil (IFO) or Heavy Fuel Oil (HFO)) as it has a lower sulphur content. MGO/MDO can cost twice as much as IFO and HFO.
Emissions managed by the implementation of a planned maintenance system (PMS) on propulsion and generation equipment.	Administrative	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector.
Use of alternate fuels (solar, wind, biofuels).	Substitute	NO	Alternate fuel sources have not been commercially proven for use in large vessels.
Eliminate air emissions when operating in the Western Eyre CMP	Eliminate	NO	Control would not allow for the operation of vessels through the area to collect data. Not practical.
No incineration on vessels	Eliminate	NO	Incineration of wastes on vessels using MARPOL-certified equipment and procedures is an accepted practice which avoids potentially greater impact through transport, treatment and disposal onshore. Incineration also saves space on board and may prevent health hazards created by long-term storage of wastes pending onshore disposal.
Routine shut-down of non-essential machinery on survey and support vessels	Eliminate	NO	Little benefit given the frequency/scale of emissions, lack of sensitive receptors and remoteness of the operational area to settlements.
Impact consequence with controls (residual)			
SLIGHT			

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	EPS	MEASUREMENT CRITERIA

<table>
<tr><td rowspan="5">EPO20: Air discharges comply with MARPOL Annex VI requirements.

MC: Vessel records verify air emissions comply with MARPOL Annex VI.</td><td>EPS49: Air discharges from vessels must comply with the requirements of:
• MARPOL Annex VI – air emissions
• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 – Part IIID – Prevention of air pollution
• Navigation Act 2012 (Chapter 4, Parts 3 & 4)
• Marine Order 97 (Marine pollution prevention – air pollution)</td><td>Survey vessel has a current International Air Pollution Certificate (IAPP) (also covering incinerator) or equivalent documentation appropriate to vessel class.

<u>Responsibility</u>: Chief Engineer</td></tr>
<tr><td>EPS50: Vessels utilise low sulphur fuels when it is available to reduce SOx emissions from combustion sources (i.e. fuel that contains less than 3.5% m/m sulphur)</td><td>Vessel bunker receipts verify use of low-sulphur marine grade MDO/MGO.

<u>Responsibility</u>: Chief Engineer</td></tr>
<tr><td>EPS51: Incinerator operation is in accordance with the requirements of MARPOL 73/78 Annex VI (Regulation 16):
• Only wastes approved by the vessel garbage management plan shall be incinerated;
• The incinerator shall operate in accordance with the manufacturer's operating manual by trained personnel; and
• Flue gas outlet or combustion chamber temperatures shall be monitored during incineration activities.</td><td>Incinerated waste details are recorded in the vessel's Garbage Record Book which verifies operation in accordance with MARPOL requirements.

<u>Responsibility</u>: Chief Engineer

Manufacturer's specifications and operating procedures are available for the operation of the incinerator.

<u>Responsibility</u>: Chief Engineer</td></tr>
<tr><td>EPS52: Fuel usage is monitored on all support vessels and abnormally high consumption investigated.</td><td>Fuel use is reported in the Daily Report.

<u>Responsibility:</u> Vessel Master</td></tr>
<tr><td>EPS53: The survey vessel implements a Ship Energy Efficiency Management Plan (SEEMP) (MARPOL 73/78 Annex VI requirement from 1 January 2012) to monitor and reduce air emissions from vessel activities. This includes:
• Emissions management via implementation of a planned maintenance system for propulsion systems in accordance with manufacturer's instructions.
• Records of daily feel consumption and fuel sulphur content.
• Other measures (vessel speed, etc.) to reduce air emissions.</td><td>SEEMP review records verify:
• Energy saving measures have been implemented;
• Propulsion systems have been maintained in accordance with manufacturer's instructions.

<u>Responsibility</u>: Chief Engineer.</td></tr>
<tr><th colspan="3">Demonstration of ALARP</th></tr>
<tr><td>Hazard Consequence Criteria</td><td colspan="2">A SLIGHT consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.</td></tr>
</table>

Hierarchy of Controls	Eliminate: • Fuel use cannot be eliminated – no alternate, commercially available sources identified. Substitute: • Survey and support vessels will utilise low-sulphur fuels which meet legislative requirements. Engineer: • Vessel combustion and incineration equipment compliant to MARPOL VI requirements Isolate: • Survey area not in proximity to coastal settlements Administrative: • Survey vessel operates under a SEEMP. • Equipment routinely maintained via a Preventative Maintenance System • Fuel consumption monitored • Incineration equipment monitored for combustion temperatures. Feedstock to incinerators limited to wastes specified in the Vessel Garbage Management Plan.
Compliance with International Conventions, Legislative Codes and Standards	Compliance with: • International Conventions: ○ International Contention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78) – Annex VI • Legislation (Commonwealth): ○ *Navigation Act 2012* (Chapter 4 (Prevention of Pollution): Part 3 – *Vessels Polluting or Damaging the Australian Marine Environment* & Part 4 – *Directions Relating to Foreign Vessels*) ○ *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Part IIID – Prevention of air pollution) and the following subordinate legislation: ○ Marine Order Part 97 (Marine Pollution Prevention – Air Pollution) ○ EPBC Regulations 2000 (IUCN principles of Schedule 8)
Good Industry Practice:	**APPEA Code of Environmental** Practice (2008) objectives met for offshore seismic surveys with respect to reducing the impacts to other marine life to a level which is ALARP and acceptable including: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the air emissions will discharge and assess potential impacts. **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management & Section 8.6 Hazardous Materials).
Professional Judgement:	Alternate controls identified and implemented where practicable. Controls adopted cover multiple levels on the control hierarchy.
Engineering Risk Assessment:	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis:	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The management strategy for air emission discharge impacts reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised about to air emissions.
External Context: Environment	Survey is in offshore waters where air environment is highly dispersive and offshore winds will assist in the dispersion and diffusion of atmospheric emissions. No sensitive receptors (e.g. populated areas) near the survey area.

Legislative criteria & standards	Legislation: ○ *Navigation Act 2012* ○ *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* ○ Marine Order Part 97 (Marine Pollution Prevention – Air Pollution) ○ EPBC Regulations 2000 (IUCN principles of Schedule 8) Industry Practice: ○ APPEA CoEP ○ IAGC Environment Manual
External Context: Marine Reserves, management Plans, Species Recovery Plans and Conservation Advices	Western Eyre CMP: Air emission impacts will be contained (locally) within the survey area within the Western Eyre CMP (as relevant). Discharge impacts do not conflict with Management plan prescriptions, and meet the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*emissions do not compromise diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Species Recovery Plans/Conservation Advice: Review and assessment of threatened species recovery plans and conservation advice (refer Section 3.7) did not identify threats associated with vessel air emission impacts. No action objectives from recovery plans are applicable to this impact.
Environmental impact demonstrated to be ALARP	The residual impact meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Fuel usage	
Record Keeping	
IAPP Bunkering Records Garbage Record Book Incinerator Specification and Operating Procedures Vessel Daily Reports SEEMP Implementation Records.	

6.7 Risk: Invasive marine species introduction

6.7.1 Hazard

The survey vessel contracted for the Duntroon multi-client survey will either mobilise from Australian or international ports to the survey area. If the survey vessel mobilises from an international port it will undergo assessment for invasive marine species (IMS), complete necessary corrective action, exchange ballast water en-route and dock initially at an Australian port where it will undergo quarantine inspections as required by regulatory authorities. International vessels mobilising from foreign ports, may act as a source of IMS which are carried on the vessel in the form of hull/niche biofouling or within ballast water tanks and released during ballast water exchange activities. Australian vessels mobilising from regions outside the Spencer Gulf Shelf bioregion will also assess IMS risk (hull/niche biofouling) and must comply with the requirements of the Australian Ballast Water Requirements (Revision 7) (DAWR, 2017). During the survey, the vessels will ballast and de-ballast to improve stability, even out vessel stresses and adjust vessel draft, list and trim, with regard to the weight of equipment and fuel, potable water and so forth on board at any one time. In summary the following activities have the potential to result in the introduction of IMS:

- Discharge of vessel ballast water containing foreign species;

- Translocation of species through biofouling of the vessel hull or niches (e.g., sea chests, bilges, strainers); and
- Biofouling of equipment that routinely becomes immersed in water.

6.7.2 Known and potential impacts

The known and potential environmental impacts of IMS introduction (assuming their survival, colonisation and spread) are:

- Ecological disruption through increased competition with native species and for resources;
- Reduction in native species diversity and abundance.

6.7.3 Evaluation of environmental impacts

IMS are marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish. More than 200 non-indigenous marine species including fish, molluscs, worms and a toxic alga have been detected in Australian coastal waters. These species can have detrimental effects on human health and aquaculture industries (AMSA, 2013).

The survey area is not expected to be a location which is conducive to IMS survival given the water depths of the survey area (100 to 3500 m)[111]. Establishment of IMS is mostly likely to occur in shallow waters in areas where large numbers of vessels are present and the vessels are stationary for an extended period.

Successful IMS colonisation requires the following three steps (CoA, 2009):

- Colonisation and establishment of the marine pest on a vector (e.g., vessel, equipment, internal vessel niches or structures) in a donor region (e.g., home port where species is established);
- Survival of the settled marine species on the vector during the voyage from the donor to the recipient region; and
- Colonisation (e.g., dislodgement or reproduction) in the recipient region by the marine species, followed by successful establishment of a viable new local population.

It is noted that within the Duntroon survey area, colonisation is considered remote given the following controls which have been adopted:

- Under the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry, a risk assessment approach is recommended to manage biofouling. The potential biofouling risk presented by the survey and/or support vessels selected to undertake the survey within the Duntroon survey area will relate to the length of time that the vessels have already been operating in Australian waters or, if they have been operating outside Australian waters, the location/s of the international surveys undertaken, the length of time spent at these location/s, and whether the vessels have undergone hull inspections, cleaning and application of new anti-foulant coating prior to operating in Australian waters. There is the possibility that the vessel(s) utilised for the Duntroon survey may have been operating outside of Australia prior to mobilising to a project. Therefore, any such vessels mobilised for the survey will have an IMS risk assessment done prior to arriving in Australia, and all of the necessary clearances to operate within Australia waters will be arranged as required;
- There is a low likelihood of colonisation and establishment in the marine environment (vessel IMS risk assessment and cleaning in home port prior to mobilisation to Australian waters);

[111] The Western Australian Department of Fisheries considers water depths greater than 50 m are unlikely to provide a settlement site for marine pests (DoF, 2015).

- The survey vessel will have undertaken ballast water exchange activities in deep water during its transit to Australia in accordance with the Australian Ballast Water Management Requirements (DAWR, 2017) to eliminate IMS species within ballast water tanks;
- The survey vessel, if mobilised from international waters, must first dock at an Australian port whereby the Department of Agriculture and Water Resources (DAWR) may determine the vessel's compliance with the Commonwealth biosecurity standards legislated under the Biosecurity Act 2015. These inspectors have significant powers to prevent the arrival and establishment of IMS of concern;
- The survey vessel will be coated in an appropriate anti-fouling system that is considered suitable for the vessel activities to be undertaken and will have a current International Anti-fouling System Certificate to verify the currency of the system. Vessels will travel from port to the survey location at a speed that is likely to prevent IMS species adhering to the hull (enhanced through the application of anti-fouling paint); and
- The survey area contains deep waters and insufficient light penetration which would be favourable to colony establishment.

While IMS introduction into the survey area would be significant, given the water depth present introduced species are not expected to survive given light limitations (i.e. 'minor' consequence). With the adoption of the listed control measures, the likelihood of IMS introduction during the proposed survey is considered remote. The residual risk associated with this hazard is assessed as LOW.

<u>Commonwealth Recovery Plans:</u>

The relevance of management actions contained in threatened species conservation/recovery plans have been assessed with respect to IMS introduction during the Duntroon Multi-client survey. No management actions, as contained in the following recovery/management plans, are considered relevant to IMS introduction:

- Recovery Plan for the White Shark (SEWPC, 2013);
- Recovery Plan for the Australia Sea Lion (SEWPC, 2013);
- Recovery Plan for Marine Turtles in Australia (EA, 2003);
- Recovery Plan for Threatened Albatross and Giant Petrels (2011-2016) (SEWPC, 2011);
- Blue Whale Conservation Plan (DoE, 2015); and
- Conservation Management Plan for the southern right whale (SEWPC, 2012).

<u>Marine Reserves (Conservation Values and Management Principles)</u>:

An assessment of IMS introduction within the survey area against the South-west Marine Parks Network Management Plan 2018 (DNP, 2018), Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-66) has been undertaken. The benthic invertebrate community KEF within the Western Eyre CMR would be considered 'at risk' from IMS introduction, however the likelihood of IMS colonisation is remote given the depth of water and associated light limitations at the seabed in the survey area. The South-west Marine Parks Network Management Plan identifies islands, reefs and other shallow-water ecosystems and native species as vulnerable to invasive species (DNP, 2018). Controls adopted to reduces the IMS risk meet the prescriptions detailed in the Management Plan and reduce the risk to a level which is ALARP. ALARP and acceptability is demonstrated in Table 6-66.

An assessment of impact against the IUCN management principles for the affected CMPs (refer Table 6-66) has found that, with controls adopted, the activity is consistent with sustainable long-term use of the area (*as per other vessels which traverse the survey area*).

6.7.4 Risk assessment

Table 6-66 provides the risk assessment for the potential introduction of IMS species within the survey area from survey activities.

Table 6-66: IMS Introduction ERA

Aspect	Introduction of IMS into the Duntroon survey area.				
Impact Summary	Competition with and loss of, diversity and abundance of, native species in the survey area.				
Extent of Impact	In the event of colonisation, the impact would be initially localised, then possibly far-reaching in the marine environment. However, IMS species are translocated from coastal environments where there is high light availability. The depth of water within the survey area limits light availability and pest species establishment is considered remote given the lack of suitable environmental conditions.				
Duration of Impact	Long-term if IMS becomes established.				
Level of certainty of impact	HIGH. Impacts associated with IMS introduction have been extensively studied and the vectors of introduction established. Corresponding regulatory guidelines controlling these vectors have been established.				
Species affected within the survey environment	A benthic invertebrate community is present in the Western Eyre CMR. IMS introduction in this area may threaten this community and have indirect impacts to other ecological processes.				
Risk Decision Framework Context	A (*Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined)*. Risk assessment decision making based upon LCS, GIP and PJ.				
Risk with controls failure (inherent)					
Consequence:	Minor	Likelihood:	Unlikely	Risk:	MEDIUM

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Vessels comply with ballast requirements in accordance with the Australian Ballast Water Management Requirements (Revision 7) (DAWR, 2017)	Administrative	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector.
Survey vessels during survey activities do not undertake routine discharge of ballast water	Eliminate	NO	Given the location of the survey, ballast water is required to maintain vessel stability during survey activities. Option may compromise safety of personnel on-board. Option not considered practicable.
Transfer of ballast water to second vessel for discharge outside the operational area in water depths and distances which comply with the Australian Ballast Water Requirements (DAWR, 2017)	Eliminate	NO	Activity would lead to potential acquisition downtime and increase in survey duration as seismic operations would need to cease during ballast water transfer operations. Operation introduced additional safety risks during vessel to vessel transfers for very little net benefit.

Vessels mobilising from regions outside the Spencer Gulf Shelf Bioregion undertake a risk assessment with respect to biofouling on hull and niche areas and for trailing equipment which has been immersed during surveys. Corrective actions are initiated prior to entry into bioregion waters which demonstrate that the vessel has a low biofouling risk (e.g. hull cleaning, antifouling paint application).	Administrative/ Engineering	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector.
Vessels will have current anti-fouling coating systems to prevent adherence of IMS species to the hull and niche areas.	Engineering	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector.
Hull cleaning and new anti-fouling coat application to vessel hull and niche areas on every occasion prior to entry into bioregion waters.	Engineering	NO	This action without a justifiable risk (i.e. presence of IMS) is a substantial cost (~$1.2M) without a net environmental benefit.

Risk Consequence with controls (residual)					
Consequence:	Minor	Likelihood:	Remote	Risk:	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	EPS	MEASURMENT CRITERIA
EPO21: No introduction of marine pest species from ballast water exchange. **MC:** Zero incidents of ballast water management not meeting IMO and Australian ballast water management requirements.	**EPS54:** Ballast water management is undertaken in accordance with the requirements of the *Australian Ballast Water Management Requirements* (Revision 7) (DAWR, 2017). This includes: o Use of a Ballast Water Treatment System; o Ballast water exchange outside of Australian Territorial seas (<12nm from coastline) involving full exchange of ballast in water depths of at least 50m; o Use of low risk ballast water (e.g. fresh potable or high seas water); o Retention of high-risk ballast water on-board; or o Discharge to an approved ballast water reception facility. International vessels have submitted a Ballast Water Report and been issued with a Biosecurity Status Document.	Records identify that a Ballast Water Report submitted to the DAWR and a Biosecurity Status Document is available prior to entry into port facilities. BWTS Certification (relevant to IOPP inspection triggers for vessel). <u>Responsibility</u>: Vessel Master/Chief Officer

	EPS55: Vessel must have a certified Ballast Water Management Plan which complies with: ○ Regulation B1 of the international Convention for the Control and Management of Ships Ballast Water and Sediments 2004; and ○ IMO Guidelines for Ballast Water Management and the Development of Ballast Water Management Plan (IMO Resolution MEPC.127(53)).	Valid Ballast Water Management Certificate for the vessel. Responsibility: Vessel Master/Chief Officer
EPO22: No introduction of marine pest species from biofouling of the survey or support vessel hulls, other niches and immersible equipment during Duntroon survey. **MC:** Zero incidents of vessel use on the Duntroon survey which have not demonstrated a low IMS risk.	**EPS56**: For survey vessels mobilising from regions outside the Spencer Gulf Shelf Bioregion, prior to mobilisation contractors are required to undertake an IMS risk assessment supplying relevant supporting information to the Vessel Manager to validate the IMS risk status. The risk assessment is undertaken in accordance with the *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2009)* and the WA IMS Risk Assessment Methodology currently managed by WA Fisheries. For vessels demonstrating via the risk assessment methodology that the IMS risk is LOW without further corrective actions, the vessel is deemed suitable for use in survey activities. For vessels demonstrating via the risk assessment methodology that the IMS risk is MEDIUM or HIGH the vessel will require inspection by a qualified independent third-party marine pest inspector to determine the corrective action to reduce the vessel to low risk. The vessels must demonstrate that all corrective actions have been implemented prior to mobilisation to the SGS bioregion.	Records verify risk assessment has been undertaken and all corrective actions implemented. Responsibility: Vessel Manager
	EPS57: Vessels carry current International Anti-fouling System Certificates (IAFS) prior to entry into Australian waters.	Records verify IAFS Certificate is current for vessels. Responsibility: Vessel Manager
	EPS58: All in-field equipment has been removed from the water, inspected and cleaned (where required) prior to deployment in South Australian waters	Records verify in-field equipment does not present an IMS risk. Responsibility: Vessel Manager

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking is considered broadly acceptable. If the risk control measures are consistent with applicable standards, then no action is required to reduce the risk further unless a reasonably practicable measure is available. The risk shall be managed in accordance with good industry practice.

Hierarchy of Controls	Eliminate: o Use of a vessel and immersible equipment (towed seismic equipment) that remain submerged in water is unavoidable, and thus biofouling of the hull and other niches, and the uptake of marine organisms in ballast water exchange can occur. This risk is unavoidable and cannot be eliminated. o In-water equipment cleaned prior to use in the survey area. o Utilisation of local vessels as support where possible to eliminate international IMS risk. Substitute: None identified Engineer: o Vessels have current anti-fouling coating systems to reduce IMS attachment. Isolate: None Identified Administrative: o International vessels adhere to Australian Ballast Water Management requirements prior to entry into Australian waters. DAWR regulate biosecurity aspects of vessels which enter Australian waters. o International Vessels are assessed for IMS risk and corrective action taken to eliminate IMS risk.

Compliance with International Conventions, Legislative Codes and Standards	Compliance with:
	o International Conventions:
	  o International Convention for Control & Management of Ship Ballast Water & Sediments 2004;
	  o International Convention on Control of Harmful Anti-fouling Systems in Ships 2001.
	o Legislation:
	  o *Biosecurity Act 2015* (Chapter 5, Part 3 – Management of discharge of ballast water & Chapter 4 – Managing Biosecurity risks: conveyances)
	  o *Protection of the Sea (Harmful Anti-Fouling Systems) Act 2006*
	  o Marine Order Part 98 (Marine Pollution Prevention – anti-fouling systems)
	  o EPBC Regulations 2000 (IUCN principles of Schedule 8)
	o Guidelines/Standards:
	  o Australian Ballast Water Management Requirements (DAWR, 2017)

Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the impacts to other marine life to a level which is ALARP and acceptable including: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the sewage will discharge and assess potential impacts. **IAGC:** There are no specific marine pest guidelines in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013). **Commonwealth Industry Guideline:** Compliance with the Industry Code National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2009).
Professional Judgement:	Alternate controls identified and implemented where practicable. Controls adopted cover multiple levels on the control hierarchy.
Engineering Risk Assessment:	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The risk management strategy for IMS introduction reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised about IMS introduction.

External Context: Environment	Risk of translocation of IMS limited to time the survey vessel spends in shallow coastal waters and in port. Deeper offshore waters of the survey area, given the depths are not expected to support the successful colonisation by IMS (especially those picked up in shallower waters, such as coastal ports). Vessels will also be continually moving making it difficult to translocate species.
Legislative criteria & standards	Compliant with the Commonwealth • *Biosecurity Act 2015* • Australian Ballast Water Management Requirements (DAWR, 2017) • *Protection of the Sea (Harmful Anti-Fouling Systems) Act 2006* • Marine Order Part 98 (Marine Pollution Prevention – anti-fouling systems).
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	Western Eyre CMP: The IMS risk associated with the survey is contained within the Duntroon survey area and subsumed areas of the Special Use/Multiple Use Zone (IUCN VI) of the Western Eyre CMP. The adopted controls conform with the prescriptions within the Management Plan and when adopted IMS colonisation is not expected, particularly given the deep-water environment and the risk has been assessed as ALARP. The South-west Marine Parks Network Management Plan (Section 4.2.1.4 – General Use and Access) allows for ballast water to be exchanges subject to compliance with Australian Ballast Water requirements and relevant legislation relating to ballast water management. With the preventative IMS measures (ballast and biofouling) implemented on vessels, the risk exposure is low and does not conflict, and meets with the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*practicable measures implemented to prevent IMS introduction corresponds to the lowest residual risk possible with respect to preservation of diversity/natural values. These measures exceed requirements of other third-party vessels which may transit the area and water depths limit the ability for IMS to colonise*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*preventative measures adopted support the ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Species Recovery Plans/Conservation Advice: Review and assessment of threatened species recovery plans and conservation advice (refer Section 3.7) does not identify threats or pressure associated with IMS impacts. No action objectives from recovery plans are applicable to this impact.
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Nil	
Biofouling Risk Assessment and Corrective Action close-out records (Vessels outside the SGS bioregion) Ballast water exchange records Vessel Ballast Water Management Plan Ballast Water Management Certificate Ballast Water Report Biosecurity Status Document IAFS Certificates 'In-water Equipment' Inspection Records	

6.8 Risk: Disruption to commercial shipping (including defence)

6.8.1 Hazard

The physical presence of survey vessels may have an adverse effect on the operation of third-party vessels also present in the area. It should be noted that sea states routinely experienced in the area restricts small vessel activity (i.e. ocean-going only).

This section deals with interference on a spatial basis. Risk associated with vessel collision and diesel spills is addressed in **Section 6-10**.

6.8.2 Known and potential impacts

AMSA has identified the major shipping channel running east-west from Investigator Strait to Cape Leeuwin passes through the Duntroon multi-client survey area (refer Section 3.8.1). AMSA advises that the Duntroon OA on average will experience 4+ heavy commercial vessels per day. This traffic includes international and national cargo trade, passenger services and petroleum tankers.

The presence of the survey vessel and towed array may cause intermittent exclusion of commercial shipping vessels from portions of the Duntroon survey area over the period of the survey. This may lead to commercial shipping deviation around the survey activity.

6.8.3 Evaluation of environmental risk

During the 2013/14 financial year 1637 commercial trade vessels (~ 5 per day) called at port facilities within Spencer Gulf or St Vincent Gulf (Ports Australia, 2016). This included the following types of commercial vessels:

- Commercial vessels (general cargo): 270;
- Commercial vessels (Container): 332;
- Commercial vessels (Bulk Liquids): 169;
- Commercial vessels (Dry Bulk): 783;
- Commercial vessels (Car Carriers): 76;
- Commercial vessels (Livestock Carriers): 7;
- Cruise vessels: 21.

Given survey activities will be undertaken in open oceanic areas with no physical restrictions present which would limit commercial shipping access to South Australian ports, commercial shipping may need to undertake minor deviations in navigation pathways to accommodate survey activities. With the implemented preventative controls as listed in Table 6-67 which will provide awareness of survey activities and allow for appropriate navigational planning/avoidance, vessel disruption is considered unlikely. On this basis the residual risk is assessed as LOW.

Commonwealth Recovery Plans:

Commonwealth recovery plans do not apply to this social hazard.

6.8.4 Risk assessment

Table 6-67 provides the risk assessment for the potential disruption to commercial shipping activities as a result of survey activities.

Table 6-67: Disruption to commercial shipping ERA

Aspect	Disruption to commercial shipping activities.
Impact Summary	Deviation of commercial shipping around Duntroon survey activities.
Extent of Impact	LOW – Localised around survey vessel to about 11 km.
Duration of Impact	Temporary (duration of the survey) and recoverable.

<table>
<tr><td>Level of Certainty of Impact</td><td colspan="7">HIGH. AMSA have advised that vessel encounter will occur during the survey and provided preventative controls to reduce disruption.</td></tr>
<tr><td>Species affected within survey environment</td><td colspan="7">Commercial shipping</td></tr>
<tr><td>Risk Decision Framework Context</td><td colspan="7">A (Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined). Risk assessment decision making based upon LCS, GIP and PJ.</td></tr>
<tr><td colspan="8">Risk with controls failure (inherent)</td></tr>
<tr><td>Consequence:</td><td>Minor</td><td colspan="2">Likelihood:</td><td colspan="2">Likely</td><td>Risk:</td><td>Medium (2)</td></tr>
<tr><td colspan="8">ASSESSMENT OF PROPOSED CONTROL MEASURES INCLUDING NON-ADOPTED CONTROLS)</td></tr>
<tr><td colspan="2">CONTROL MEASURE</td><td colspan="2">CONTROL TYPE</td><td colspan="2">PRACTICABLE AND IMPLEMENTED</td><td colspan="2">JUSTIFICATION</td></tr>
<tr><td colspan="2">Adherence to the requirements of the Navigation Act 2012 and specifically Marine Order Part 30: Prevention of collisions</td><td colspan="2">Administrative</td><td colspan="2">YES</td><td colspan="2">Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry.</td></tr>
<tr><td colspan="2">Issue of marine navigation warnings and notice to mariners of survey presence and towed array</td><td colspan="2">Administrative</td><td colspan="2">YES</td><td colspan="2">Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry</td></tr>
<tr><td colspan="2">Support vessel is available to manage vessel interactions</td><td colspan="2">Isolation</td><td colspan="2">YES</td><td colspan="2">Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry.</td></tr>
<tr><td colspan="2">All marine crew are appropriately trained to detect and interact with commercial shipping if this poses a threat to the survey.</td><td colspan="2">Administrative</td><td colspan="2">YES</td><td colspan="2">Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry</td></tr>
<tr><td colspan="2">Trailing equipment will be identified, and day shapes displayed to identify the survey activity</td><td colspan="2">Administrative</td><td colspan="2">YES</td><td colspan="2">Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry</td></tr>
<tr><td colspan="2">Seismic acquisition will only occur outside areas with substantial vessel movements (e.g. recognized shipping routes)</td><td colspan="2">Eliminate</td><td colspan="2">NO</td><td colspan="2">This would create large gaps in survey data coverage with substantial costs require to fill those gaps. A large amount of infill acquisition would be required.</td></tr>
<tr><td colspan="2">Seismic acquisition will only occur during daylight hours to provide for visual identification</td><td colspan="2">Eliminate</td><td colspan="2">NO</td><td colspan="2">Measure would double survey duration and PGS would not be able to meet seismic data delivery requirements to clients.

If equipment was deployed and retrieved daily, survey objectives would not be realised as the time taken to deploy and retrieve is greater than the daylight hours.</td></tr>
<tr><td colspan="2">Use of automatic radar plotting aid (ARPA) to calculate objects course and closest point of approach</td><td colspan="2">Administrative</td><td colspan="2">Yes</td><td colspan="2">Good Industry Practice. ARPA is standard equipment on-board survey vessels to facilitate awareness of potential collisions.</td></tr>
</table>

Procedure for Closest Point of Approach (CPA) to survey vessel incorporating survey vessel master establishing communications early with vessels/spatial conflict	Administrative	Yes	Good Industry Practice. Procedure will be in place for the duration of the survey. The extent of the CPA will be determined in-field at the commencement of the surveys and will be specific to the vessel and length of the towed array.
Seismic transect to run parallel with shipping routes to avoid interference.	Substitute	NO	For operational safety and data quality reasons the preferred shooting direction in the GAB is determined by the dominant swell direction. Seismic acquisition in the GAB is preferred to be run perpendicular to the wave direction (i.e. not directly east/west parallel to shipping routes). The orientation of the MC3D survey within the Duntroon OA is 45º to the prevailing current which also assists with minimising any sound impacts on plankton (refer Section 6.2.3.2). The additional benefit of acquisition in this preferred direction is that data quality is improved. The pressure variations induced by the swell over the top of hydrophones become relatively consistent (not dynamic or "pulsing"). The increased data quality leads to improvement in safety by reducing exposure hours (shorter project duration). Acquiring data in alternative directions would entail additional time to re-acquire data not accepted due to the severity of "swell noise". This is a real and very significant issue when acquiring in areas of high magnitude and long period swell (GAB). Unfortunately, some acquisition programs, such as 2D marine seismic, require more than a single direction of acquisition to provide a beneficial data volume. Where this type of technique is required most of seismic lines should be ideally oriented perpendicular to the dominant wave direction. As a necessity to tie in the sparse grid of widely spaced 2D lines some additional lines may be required parallel to the wave direction.

Risk with controls (residual)					
Consequence	Minor	Likelihood:	Highly Unlikely	Risk:	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	EPS	MEASUREMENT CRITERIA
EPO23: No unplanned interference with third-party vessels and other concurrent activities (i.e. defence, etc.). **MC:** Incident records verify zero incidents of unplanned	**EPS59:** *Navigation Warning*: AMSA RCC will be notified of survey activities 24-48 hours before operations commence, at survey commencement and at completion. A daily notification of position is made to the RCC and a vessel exclusion zone applied to the activity.	Available records verify AMSA RCC notifications have been made. Responsibility: Vessel Master

interference.	**EPS60:** The Australian Hydrographic Service (AHS) is advised 4 weeks prior to Duntroon survey commencement to allow for the issue of a Notice to Mariners.	Records verify that Notice to Mariners issued by AHO prior to Duntroon MSS commencement. Responsibility: Vessel Manager
	EPS61: Survey vessels conform to the hardware requirements of AMSA: • *Marine Order 30: Prevention of Collisions* for AIS, navigation lighting, sound signals, day shapes, and ARPA[112] and • *Marine Order 27: Safety of Navigation and radio Equipment.*	Class survey certificate verifies that navigational safety equipment is compliant with the requirements of Marine Order 30 & 21. Responsibility: Vessel Manager
	EPS62: The seismic vessel will display appropriate day shapes, lights and streamers, reflective tail buoys, radar reflectors during the survey so third-party vessels are aware the vessel is in tow and restricted in manoeuvrability	Records verify that warning signals are displayed. Responsibility: Vessel Master
	EPS63: Visual and radar watches are maintained on the bridge at all times. The Vessel Master and deck officers are appropriately qualified in accordance with AMSA Marine Order 3 (seagoing qualifications) (e.g. *International Convention on Standards of Training, Certification and Watch-keeping for Sea-farers [STCW95], GDMSS proficiency)* (or equivalent according to vessel class) to operate radio equipment to warn of potential unplanned interference between vessels.	Bridge log verifies watch is undertaken 24/7 during survey activities. Responsibility: Vessel Master Training and competency records verify all relevant marine crew are qualified to fulfil required roles. Responsibility: Vessel Manager
	EPS64: The survey vessel will be fitted with and make use of an automatic radar plotting aid (ARPA) to calculate third party vessel course and the closest point of approach (CPA) and Automatic Identification System (AIS). The CPA procedure and spatial extent of the CPA will be determined in-field at the commencement of individual surveys (specific to the vessel and tow length). The procedure will incorporate third party communication requirements between the survey vessel and third-party vessels. Prior to survey commencement, the anti-collision monitoring equipment (ARPA and AIS) are inspected and tested and confirmed as operational.	Records verify vessel holds current survey certification for the Class type (i.e. confirms required anti-collision monitoring equipment is in place) and that the equipment in on-board, tested and operational. CPA procedure available for the survey with spatial dimensions identified. Radio logs verify CPA Procedure is implemented. Responsibility: Vessel Master
	EPS65: A support vessel, with multiple communication methods patrols the area around the streamers to prevent, and to escort, third-party vessels away from interacting with the streamers.	Bridge radio log verifies that support vessels are scouting for third-party vessels. Responsibility: Vessel Master

[112] Not required on escort vessel.

	EPS66: Support vessels will intercept other vessels in the area that do not actively avoid the survey vessel or are at risk of entering the path/avoidance zone of the seismic vessel and equipment.	Incident record logged when errant vessels require interception by support vessels. Responsibility: Vessel Master
	EPS67: PGS will provide a weekly summary of the planned activity of the survey vessel to the Department of Defence to de-conflict any training activities that may occur during the survey activity.	Weekly consultation records with the Department of Defence. Responsibility: Vessel Manager

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking is considered broadly acceptable. If the risk control measures are consistent with applicable standards, then no action is required to reduce the risk further unless a reasonably practicable measure is available. The risk shall be managed in accordance with good industry practice.
Hierarchy of Controls	Eliminate: No elimination controls identified. Substitute: ○ None identified Engineer: ○ Survey vessel has anti-collision monitoring equipment (e.g. radar, ARPA) and navigation safety devices (e.g. AIS) fitted. Isolate: ○ Survey utilises support/scout vessels to identify possible commercial shipping/MSS impacts and warn vessels of the hazard Administrative: ○ Marine warnings issued to all vessels which may utilise the area. ○ Survey vessel has navigation safety devices (e.g. shapes) to warn third party vessels of presence. ○ Crews maintain 24/7 watch with STCW95 (or equivalent) competencies. ○ Consultation with stakeholders.

Compliance with International Conventions, Legislation, Codes and Standards	Compliance with:
	○ International Conventions:
	  ○ International Regulations for Preventing Collisions at Sea 1972
	  ○ International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW)
	○ Legislation (Commonwealth)
	  ○ Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – *Interference with Other Rights*
	  ○ Navigation Act 2012 (Chapter 3 – Vessel Safety)
	  ○ Marine Order 3 (Seagoing Qualifications)
	  ○ Marine Order 27 (Safety of navigation and radio equipment)
	  ○ Marine Oder 30 (Prevention of Collisions)
	  ○ Marine Order 58 (Safe Management of Vessels).

Good Industry Practice	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing disturbance to other marine users to a level which is ALARP and acceptable by: • Liaising with third party stakeholders to advise of hazard and determine appropriate control requirements; • Continue to liaise with stakeholders on status of survey and agreed procedures. **IAGC:** The Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) objectives met for ensuring interruption to third party operations and equipment (Section 8.4 Travel – Water Travel).
Professional Judgement	Alternate controls identified and implemented where practicable. Controls adopted cover multiple levels on the control hierarchy.
Engineering Risk Assessment	Not Applicable – 'Risk Decision Framework Context' is Category A.

Cost Benefit Analysis	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The risk management strategy for third party vessel interference reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	Section 7 demonstrates PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). Controls raised by AMSA (**Stakeholder No: 12 Records**) regarding spatial conflict with commercial vessels have been included within the EP.
External Context: Environment	The survey area is in deep offshore waters coincident with the main shipping route from Investigator Strait to Cape Leeuwin.
Legislative criteria & standards	Compliant with the following legislation: • *Offshore Petroleum & Greenhouse Gas Storage Act 2006* Section 280 (Interference with other rights): *A person carrying on activities in an offshore area under an authority must carry on those activities in a manner that does not interfere with (a) navigation; or (b) fishing; or (c) the conservation of the resources of the sea and seabed; or (d) any activities of another person being lawfully carried on; or (e) the enjoyment of native title rights and interests; to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person*. Control measures adopted ensure that interference with navigation is reduced to levels which are as low as reasonably practicable. • *Navigation Act 2012* Marine Order 3 (Seagoing Qualifications) Marine Order 27 (Safety of navigation and radio equipment) Marine Oder 30 (Prevention of Collisions) Marine Order 58 (Safe Management of Vessels)
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	Western Eyre CMP: Socio-economic impacts will be contained (locally) within the survey area and Special Purpose/Multiple Use Zone (IUCN VI) of the Western Eyre CMR (where there is a spatial overlap). Impact does not conflict with prescriptions detailed in the South-west Marine Parks Network Management Plan 2018, and meets, the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*interference does not compromise diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*third party vessel and survey activities meet this requirement*).
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Support/escort vessel patrol for third-party vessels during survey	

Stakeholder consultation records (AMSA, AHS) Class certification for anti-collision and safety navigation equipment STCW (or equivalent) Certificates [Marine Crew] Vessel Log/Bridge Log Support vessel bridge radio logs Consultation records Closest point of approach (CPA) procedure

6.9 Risk: Disruption to commercial fishing (spatial conflict)

6.9.1 Hazard

The physical presence of survey vessels within the Duntroon OA may have an adverse effect on the operation of third-party fishing vessels also present in the area. As per commercial shipping, sea states routinely experienced in the area restricts small vessel activity (i.e. ocean-going only).

A review of fishing activity within the Duntroon OA identified that low levels of commercial and recreational fishing may occur within the OA.

This section deals with interference on a spatial basis. Risk associated with vessel collision and diesel spill is addressed in **Section 6.10** and impacts to commercial fishing 'catch' or 'disturbance' from the acoustic array operation are assessed in **Section 6.2**.

6.9.2 Known and potential risks

The known and potential risks of interaction with third party fishing vessels are:

- Damage to, or loss of, fishing equipment;
- Loss of commercial catch;
- Disruption to commercial fishing activities.

6.9.3 Evaluation of environmental risk

The Duntroon OA is located within seven (7) commonwealth and six (6) state fishing management areas. Information obtained from SARDI and ABARES (refer **Section 3.8.3**) and during consultation activities with fishery stakeholders (refer **Section 9**) has identified fisheries active in the Duntroon OA during the survey period. A summary of their exposure to spatial conflict is summarised in Table 6-68 (information has been extracted for Section 6.2.3.4, Table 6-30).

Key points to note from this analysis:

- Fishing effort and catch is very low in the Duntroon OA for both SA and Commonwealth fisheries. The Duntroon OA does not represent primary fishing grounds for any of these fisheries, there are no unique features attracting fish, fishing licences are nonexclusive and the OA is a considerable distance from ports (i.e. fishing is incidental).
- For SA fisheries, the Duntroon OA lies at the outer perimeter of the SA fisheries, (i.e. most fishing is landward of the survey area) does not contain any unique features attracting fish, fishing licences are nonexclusive and any relocation would be towards shorelines into areas of greater recorded catch. The OA does not block access to any fishing areas

Stakeholder Feedback:

All peak fishing bodies have been consulted with respect to the Duntroon survey. Most feedback from peak groups has been related to sound impacts from acoustic array operation upon commercial fishing stock. These aspects are addressed in **Section 6.2**. Feedback from the Rock Lobster Fishing Industry body (SARLAC) **[Stakeholder Record 4]** was concerned about displacement from fishing grounds and/or economic loss from the survey. Further data analysis has identified that the Duntroon OA does not spatially overlap this fishery and no displacement impacts are anticipated. This information has been provided to SARLAC with no response to date.

Table 6-68: Duntroon OA – Commercial and Recreational Fishery Summary (Spatial Conflict)

Fishery	Duntroon OA Presence			No of Vessels in OA	Estimated Catch Loss (max) (per month of fishing season) IF FISHED & IF SPATIAL CONFLICT CANNOT BE AVOIDED	OA in High Productivity Grounds	Consequence (per month)
	September	October	November				
Small Pelagic Fishery	X	X	X	1 (NSW)	NA	NO	NA
GAB Trawl Sector	X	✓	✓	5	17 t/mth [Flathead]	NO	3.1% Catch (SLIGHT)
GH&TS (Shark)	✓	✓	✓	5	5 t/mth	NO	0.31% Catch (SLIGHT)
GH&TS (Hook)	✓	✓	✓	5	1.0 t/mth [blue-eye trevalla] 1.1 t /mth [pink ling]	NO	0.36% Catch [SLIGHT] 0.37% Catch [SLIGHT]
Giant Crab	X	X	✓	2	0.26 t/mth	NO	1.9% Catch (SLIGHT)
Whiting	✓	✓	X	5	0.036 t/mth	NO	0.03% Catch (SLIGHT)
Snapper	✓	✓	X	5	0.038 t/mth	NO	0.02% Catch (SLIGHT)
Sardine	X	✓	✓	5	342 t/mth (spatial) 5 t/mth (actual)	NO	1.1% Catch (SLIGHT) 0.02% Catch (SLIGHT)
CBF	✓	✓	✓	5	184 Fish/mth	NO	0.4% Catch (SLIGHT)

The SBT Fishing Industry Body (ASBTIA) **[Stakeholder Record 6]** advises that survey operations should not proceed prior to April 1. ASBTIA's concerns relate to fish disturbance/displacement during the previous survey timeframe (March 15 – May 31). PGS has altered the survey timeframe to September 1 and November 30 which avoids any conflicts with the SBT fishing season (December to April) or SBT stock presence in the eastern GAB (refer also to **Section 6.2**).

Note that an assessment of behavioural impacts to fisheries as it relates to catchability from seismic activities is provided in Section 6.2.3.4. This section relates only to spatial conflict (exclusion) from fishing grounds.

Communication with a crab fisherman (**Stakeholder Record 72**) has identified a potential spatial conflict between fishing/survey activities in the April timeframe as the fisherman normally fishes in the Duntroon OA during that period. The Duntroon survey has been repositioned to between September to November which overlaps the fishery closure season. Crab fishermen have been advised of this altered timeframe. No feedback on any spatial conflicts within that timeframe have been received. .

Consultation feedback from GABIA **[Consultation Record 3]** identified that target demersal species took a downturn after the MC3D survey activity during 2015. The stakeholder has requested that no survey activity occurs in the period November 2017-April 2018 to manage potential impacts and risks to the fishery to ALARP and acceptable levels; and ensure operational timeframes do not impact on the activities of the GAB trawl fishery. The GAB trawl fishery area affected by the 2015 MSS activity was located close to or overlapped the primary HOB fishing zones for this fishery located between 126^{o}E and 133^{o}E. The Duntroon OA is not located in proximity to these HOB fishing grounds (~ 86 km distant) and spatial overlap with the Duntroon OA is limited to lower productivity grounds (i.e. shelf/slope areas to the west of the gulper shark closure). GABIA has not expressed concern with spatial overlap of fishing activity within the Duntroon OA nor any overlap in the OA, if fished during the revised timeframe of September 1 to November 30 2019 or 2020Notification and activity location awareness controls will be implemented to prevent spatial conflict from arising.

All other peak fishing groups contacted have either not responded or not been concerned with displacement/exclusion effects. PGS considers that this reflects the low levels of fishing effort within the Duntroon OA and the presence of more productive fishing grounds in other regions.

Managing interactions with fisheries in the Duntroon OA, if present, will be achieved by coordinating access to fishing areas prior to/ after the seismic vessel has surveyed an area. This also requires PGS to work with fishers during the survey and advise of the intended planned location of the survey vessel, on a certain frequency (e.g. 48 hrs) that allows the fishers to plan-ahead. Recognising common use rights of the marine environment and in accordance with the OPGGSA Section 280 (Interference with other rights), PGS will ensure that in carrying out the Duntroon survey activities, interference with fishermen will be to an extent that is necessary for the reasonable exercise of acquiring seismic data (i.e. controls to *minimise interference* are at ALARP).

<u>*Summary – SBT Fishery*</u>:

Consequence: As Duntroon survey now do not spatially overlap SBT operations in September to November, no impact is predicted to the SBT fishery (spatial or exclusion).

<u>*Summary – Other Fisheries (low level fishing):*</u>

Consequence: A summary of the potential impact associated with spatial conflict/exclusion is provided in Table 6-68. Impacts are assessed as slight based upon catch data (SLIGHT Consequence).

Likelihood Level: Without controls adopted it is possible spatial conflict/exclusion may be realised, however with controls adopted, and given the known low presence of fishing vessels in the Duntroon OA, the likelihood of displacement is assessed as highly unlikely (LOW risk).

<u>Commonwealth Recovery Plans:</u>

Commonwealth recovery plans do not apply to this social hazard.

6.9.4 Risk assessment

Table 6-13 provides the risk assessment for the potential disruption to commercial fishing vessels within the survey area from survey activities.

Table 6-69: Disruption to commercial fishing ERA

Aspect	Disruption (spatial/exclusion) to commercial fishing activities.
Impact Summary	Possible damage to fishing equipment, loss of catch and general disruption.
Extent of Impact	Localised around the survey vessel
Duration of Impact	Temporary (duration of the survey) and recoverable.
Level of Certainty of Impact	HIGH. Information is based upon consultation feedback and published literature
Fisheries affected within the environment	Commercial fisheries – giant crab, sardine fishery, gillnet hook and trap fishery, charter boat fishery, Marine Scalefish Fishery (Snapper, King George Whiting), GAB Trawl Sector. Note small pelagic fishery is not active in SA waters.
Risk Decision Framework Context	**A** (*The activity is a standard operation and well understood, it is not new to the area and good practice is well defined*). Risk assessment based upon LCS, GIP, PJ and input from fishing groups.

RISK WITH CONTROLS FAILURE (INHERENT)			
Potential disruption to Other Fisheries	CONSEQUENCE: SLIGHT	LIKELIHOOD: Possible	RISK: MEDIUM (3)

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	**CONTROL TYPE**	**PRACTICABLE AND IMPLEMENTABLE**	**JUSTIFICATION**
Adherence to the requirements of the Navigation Act 2012 and specifically Marine Order 30: Prevention of Collisions	Administrative	YES	Good Practice – well defined and established standard practice adopted by the Offshore Petroleum Industry
Issue of navigation warnings and notice to mariners of survey presence and towed array (and establishment of an exclusion zone around vessel).	Administrative	YES	
Support vessel available to manage vessel interactions	Administrative	YES	
Consult and inform fishery stakeholders of survey activity to minimise disruption/ displacement.	Administrative	YES	
Streamer deployment occurs off the shelf away from fishing areas to avoid any spatial conflicts	Eliminate	YES	Good Practice – well defined and established standard practice adopted by the Offshore Petroleum Industry
For SBT Fishery: Towed SBT Pontoons given right-of-way	Administrative	Not Applicable to Duntroon Survey timeframe	
For SBT Fishery: Source not activated and shut-down in proximity to towed pontoon	Administrative	Not Applicable to Duntroon Survey timeframe	

For SBT Fishery: Undertake deeper water survey (off shelf) while pontoons are present on the shelf	Isolate	Not Applicable to Duntroon Survey timeframe	
Fishing Compensation for Temporarily displaced/ damaged Fishing Equipment	Administrative	NO	The Duntroon OA does not represent primary fishing grounds for any of the fisheries present in the area. Peak Industry groups representing fisheries that are active within the Duntroon OA have either not responded or have not raised concerns regarding displacement impacts. On this basis, fishing compensation is not warranted.
Undertake survey outside key seasonal fishing periods.	Eliminate	YES	Based on this assessment, the shelf areas (where most fishing occurs) will be avoided during periods of upwelling and fisheries present during that period (i.e. sardine, crab, charter boat).
Seismic acquisition will only occur outside any fishing grounds	Eliminate	NO	The Duntroon OA overlaps fishing grounds within the OA. Not undertaking survey over this area would result in significant gaps in data and not meet the objectives of the survey and deliver client requirements.
Provide notice to fisheries of impending survey commencement (one and two months prior) to allow for fish harvest within the Duntroon OA prior to or after survey operations.	Administrative	Yes	Good Practice – well defined and established standard practice adopted by the Offshore Petroleum Industry
Provide daily updated forward plan and near real-time web-based seismic vessel positioning to inform fishing activities.	Administrative	Yes	Good Practice – well defined and established standard practice adopted by the Offshore Petroleum Industry

Risk with controls (residual)			
Potential disruption to Other Fisheries	CONSEQUENCE: SLIGHT	LIKELIHOOD: Highly Unlikely	RISK: LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**Measurement Criteria**
Controls identified for the prevention of commercial shipping spatial conflicts (refer Table 6-67*) also apply to commercial fishing activities and should be read in conjunction with this table.*		

EPO24: No unplanned interactions with marine users (fisheries). **MC:** Incident records verify zero incidents of unplanned interaction.	**EPS68**: Based upon consultation information received, fishing stakeholders which may be present in the area are clearly identified for continued liaison and information is provided to these stakeholders through the survey activities (refer **Section 9**). PGS will keep relevant fishing stakeholders updated on activities on following triggers (minimum requirements) (Season 1): • At least one month prior to survey commencement; • 5 days prior to streamer deployment; • At survey commencement; • Website updated for survey activity with 48 hrs look ahead (during survey); and • Survey completion (within 10 days). A longer-term forward plan and near real-time web-based seismic vessel positioning to inform fishing activities will be provided to fishermen if requested. All fishermen will be provided with this information.	Consultation and notification records verify these stakeholders have been informed of MSS activities throughout the survey period. Responsibility: PGS Vessel Manager
	EPS69: The survey vessel will deploy/ retrieve equipment off the continental shelf to avoid fisheries interaction (in water depths greater than 500m).	Vessel log verifies streamer deployment occurred in deep waters off continental shelf. Responsibility: Vessel Master

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking is considered broadly acceptable. The hazard will be managed for continuous improvement by application of good industry practice.
Hierarchy of Controls	*Controls presented in this section should be read in conjunction with controls stated in* Table 6-67 *for commercial shipping.* Eliminate: Streamer deployment occurs away from fishing areas to eliminate disruption. Survey activities will be undertaken in September to November (eliminating overlap with primary upwelling timeframe). Substitute: None identified Engineer: None identified Isolate: Survey utilises support/scout vessels to identify and warn fishermen of the hazard. Administrative: Stakeholder notification and updates serve as a reminder of the activity and its operational status. *It should be noted that the MSS area is not heavily fished by commercial operators (most fishing is inshore of survey area).*

Compliance with International Conventions, Legislation, Codes and Standards	Compliance with:
	○ International Conventions:
	  ○ International Regulations for Preventing Collisions at Sea 1972
	  ○ International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW)
	○ Legislation (Commonwealth)
	  ○ Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – *Interference with Other Rights*
	  ○ Navigation Act 2012 (Chapter 3 – Vessel Safety)
	  ○ Marine Order 3 (Seagoing Qualifications)
	  ○ Marine Order 27 (Safety of navigation and radio equipment)
	  ○ Marine Oder 30 (Prevention of Collisions)
	  ○ Marine Order 58 (Safe Management of Vessels).

Good Industry Practice	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing disturbance to other marine users to a level which is ALARP and acceptable by: • Liaising with third party stakeholders to advise of hazard and determine appropriate control requirements; • Continue to liaise with stakeholders on status of survey and agreed procedures. **IAGC:** The Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) objectives met for ensuring interruption to third party operations and equipment (Section 8.4 Travel – Water Travel).
Professional Judgement	Alternate controls identified and negotiated as far as possible with stakeholders to prevent displacement impacts. Difficulty in getting stakeholders to engage. . No feedback from other fisheries which have a low catch effort in the survey area. On this basis, PGS considers adopted controls for the fisheries present in the survey area to be ALARP.
Engineering Risk Assessment	Not applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis	Not applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The risk management strategy for commercial fishing interference reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	Section 7 demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for the survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). Concerns were raised by ASBTIA (**Stakeholder No: 6 Records**) regarding spatial conflicts and disruption to southern Bluefin tuna fishing if survey activities commence before April 1 during the previous Duntroon timeframe of March 15 to May 31. ASBTIA has been consulted on the altered timeframe (September 1 to November 30) and no feedback has been provided. PGS understand that the SBT fishing season commences in December and hence the survey activity does not temporally overlap the fishing season (i.e. no expected displacement effects). Concerns raised by SARLAC (**Stakeholder Record 4**) as to displacement effects associated with the NZRLF. Further data acquisition has identified that the NRLFZ is not present within the Duntroon OA. This information has been provided to SARLAC however no feedback response has been provided to date. Crab fisherman (**Stakeholder Record 72**) has identified that there is the potential for spatial conflict with Duntroon activities in April. These fishermen have been consulted on the revised survey timeframe and no feedback has been provided. It is to be noted that September and October lie in a period of fishery closure where crab fishing activities cannot be undertaken. SSIA (**Stakeholder Record 61**) identified shark fishermen that may fish within the survey area to determine if there was possible conflict with fishing/survey activities. Information has been provided to these fishermen, however no response has been received of potential conflicts.

External Context: Environment	The Duntroon OA is located in areas of low fishing effort and catch. The area does lie adjacent to inshore fisheries (located on the continental shelf) and within demersal fisheries (giant crab, GHaT and demersal trawl) fisheries which utilise the outer continental shelf/slope to gather stock.
Legislative criteria & standards	Legislative criteria as detailed in Table 6-67 for commercial shipping apply to this hazard. Note:
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices	Western Eyre CMP: Socio-economic impacts will be contained (locally) within the survey area and Multiple Use and Special Use Zones (IUCN VI) of the Western Eyre CMP in areas of spatial overlap. Impact does not conflict with the South-west Marine Parks Network Management Plan 2018 (DNP, 2018), and meets, the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*interference does not compromise diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*commercial fishing and survey activities meet this requirement*).
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Acceptability Statement:	Impacts to spatial conflict with fishermen during the Duntroon OA is considered acceptable, with controls implemented, based upon the following criteria: ○ No sound interference or spatial conflict to SBT fishing operations located on the continental shelf between December and April from Duntroon survey activities (ASTBIA – Stakeholder Record 6); ○ No displacement or economic loss to rock lobster fishermen with an established fishing history in the survey area due to acquisition activities (SARLAC – Stakeholder Record 4); ○ Arrangements are in place to notify fishermen of pending survey activities within the Duntroon OA to allow access to obtain fish stock prior to survey (if seasonal fish closures do not prevent access). ○ The Duntroon survey activity will not interfere with fishing to a greater extent than is necessary for the reasonable exercise of acquiring seismic (OPGGSA, S280 – Interference with other's rights). The Duntroon survey contains low level fishing which might be temporarily disrupted during the September-November period. Access to the fishing resources within the OA will be managed via effective communication prior, during and after the survey. Impacts to available fishing grounds are localised, temporary and completely recoverable.
Environmental Monitoring	
Support/escort vessel patrol for third-party vessels during survey	
Consultation records (including notifications) 48 hr "look-ahead" records Vessel logs/tracks MFO Observation Records Vessel logs	

6.10 Risk: Marine diesel spill (vessel collision)

6.10.1 Hazard

Marine diesel oil (MDO) or Marine gas oil (MGO) will be utilised as fuel in survey vessels during the Duntroon survey. Causal pathways which may lead to a significant MDO spills from survey activities include:

- **Hull damage** [*structural failure, loss of stability or flooding, fire*]: Vessels selected have appropriate class certifications, training and competencies of crew members and vessel maintenance standards.

  If the survey vessel is entering Australian waters, a safety audit is undertaken prior to mobilisation. If the vessel has been operating in Australian waters a safety audit must have been undertaken within 3 years, else a new audit is initiated. Given this selection process, vessels with integrity issues which might be prone to hull damage (failure) are essentially eliminated and vessel integrity is not seen as contributing significantly to the risk of hull damage. Conservatively, it has been assumed that should an event occur which leads to hull damage, the largest fuel tank volume might escape to the marine environment (refer *vessel collision* below).

- **Vessel Grounding** [*drift or powered*][113]: The Duntroon survey area is in water depths exceeding 100 m with the closest distance to the South Australian coastline of 51 km and to an offshore island is 10 km (Rocky (south) Island). No emergent reef systems lie within, or in proximity to, the Duntroon multi-client survey area.

  Given the distance from the nearest landfall, the risk of powered grounding is negligible. Additionally, it should be noted that the survey and support vessels have multiple independent propulsion systems (redundancy). In the scenario of loss of power, the support vessel is equipped, capable and prepared to tow the survey vessel. Given these multiple redundancies of systems, the lack of emergent reefs and the distance to landfall, drift grounding is not considered credible.

- **Vessel Collision (Intra-field Vessels):** Collision between two survey vessels with sufficient energy to result in a fuel tank rupture is not considered a likely scenario. While collisions have been recorded between these vessels, records identify that these events have resulted in hull damage with no damage severe enough to cause a tank rupture and subsequent oil spill.

  Where the survey vessel and support vessels are working in close proximity, activities are conducted a very low speed, only in safe sea-states and under strict control of the Vessel Masters. During normal seismic operations, the support vessels will be scouting the seismic line well in front and to one side of the seismic vessel not in the direct path of the vessel or the towed equipment. While the support vessel is more manoeuvrable than the survey vessel (due to streamer constraints), and can divert with increased speed, these activities are controlled, and it is not considered that the vessels would approach each other with sufficient speed to cause a collision resulting in an oil spill.

- **Vessel Collision (Large Third- Party Commercial Vessel):** A survey vessel collision with a third-party vessel travelling at speed (i.e. high energy) is considered a collision scenario which would have sufficient energy to damage a vessel's hull with the potential for a resultant fuel spill. AMSA has identified that a major shipping lane intersects the Duntroon survey area and commercial vessel traffic will be encountered in that area. As per Section 3.8.1 an average of 4^{+} heavy commercial vessels per day.

  Vessels to be used by PGS for the survey, such as the Ramform Sovereign, typically use MDO, MGO and Heavy Fuel Oil (HFO). The vessel utilised for the survey may utilise HFO during transit to Australia, however for survey activities will use MDO/MGO which is a light petroleum distillate and will undergo rapid dispersion and evaporation if spilt in the high energy GAB environment. No HFO will remain on the vessel for Duntroon survey activities.

[113] The probability of grounding from a location more than 4nm from the nearest coast or reef is negligible (DNV, 2011).

Details of the Ramform Sovereign's fuel storage tanks are provided in **Appendix C**. Fuel tanks are never filled to 100% capacity and normal practice is to fill to 90% capacity. Therefore, in the extremely unlikely (improbable) event of a ruptured fuel tank the maximum spill size possible would be in the order of ~ 850m^3 (largest fuel tank on the Ramform Sovereign). This will be used as the basis of the spill assessment. Should a vessel with a larger maximum fuel tank be utilised in the survey, a risk assessment will be undertaken to determine if there is an increase in environment which may be affected (EMBA) and therefore an increased risk not covered under the scope of this EP (refer to Section 7.8 for revision criteria).

It is to be noted that this spill volume is very conservative. In the event of a rupture of the vessel's largest MDO tank, the volume lost to the marine environment would be less than its whole volume as the leak would reduce to a level in the tank equivalent to the water line and emergency procedures would be initiated to reduce the volume in the tank and transfer contents to another tank on-board the vessel.

- **Refuelling:** Refuelling of the survey vessel will occur in offshore waters by support vessels and is a planned activity undertaken in suitable weather conditions and controlled by both vessel masters in accordance with approved bunkering procedures (refer **Appendix H**). This activity is a credible spill source although it would result in a much smaller spill volume that a high energy vessel collision.

  Causal pathways leading to those spills include hose breaks, coupling failures and tank over-fill. Spills resulting from overfilling are contained within the vessel drains and slops tank system. In the event the refuelling pipe is ruptured, the fuel bunkering activity will cease by turning off the pump; the fuel remaining in the transfer line will escape to the environment as well as fuel that was released prior to the transfer operation being stopped. Based on an expected pumping rate of 150 m^3/ hour and a conservative time of 15 minutes to shut down the pumping operation once the fuel spill had been identified, a total spill volume of approximately 37.5 m^3 is proposed as the worst case credible volume for a refuelling incident. This scenario and volume of fuel released was determined according to AMSA's technical guidance (AMSA, 2013).

  As the volume of 37.5 m^3 is smaller than the worst case credible 850 m^3 estimated for a vessel collision, it is considered that the impacts assessed in the following section also cover a fuel spill. However, to place this spill in context, based upon ADIOS modelling for average weather conditions expected in the survey area (15 knot wind speed, 15°C water temperature) a release of this size would dissipate with 12 hours. In addition, the maximum area a spill of this size would cover assuming no evaporation at a thickness of 10 µm, is approximately 1.8 km^2.

6.10.2 *Known and potential impacts*

The known and potential impacts of a MDO/MGO spill are:

- Temporary decreases to marine water quality;
- Injury or death to exposed marine fauna;
- Habitat damage where the spill reaches shorelines.

6.10.3 *Evaluation of environmental impacts*

MDO/MGO is a common marine fuel used in vessel engines and is a mixture of both low/semi-volatile compounds (95%) and persistent hydrocarbons (5%) and is classified as a Group II hydrocarbon (ITOPF, 2011). Physical properties of MDO/MGO are provided in Table 6-70.

Although classified as persistent, due to low viscosity diesel undergoes rapid spreading and evaporative loss particularly in high energy environments, such as eastern GAB waters, and slicks will quickly disperse/break-up. On this basis, the MDO is expected to evaporate rapidly, depending on the prevailing weather conditions, with further evaporation slowing over time. The heavier (low volatile) components of the fuel will tend to entrain in the upper water column due to wind-generated waves and may resurface if wind and waves abate. This residue would disperse and dilute in the marine environment until biodegradation occurs.

Given the high energy (wind and wave) that prevails in the Duntroon OA, MDO is expected to:

- Undergo rapid dispersion and evaporation; and
- Spread rapidly in the direction of the prevailing wind and current.

Diesels are considered to have a higher short-term aquatic toxicity when compared to many crude oils and condensates due to the solubility of the smaller-compound hydrocarbons present and their ease of entrainment/dispersion into the water column. Diesel spills on this basis may have a greater ecological impact in comparison to other floating oil slicks and are known to taint seafood. According to the International Maritime Organisation (IMO), diesel oil has a GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) rating of 3 for acute toxicity (damage to living organisms) and 4 for bioaccumulation/tainting (4 = high potential to bioaccumulate, 5 is the highest) (GESAMP,2002).

MDO contains very low concentrations of aromatic components. ADIOS (NOAA, 2013) identifies the following aromatic content for MGO/MDO:

- Boiling Point Range <180°C: 1.9mol% (MGO), 1.7mol% (MDO);
- Boiling Point Range (180-264°C): 1.1 mol% (MGO), 1.0mol% (MDO); and
- Boiling Point Range (265-380°C): 0.15 mol% (MGO), 0.1mol% (MDO).

Generally, for components with boiling points <180°C, evaporation will occur within a few hours, and for components between 180-264°C evaporation/dissolution will occur within one day (APASA, 2013). Accordingly, MGO/MDO after 24 hours has very little toxicity associated with aromatics in the weathered residue.

Diesel in the water column may adhere to fine-grained suspended sediments that can eventually settle on the seabed. Diesel spills that reach shorelines may penetrate shoreline sediments due to their low viscosity (i.e., rapid spread) of the oil and effect in-faunal organisms.

The physical properties of marine diesel limit the available spill response options which may be adopted to respond to a spill. Given the rapid spreading of the fuel, together with the evaporative loss, rapid slick break-up is expected. Spill response techniques such as containment and recovery and dispersant application are ineffective on these types of hydrocarbons (ITOPF, 2011).

An assessment of spill response options as it applies to the Duntroon survey is provided in Section 6.11.

Table 6-70: Fuel Properties (ITOPF, 2011)

Hydrocarbon	SG (@15°C)	Viscosity (cP@15°C)	Pour Point (°C)	Flash Point (°C)	API Gravity	Oil Persistence Category/ Classification
MGO	0.842	5.0 @15°C	-3	61.5	36.5	Group II (Light Persistent Oil)
MDO	0.829	4.0@25°C	-14	64.0	37.6	Group II (Light Persistent Oil)

6.10.3.1 *Predictive modelling – diesel spill*

For the proposed Duntroon survey, indicative modelling was undertaken using ADIOS2 (Automated Data Inquiry for oil spills) modelling software (NOAA, 2017).

AMSA's Technical Guidelines for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities indicates that an appropriate volume from a vessel collision on which to base modelling is the volume of the largest fuel tank (AMSA, 2015). For the Ramform Sovereign this volume is 850m^3. For this spill scenario, it has been conservatively assumed that this volume will be lost over 6 hours, however in reality this may occur over a considerable period of time (days). The ADIOS2 model assumed annual average sea surface temperatures for the area (16-18°C) given the survey period spans spring; and two wind speeds which represent lower wind conditions in the GAB (~ 9 knots or 4.6 m/s representing low hydrocarbon entrainment conditions) and mean wind conditions[114] (~ 15 knots or 8 m/s representing expected hydrocarbon entrainment conditions).

Surface oiling (oil spill budget) under these two different wind scenarios is provided in Table 6-58. Figure 6-19 provides oil remaining on the surface as a function of time for these two conditions. Distances travelled assume that a surface slick moves at 3% of wind speed and 100% current speed.

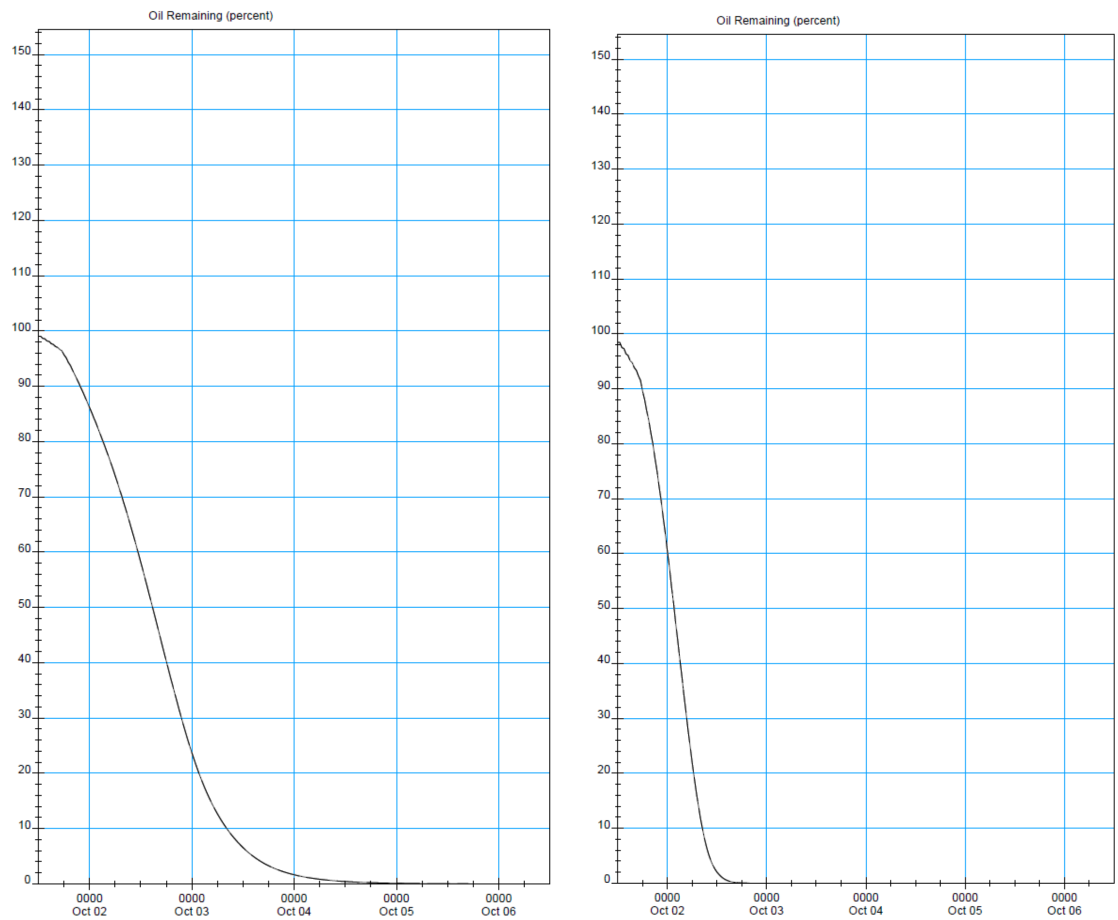
Table 6-71: ADIOS2 Oil spill Budget for 850 m^3 MDO spill (light and average wind conditions) (NOAA, 2017).

Light Wind Conditions				
Hours into Spill	**Released (m^3)**	**Evaporated %**	**Dispersed (%)**	**Remaining (%)**
1	142	1	0	99
2	283	1	0	99
4	567	2	0	98
6	850	3	1	96
8	850	5	1	94
10	850	7	2	91
12	850	9	4	87
14	850	11	6	83
16	850	13	8	79
22	850	18	17	65
28	850	23	29	48
34	850	26	43	30
40	850	28	55	17
48	850	30	64	6
60	850	30	68	2
72	850	30	70	0
Mean Wind Conditions				
Hours into Spill	**Released (m^3)**	**Evaporated %**	**Dispersed (%)**	**Remaining (%)**
1	142	1	0	98
2	283	2	1	97
4	567	3	2	95
6	850	4	4	92
8	850	7	9	84
10	850	9	16	75
12	850	12	25	64
14	850	14	35	51
16	850	16	47	38
24	850	18.5	78	3.5
30	850	19	81	0

[114] Mean wind speed at the Neptune Islands is approximately 28 km/hr (~15 knots) (BOM, 2018).

Figure 6-23: Predicted Residual surface oil under (a) low and (b) mean wind conditions (NOAA, 2017)

(a) (b)



Summary of Surface Oiling Results:

- *For light wind conditions*: Surface hydrocarbon will evaporate and disperse within 72 hours. Based upon average currents within the region for September to November (~0.3 m/s) (refer Figure 3-9) and 3% of light wind vector (9 knots or 0.14m/s) acting in the same direction, surface oiling may travel 114 km from the spill site. Based upon high current conditions (~0.6 m/s) and light wind conditions, surface oiling may travel 199 km from the spill site. *This defines the maximum extent of the visible surface oil footprint*.

- *For mean wind conditions*: Surface hydrocarbon will evaporate and disperse within 30 hours. Based upon average currents within the region for September to November (~0.3 m/s) (refer Figure 3-9) and 3% of mean wind vector (15 knots or 0.23m/s) acting in the same direction, surface oiling may travel 16 km from the spill site. Based upon high current conditions (~0.6 m/s) and mean wind conditions, surface oiling may travel 95 km from the spill site. *This defines the probable extent of the visible surface oil footprint*.

Currents within the Duntroon survey prevail in a WNW and ESE direction, parallel with the coastline. On this basis, the primary direction of any surface oil from a spill will align primarily along this axis (refer Figure 6-23) and if not influenced by wind direction, surface oils will not contact land. The wind component of the spill, for the period September to November does not have a predominant directionand is evenly distributed and may reach wind speeds of 24-30 knots (max) in September and lower maximum wind speeds of 18-24 knots in October/November. Thereis potential to direct surface oil to adjacent shorelines at a speed of 3% of the wind vector (or 1.5 km/hr). On this basis, for the closest receptor locations to the

Duntroon OA, Table 6-72 provides a summary of the time for surface spill residues to contact adjacent shorelines based on this maximum wind speed (conservative).

Table 6-72: Surface oil residues to nearest adjacent shorelines

Location	Distance and Direction from Duntroon OA (nearest boundary)	Time to intersect (hrs) (based upon 3% wind vector[115] in direction of coastline)
Rocky (Island) South	10 km NNE	6.7 hours
Four Hummocks Island	36 km ENE	24 hours
Liguanea Island	42 km NNE	28 hours
Sleaford Bay	60 km NNE	40 hours
Neptune Islands	47 km ENE	31.3 hours

Summary for Entrained Phase:

Maximum hydrocarbon entrainment occurs under high wind conditions. For the scenarios assessed, this would occur in the mean wind speed case where after 24 hours 78% of the spill (663 m^3) is predicted to disperse in the water column. The following is relevant to the movement of the entrained phase:

- Given the density differences between hydrocarbon and water, entrainment is expected to remain in the upper (~5m) of the water column; and
- Once entrained, oil movement is not influenced by wind and will move with the current (i.e. not towards shorelines).

Hydrocarbon Thresholds Utilised for Impact Assessment:

Table 6-73 provides details of the hydrocarbon thresholds adopted to assess potential effects of the MGO/MDO spill. This information is utilised in the impact assessment section.

Table 6-73: Diesel spill concentration thresholds for impact assessment purposes

Threshold	Supporting Literature
Sea Surface Oil	
LOW: 0.5 – 10 g/m^2 (0.5 – 10µm)	This threshold provides a measure of visual extent of an oil slick on the surface and while the threshold is not at a level which measures ecological impacts, it does define a threshold of 'community concern' particularly around high tourism areas. Threshold has been selected to define socio-economic impacts.
MODERATE: 10 - 25 g/m^2 (10 - 25µm)	This is the minimum thickness of oil that could impart a lethal dose to wildlife intersecting surface hydrocarbons. Research has shown that harm to seabirds through preening contaminated feathers or loss of thermal protection in their feathers occurs at 10µm to 25µm. Threshold has been selected to define ecological impacts.
HIGH: > 25 g/m^2 (> 25µm)	A concentration of surface oil greater than 25 g/m^2 is expected to be harmful to marine birds that come in contact with the slick. Marine birds may be affected should they come into direct contact with the hydrocarbon, and mortality may result from ingestion during preening, or from hypothermia from matted feathers.
Dissolved Aromatic Hydrocarbons	

[115] This is based on a maximum wind speed of 27 knots (refer wind roses contained in Figure 3-9) occurring in September. The 3% wind vector equates to 0.41m/s (or 1.5 km/hr). This assumes that the wind blows constantly from the SSW direction to intersect landfall for the calculated duration (conservative).

Threshold	Supporting Literature
LOW EXPOSURE (6 ppb – 96Hr LC_{50}): 576 ppb-hrs Very Sensitive Species (99% species protection)	McCay-French (2002) undertook a global review of available ecotoxicity data for multiple species across a wide taxonomic range to estimate the magnitude of toxicity effects to marine biota. This included 115 fish species, 129 crustacean species and 34 other invertebrate species which were predominantly derived from species at their most sensitive early life stages (i.e. eggs, larvae and juveniles). As early life stages are more sensitive than adults, results of the review represent conservative values. The outcomes of the review established lethal effects concentrations to fish and invertebrates (LC_{50}) from dissolved aromatic hydrocarbons over a period of 96hrs, under different environmental conditions. Concentrations varied from 6ppb to 400ppb with an average of 50ppb for Poly-aromatic Hydrocarbon (PAH) components. On this basis, LC_{50} values of 6ppb (99% species protection); 50ppb (95% species protection) and 400ppb (50% species protection) represent the range of exposures which could elicit a toxic response. *Note given the proportion of aromatics within MGO/MDO and their rapid removal from the marine environment, there is insufficient time in the marine environment for these effects to be realised.*
MODERATE EXPOSURE (50 ppb – 96Hr LC_{50}): 4,800 ppb-hrs Average sensitive species (95% species protection)	
HIGH EXPOSURE (400 ppb – 96Hr LC_{50}): 38,400 ppb-hrs Tolerant species (50% species protection)	
Entrained Hydrocarbons	
LOW EXPOSURE (7 ppb – 96Hr LC_{50}): 672 ppb-hrs Very Sensitive Species (99% species protection)	The Predicted No Effects Concentration (PNEC) (1% affected fraction) accords with the 'trigger value' of 7ppb (Total Petroleum Hydrocarbon (TPH)) (99% species protection) (ANZECC, 2000) derived by Tsvetnenko (1998). This acts as conservative estimate of TPH water quality criteria to protect aquatic biota at constant discharge rates to the environment.
MODERATE EXPOSURE (70.5 ppb – 96Hr LC_{50}): 6768 ppb-hrs Average sensitive species (95% species protection)	Scholten et al (1993; cited in Smit et al, 2008) undertook a review of No Observable Effects Concentrations (NOECs) for 26 marine organisms exposed to several types of oils. All test exposures focussed on whole-organism effects (reproduction, growth and survival) and test exposure times exceeded 7 days to represent chronic exposure of 17 marine species from five taxonomic groups. A species sensitivity distribution (SSD) curve was constructed based upon these chronic NOECs, and Predicted No Effects Concentration (PNEC) or Hazardous Concentration (HC5) of 70.5 ppb (THC) (95% species protection) and HC50 of 804ppb (50% species protection) were determined. The HC5 based upon chronic NOECs serves as the threshold for the protection of ecological structure, which is considered more sensitive than ecosystem functioning. As identified in OSPAR (2012), the HC5 (or PNEC) is considered the maximum continuous (chronic) concentration level for total hydrocarbons in Produced Formation Water discharges in the North Sea, one of the most concentrated areas in the world for oil and gas production. This 'threshold' approach is considered representative of 'weathered' entrained MDO/MGO in the water column, given the low level of aromatics within the fuels, the rapid evaporation of lighter ends on release (surface) and water-washing of entrained hydrocarbons within the marine environment in the first 24hrs. These effects levels may be observed in species when exposed to concentrations over 96 hrs.

Based on Table 6-73 thresholds, the EMBA for dissolved and entrained phases is as follows:

- Dissolved phase: Given the initial concentrations of aromatic components within diesel; the observed rapid weathering and reduction of aromatic content in MDO/MGO over 24 hours; and the dispersion present in the marine environment, concentrations of dissolved phase components will not remain for *sufficient* time (i.e. 96hrs) for any toxic impacts to be realised. Impacts associated with this phase are not considered further.
- Entrained phase: ADIOS2 modelling identifies at 24 hours that 78% of hydrocarbon may be entrained within the water column from a large spill. Exposure for 96 hrs to these entrained hydrocarbons may result in "effect" levels as described in Table 6-73. **Appendix G** provides the calculation basis for establishing the area affected by entrained hydrocarbons from diesel spills. To achieve a concentration of 70.5ppb (µg/kg) (i.e. PNEC for 95% species protection) within the upper 5m of the water column the spill would occupy a footprint of approximately 158,367 Ha which is equivalent to a 39.7 km x 39.7 km area. At 804 ppb (i.e. PNEC for 50% species protection) where effects may be felt by more tolerant species, the footprint is approximately 11.7 km x 11.7 km.

  The entrained phase will be affected by currents only (not wind unless resurfacing occurs). Regional currents move parallel to the shoreline in a predominantly in a WNW-ESE direction (refer Figure 3.9). Utilising average and maximum current data, the leading edge of the spill may travel between 52 km/day[116] parallel to the shelf-break and after 96 hrs the dispersed oil may travel up 208 km. Minor encroachment into coastal waters is possible depending on the movement of surface oil and the level of wind entrainment into the water column. Factors which decrease the entrained oil concentration over the 208 km distance not included in this assessment includes the time over which the leak occurs (i.e. leak is distributed on 6 hrs); further evaporative effects which occur post 24 hrs; and dispersion along the spill corridor due to minor cross currents (hence conservative). Entrained phase concentrations after 96 hrs are expected to be no greater than 208 km from the spill site running parallel to the shoreline. *This defines the oil spill entrained phase EMBA*.

Previous 'Lightning MSS' modelling:

Predictive modelling was undertaken for the Lightning MSS for a 300 m^3 MGO spill (over 6 hours) at the closest site[117] in the Lightning survey area to the mainland (providing worst case oil spill impacts to adjacent shorelines) for the period January to June. This period has similar prevailing current speeds and directions to the September to November period (refer Figure 3-12). While the spill volume within the Duntroon survey is larger, the extent of surface oiling is comparable and consistent with the results obtained in predictive modelling for the Lightning MSS for the smaller volume.

A summary of the Lightning MSS surface oiling results from predictive modelling is provided in Table 6-74 and plots of surface oiling probability at thresholds 0.5µm and 10 µm are provided in Figure 6-23 and Figure 6-24. Time for visible oil to contact adjacent shorelines within that modelling is provided in Table 6-75.

While the Lightning MSS results relates to a smaller spill volume, the distances of travel for various surface oil thicknesses (10 µm and 25 µm) have been used as indicative distances for the assessment of surface oil impacts.

The Lightning MSS report is provided in **Appendix J** for reference.

Table 6-74: Lightning MSS Predictive modelling – summary results (APASA, 2012)

Threshold	Predictive Modelling Results
Sea Surface Oil	
LOW: 0.5 - 10 g/m^2	• Maximum distance of 140 km to the northwest of the spill site. • > 5% of trajectories contacted up to 140 km northwest and south of the spill site. • > 5% of trajectories extended northeast towards islands located at the mouth of Spencer Gulf and Investigator Strait • 9% of trajectories contacted Northern and Southern Neptune Islands and the southeast tipe of Eyre Peninsula. No contact was made at any of these locations above 1µm. Visible hydrocarbons were predicted to not persist beyond 7 days.
MODERATE: 10 – 25 g/m^2	• Majority of exposures were within 10 km radius of the spill site • >5 % of trajectories extended a maximum distance of 31 km to the northwest. • Thicknesses of 10µm did not persist longer than 24 hrs
HIGH: > 25 g/m^2	Trajectories extended no more than 18 km to the south-southeast from the spill site.
Shoreline Oiling	
OIL STAIN/FILM: 10-100 g/m^2	No shoreline contact above 10 g/m^2.
OIL COAT: 100-1000 g/m^2	No shoreline contact above 100 g/m^2.
OIL COVER: > 1000 g/m^2	No shoreline contact > 1000 g/m^2.
Dissolved Aromatic Hydrocarbons	
LOW EXPOSURE (6 ppb – 96Hr	No zones above lowest threshold.

[116] This value is based upon a medium to high current scenario (0.6m/s) (September period) (refer Figure 3-9 and Appendix G for entrained phase calculation).

[117] The EPP-41/42 survey area has been moved northwards from this location in the Duntroon MSS.

Threshold	Predictive Modelling Results
LC_{50}): 576 ppb-hrs	
MODERATE EXPOSURE (50 ppb – 96Hr LC_{50}): 4,800 ppb-hrs	No zones above lowest threshold.
HIGH EXPOSURE (400 ppb – 96Hr LC_{50}): 38,400 ppb-hrs	No zones above lowest threshold.
Entrained Hydrocarbons	
LOW EXPOSURE (7 ppb – 96Hr LC_{50}): 672 ppb-hrs	Effects level footprint approx. 126 km x 126 km extending up to 208 km from the spill site.
MODERATE EXPOSURE (70.5 ppb – 96Hr LC_{50}): 6768 ppb-hrs	Effects level footprint approx. 39.7 km x 39.7 km extending up to 208 km from the spill site.
HIGH EXPOSURE (804 ppb – 96Hr LC_{50}): 77,184 ppb-hrs	Effects level footprint approx. 11.7 km x 11.7 km extending up to 208 km from the spill site.

Table 6-75: Lightning MSS - Summary of predicted shoreline contact to various mainland and island coastlines. Results were calculated for a 300 m^3 release over 6 hrs following a spill (APASA, 2012)

Location	Minimum Time (days) [Hours] before shoreline contact above 0.5 µm	Probability (%) of shoreline contact above 0.5 µm	Probability (%) of shoreline contact above 1.0 µm
Eyre Peninsula – Lincoln National Park	3.6 [85]	1	-
Northern Neptune Islands Conservation Park	1.5 [37]	1	-
Southern Neptune Islands Conservation Park	1.4 [33]	1	-
William Island	-	-	-
Thistle Island	-	-	-
Wedge Island	-	-	-
Yorke Peninsula	-	-	-
Kangaroo Island	-	-	-

Figure 6-24: Map showing the **probability of sea surface exposure** (reported to **0.5 g/m²**), in the event of a 300 m^3 in predictive trajectories modelled, for **January to June** wind and current conditions (APASA, 2012)

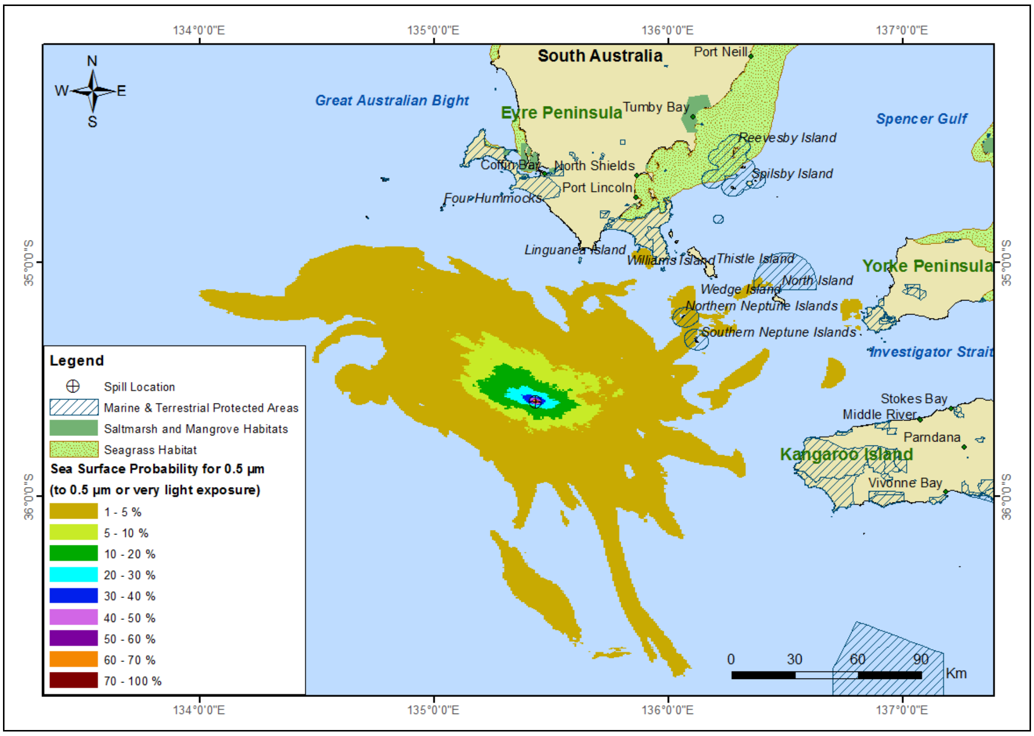
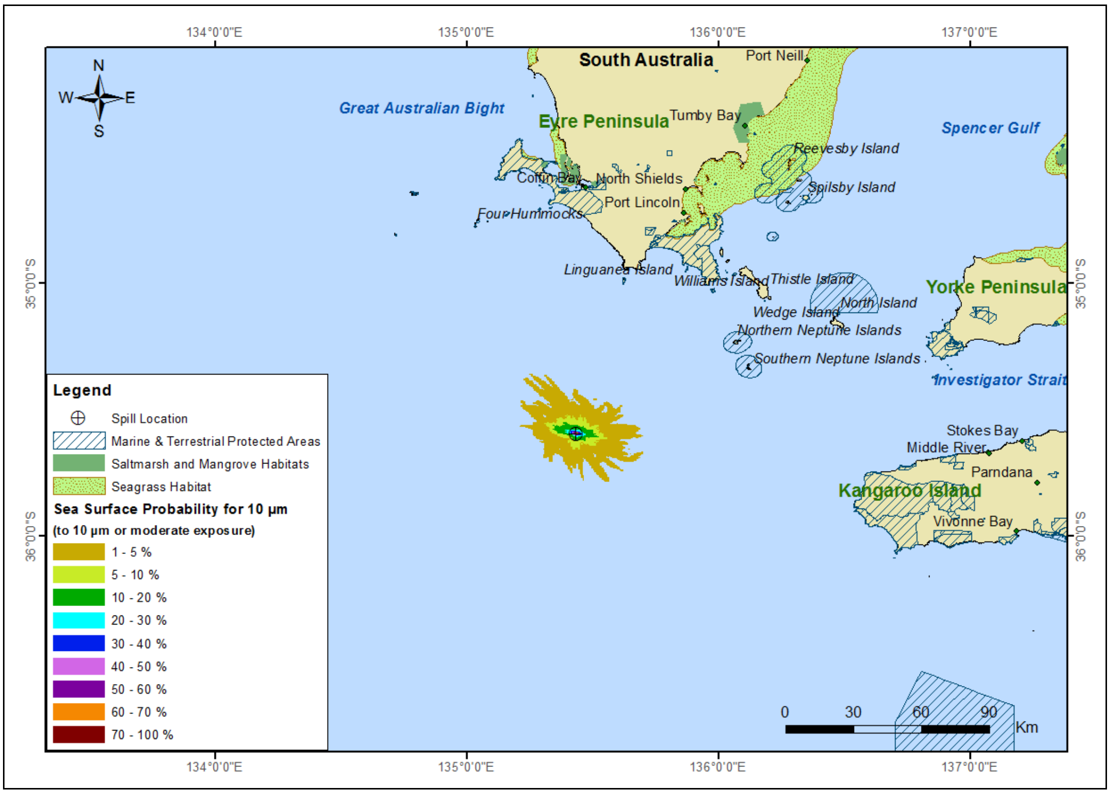


Figure 6-25: Map showing the **probability of sea surface exposure** (reported to **10 g/m²**), in the event of a 300 m³ release of diesel over 6 hours. The output is calculated for each grid cell and provides a summary from 200 spill trajectories modelled, for **January to June** wind and current conditions (APASA, 2012)



6.10.3.2 *Environmental and Social Impact of Spill*

The exposure to environmental sensitivities within the Duntroon EMBA for a significant oil spill is summarised in Table 6-76. An assessment of possible impacts is provided in Table 6-77 (marine) and Table 6-78 (shoreline).

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Table 6-76: Summary of receptors and locations within the Duntroon multi-client survey (based upon 850m^3 MGO/MDO spill during survey period September to November)

ENVRONMENTAL RECEPTOR (for State marine reserves, this includes adjacent coastline resources)	Distance from nearest Duntroon OA (Time to Impact (hrs)) Time to impact calculated on following basis: Locations (*east/west and survey area aligned with prevailing current*) based upon high current speed (0.6 m/s). Locations (*NE/NNE/ENE and not aligned with prevailing current*) based upon 3% wind vector speed (1.5km/hr)	MARINE RECEPTORS													SHORELINE														PREDICTED HYDROCARBON IMPACT				
		HABITAT	ECOLOGICAL									SOCIOECONOMIC			ECOLOGICAL				HABITATS			SOCIOECONOMIC											
		Marine Open Water	Cetaceans	Seals/Sea Lion (Foraging)	Turtles	Seabirds (EPBC-listed)	Other Birds	EPBC Protected Sharks & Rays/Fish	Other Fish Species (e.g. Small Pelagic)	Sub-tidal Invertebrates	Plankton	Commercial Shipping	Commercial Fishing	Charter Operators	Sea Lion/Seal Colonies	Shoreline / Seabird Bird Colonies	Macrophytes / seagrass	Saltmarsh/Mangrove	Sand Beaches	Inter-tidal & Sub-tidal Reef	Inter-tidal Rocky Platforms / Cliffs	Coastal Shipwrecks/ European Heritage	Aboriginal Heritage	Water-sports (Diving, Swimming, Surfing)	Tourism (Landscapes, NP)	Recreational Fishing	Aquaculture	Charter-boars (ecotourism)	Surface Hydrocarbons (>0.5µm)	Surface Hydrocarbons(>10µm) (Ecological)	Entrained Hydrocarbon (>70ppb x 96hrs)	Entrained Hydrocarbon (<70.5ppb x 96hrs)	Shoreline Loading >100g/m^2
MARINE ENVIRONMENT																																	
Australian Whale Sanctuary	Coincident (0 hrs)	X	X	X	X	X	X	X	X	X	X	X	X	X															X	X	X		
Western Eyre CMP	Coincident (0 hrs)	X	X	X		X	X	X	X	X	X	X	X																X	X	X		
West. Kangaroo Island CMP	47 km east (22 hrs)	X	X	X		X	X	X			X	X																	X		X		
Southern Kangaroo Island CMP	155 km east (72 hrs)	X	X	X				X			X	X																	X		X		
Great Australian Bight CMP	130 km west (60 hrs)	X	X	X		X		X		X		X																	X		X		
Murray CMP	126 km SE (58 hrs)	X	X	X		X				X																			X		X		
Neptune Island Marine Park (SA)	45 km ENE (30 hrs)	X	X	X		X	X	X	X	X	X		X	X	X	X	X			X	X	X		X		X		X	X			X	
West. Kangaroo Island Marine Park (SA)	60 km east (28 hrs)	X	X	X		X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X		X	X		X		
Thorny Passage Marine Park (SA) (coastline)	60 km NE (40 hrs)	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X [118]	X	X[119]	X	X	X	X	X	X	X[120]	X	X	X[121]	X		
Investigator Marine Park (SA)	97 km NNE (65 hrs)	X	X	X		X	X	X	X	X			X	X	X	X	X		X	X	X	X	X	X	X	X		X	X			X	
Sir Joseph Banks Group Marine Park (SA)	85 km NE (56 hrs)	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			X	
Gambier Island Group Marine Park (SA)	85 km ENE (57 hrs)	X	X	X		X	X	X	X				X	X		X	X		X	X	X	X		X	X	X		X	X			X	
South Spencer Gulf Marine Park (SA)	115 km ENE (76 hrs)	X	X	X		X	X	X	X	X			X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X			X	
South Kangaroo Island Marine Park (SA)	157 km east (73 hrs)	X	X	X		X	X	X	X	X			X	X	X	X	X		X	X	X	X	X	X	X	X			X			X	
Key Ecological Features																																	
Ancient Coastline (90-120m water depth)	Coincident (0 hrs)	X							X	X		X	X																X	X	X		
Kangaroo Island Pool, canyons and adjacent shelf-break & Eyre peninsula upwelling	Adjacent/Coincident (0 hrs)	X	X	X		X	X	X	X		X	X	X																X	X	X		
Meso-scale eddies	Adjacent (0 hrs)	X	X	X				X	X		X	X	X																X	X	X		
Benthic Invertebrates of the eastern GAB	Coincident (0hrs)	X								X																			X	X	X		
Small pelagic fish of SW region	Coincident (0hrs)	X							X			X	X																X	X	X		
Shelf Rocky reefs and hard Substrates	~170 km SE (79 hrs)	X							X	X																							
TERRESTRIAL ENVIRONMENT																																	
Memory Cove Wilderness Protection Area	61 km NE (41 hrs)														X	X			X		X	X	X						X		X		
Lincoln National Park	57 km NNE (38 hours)														X	X			X		X			X	X	X			X		X		
Tumby Bay Conservation Park	119 km NE (80 hrs)															X					X								X			X	
Flinders Chase National Park	100 km east (46 hrs)														X	X					X		X		X				X		X		
Cape Grantheaume Conservation Park	170 km east (79 hrs)														X	X															X		

118 Saltmarsh present in Coffin Bay

119 Reefs occur at Coffin Bay, near Williams Island, and Cape Catastorphe. Greenly, Four Hummocks and Rocky Islands are fringed by Reef

120 Oyster cultivation is located at Coffin Bay.

121 Spill thresholds < 10 µm predicted for Rocky (south) Island, Greenly and Four Hummocks Islands only. Mainland portions of Thorny Passage MP are approximately 60 km from nearest OA boundary.

ENVRONMENTAL RECEPTOR (for State marine reserves, this includes adjacent coastline resources)	Distance from nearest Duntroon OA (Time to Impact (hrs)) Time to impact calculated on following basis: Locations (*east/west and survey area aligned with prevailing current*) based upon high current speed (0.6 m/s). Locations (*NE/NNE/ENE and not aligned with prevailing current*) based upon 3% wind vector speed (1.5km/hr)	MARINE RECEPTORS													SHORELINE														PREDICTED HYDROCARBON IMPACT				
		HABITAT	ECOLOGICAL									SOCIOECONOMIC			ECOLOGICAL				HABITATS			SOCIOECONOMIC											
		Marine Open Water	Cetaceans	Seals/Sea Lion (Foraging)	Turtles	Seabirds (EPBC-listed)	Other Birds	EPBC Protected Sharks & Rays/Fish	Other Fish Species (e.g. Small Pelagic)	Sub-tidal Invertebrates	Plankton	Commercial Shipping	Commercial Fishing	Charter Operators	Sea Lion/Seal Colonies	Shoreline / Seabird Bird Colonies	Macrophytes / seagrass	Saltmarsh/Mangrove	Sand Beaches	Inter-tidal & Sub-tidal Reef	Inter-tidal Rocky Platforms / Cliffs	Coastal Shipwrecks/ European Heritage	Aboriginal Heritage	Water-sports (Diving, Swimming, Surfing)	Tourism (Landscapes, NP)	Recreational Fishing	Aquaculture	Charter-boars (ecotourism)	Surface Hydrocarbons (>0.5µm)	Surface Hydrocarbons(>10µm) (Ecological)	Entrained Hydrocarbon (>70ppb x 96hrs)	Entrained Hydrocarbon (<70.5ppb x 96hrs)	Shoreline Loading >100g/m^2
Vivonne Bay Conservation Park	160 km east (74 hrs)															X													X		X		
Cape Torrens and Western River Wilderness Area	109 km east (50 hrs)															X					X	X	X						X		X		
Innes National Park	115 km east (53 hrs)														X	X			X		X		X	X	X	X			X		X		
Locations within Investigator MP:																																	
Topgallent Is	109 km NNE (73 hrs)																X			X	X								X			X	
Ward Is	95 km N (63 hrs)																			X	X								X			X	
Flinders Is	98 km NNE (65 hrs)																X			X									X			X	
Pearson Is	73 km N (49 hrs)														X		X		X	X	X								X			X	
Waldegrave Islands CP	125 km NE (83 hrs)														X	X			X		X								X			X	
Cap Island CP	115 km NE (77 hrs)														X	X					X								X			X	
Locations within Thorny Passage MP:																																	
Coffin Bay	75 km ENE (50 hrs)														X	X	X		X	X	X						X		X			X	
Greenly Is CP	28 km NNE (19 hrs)														X		X			X	X		X		X				X	X	X		
Rocky island (South) CP	10 km NNE (6.6 hrs)														X		X			X	X								X	X	X		
Four Hummocks Island	36 km ENE (24hrs)														X		X			X									X	X	X		
Whidbey Is	48 km ENE (32 hrs)														X						X								X		X		
Liguanea Is	43 km N (29 hrs)														X														X		X		
Other Locations within MPs:																																	
Rocky (North) Island CP	90 km NE (60 hrs)														X	X					X								X			X	
Dangerous Reef (part Sir Joseph Banks Group NP & CP)	86 km NE (57 hrs)														X		X	X	X	X					X	X		X	X			X	
Wedge Is (Part of Gambier Island Group MP & CP)	86 km ENE (57 hrs)														X	X	X		X	X	X								X			X	

Table 6-77: Potential Impacts of surface and entrained diesel to environmental sensitivities (marine)

<table>
<tr><th rowspan="2">Receptor</th><th rowspan="2">Proximity to potential source of spill</th><th colspan="2">Potential Impact</th></tr>
<tr><th>Surface Marine Diesel</th><th>Entrained Marine Diesel</th></tr>
<tr><td colspan="4">Marine Fauna</td></tr>
<tr><td rowspan="2">Cetaceans</td><td rowspan="2">Coincident & adjacent</td><td colspan="2">Marine mammals are generally able to metabolise and excrete limited amounts of hydrocarbons, but acute or chronic exposure poses greater toxicological risks. Such impacts may include changes in behaviour and reduced activity, including inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci, 1990).
The Dunroon OA has the following cetacean presence:
• Area overlaps a BIA for the pygmy blue whale (foraging – abundant food source) (krill). Blue whale presence is from November to April. Survey timeframe (September to November) predominantly avoids temporal overlap with species . Sei and fin whales are recorded as having a similar presence.
• Area overlaps a BIA for the sperm whale (foraging). The sperm whales is present year-round however peak presence is identified as August to September. Species feeds on cephalopods.
• Area overlaps migratory pathways for the southern right whale which is present on the Australian coastline between May and October. No foraging is recorded for this species in Australia waters.
• Thirty other cetaceans species have been identified as possibly transiting the survey area. These species are described in Section 3.7.5.</td></tr>
<tr><td>Direct surface oil contact appears to have little deleterious effect on whales, possibly due to the skin's effectiveness as a barrier to toxicity. As cetaceans have mostly smooth skins and limited areas of pelage, there is limited opportunity for oil adhesion to the species as oil tends to adhere to rough surfaces. However the species may be impacted by surface oil exposure during surfacing events leading to aspiration hazards which are present in fresh spills (GESAMP, 2002). Such exposure could damage mucous membranes or damage airways during surfacing (AMSA, 2011b).
Baleen whales which skim the sea surface for food are more likely to ingest oil compared with the 'gulp feeders' or toothed cetaceans (AMSA, 2011b). Studies have identified that oil exposure through ingestion of tar-like residues may temporarily inhibit foraging baleen whales however for light/medium oils this inhibition is only predicted to occurred for 40 seconds, heavy oils for up to 15 minutes with total clearance of residues within 15-20 hrs (ECOS, 2001). As refined products, such as diesel, are not very sticky or viscous compared with black oils (some crude oils and heavy fuel oils) adhesion to baleen plates is not likely (AMSA, 2011b).
There were some reports of declines in health of individual pods of killer whales though not to the population as a whole in Prince William Sound after the Exxon Valdez spill (Matkin et al, 2008 in Hook et al, 2016).
French-McCay (2009) identifies a 10-25µm oil thickness threshold has the potential to impart a lethal does to intersecting wildlife and estimates a probability of 0.1% mortality to cetacean species if they encounter these thresholds based on the proportion of time spent at surface.</td><td>As described for surface oil, acute or chronic exposure, through skin contact, inhalation or ingestion can result in toxicological risks. However, the concentration of entrained hydrocarbons will be less in comparison to surface slicks, due to the effects of dilution with sea water. This combined with a thick epidermis layer means cetaceans are unlikely to be affected greatly from skin contact with entrained hydrocarbons. Further, inhalation of entrained hydrocarbons is not a significant exposure pathway. However, entrained oil can be ingested during feeding, in particular by gulp feeding whales.</td></tr>
</table>

Receptor	Proximity to potential source of spill	Potential Impact	
		Surface Marine Diesel	Entrained Marine Diesel
Cetaceans (Con't)	Coincident & adjacent	Implication for the Survey (Impact Assessment): • Baleen whales (blue, sei, fin) may encounter a diesel spill given the BIA overlap. Baleen whale foraging typically occurs as an individual or in groups of two. However, controls in place to identify the presence of blue (& associated) whales and halt survey activities if present in proximity to survey activities will limit temporal overlap of survey and foraging activities. In addition, given the limited area at ecological levels (~10km from spill site) and period where a diesel spill may be at thicknesses which are considered harmful (<24 hrs) it is possible that individual whales may be affected, however this is not considered significant at a population level. • Foraging odontocetes are considered less likely to ingest surface or entrained hydrocarbons as they obtain their prey from deeper pelagic waters. Given this, , impacts are not considered as great to this species type, and not significant at a population level. • Migrating baleen whales (e.g. southern right whale), which migrate in individuals/pairs, may encounter surface oils during surfacing, while traversing from the coastline. From the above assessment, it is considered that impacts to whale species present in the survey area, based upon foraging impacts, is MINOR – *Minor and temporary disruption to small portion of the population. No effects on critical habitats/activities.*	
Marine Turtles	Coincident & adjacent	The EPBC Protected matters database identified three marine turtles species as potentially present in the survey area. Two of these species a very unlikely to be present given their tropical habitat preferences. Marine turtles are vulnerable to the effects of hydrocarbon spills at all life stages (eggs, post hatchlings, juveniles and adults) while in the water or onshore (NOAA, 2010). There are no feeding, nesting or breeding areas within the survey area and wider environment. No BIAs for turtles are identified in the survey area.	
		The pathways for exposure include ingestion and inhalation of vapours. The effects of hydrocarbons on marine turtles include toxicity leading to significant changes in blood chemistry, irritation of eyes and mouth and potential digestive related illness. Contact with hydrocarbons can have lethal or sub-lethal effects or may impair mobility. Similar to cetaceans, turtles through surfacing activities may contact a surface slick which may coat the species and allow for inhalation exposure. On contact with the slick, turtles may experience skin irritation and injury to airways or lungs, eyes and mucous membranes of the mouth and nasal cavities (AMSA, 2011b). Sea turtles' diving behaviour also puts them at risk. They rapidly inhale a large volume of air before diving and continually resurface over time, therefore turtles in an oil spill would experience both extended physical exposure to the oil and prolonged exposure to hydrocarbon vapours. Evidence from the Montara crude oil spill, identified that turtles also exhibit severe dermal pathologies (particularly in the softer skin of the neck) through surfacing behaviour (Gagnon, 2010). A stress response associated with this exposure pathway includes an increase in the production of white blood cells, and even a short exposure to hydrocarbons, such as crude oil, may affect the functioning of their salt gland (Lutcavage *et al*., 1995). Turtles are also prone to ingestion of surface oil particularly when it forms solid masses such as tarballs. Adult sea turtles spend 1-10% of their time at the surface with each dive lasting between 30-70 minutes (French-McCay, 2009). French-McCay (2009) identified that a 10-25µm oil thickness has the potential to impart a lethal dose to intersecting wildlife and estimates a probability of 5% mortality to turtle species, if they encounter surface oil more than 10µm thick, based on the proportion of the time turtles spend at surface.	Entrained oil presents fewer impacts to turtles. While skin contact with entrained oil may occur, the entrained hydrocarbons will be at lower concentrations, due to dilution with water in the water column, and oiling effects to the skin are not expected to be significant. Small quantities of hydrocarbons may be ingested, but concentrations, and resulting toxicity, will be less than surface oil. Further, the impacts of inhaling hydrocarbon vapours are not applicable to entrained oil.

<table>
<tr><th rowspan="2">Receptor</th><th rowspan="2">Proximity to potential source of spill</th><th colspan="2">Potential Impact</th></tr>
<tr><th>Surface Marine Diesel</th><th>Entrained Marine Diesel</th></tr>
<tr><td>Marine Turtles (Con't)</td><td>Coincident & adjacent</td><td colspan="2">Implication for the Survey (Impact Assessment):
Marine turtles may be present in offshore open waters however, the Duntroon OA is not a recognised BIA and they are likely to occur in low numbers. Exposure may range from no effect to injury to airways, lungs, eyes or mucus membranes. Given the rapid evaporation of diesel, the limited time and spatial area of the surface diesel slick at 10 µm, it is expected that only individual turtles may be affected. No population level impacts are expected.
From the above assessment, it is considered that impacts to turtle species present in the survey area is MINOR – 'Minor and temporary disruption to small portion of the population.No effects on critical habitats/activities'.</td></tr>
<tr><td rowspan="3">Pinnipeds (Foraging)</td><td rowspan="3">Coincident & adjacent</td><td colspan="2">The Australian sea lion and New Zealand fur seal forage within the survey area. The OA overlaps a portion of the BIA (foraging) for the male Australian sea lion. The closest breeding area for the NZ fur seal and a small population of sea lions is located at Rocky (south) Island (approx. 10 km NNE of the nearest survey boundary) and a haulout is located at Greenly Island (28 km NNE). The EMBA defined by the 10 µm surface oiling contour may contact Rocky (south) Island.
Both sea lions and fur seals are expected to be present foraging within, and adjacent to, the Duntroon OA.</td></tr>
<tr><td>Fur seals are vulnerable to oil as a result of oil adhering to fur. Heavy oil coating and tar deposits on fur seals may result in reduced swimming ability and lack of mobility out of the water (AMSA, 2014). Oil residues can 'stick' flippers to fur seal bodies preventing escape from predators and may disguise scent that seal pups and mothers rely upon to identify each other which may lead to pup abandonment and starvation.
Ingestion of oil may damage digestive tracts, suppress immune systems or damage mucous membranes (AMSA, 2014). Fur seals possess only a thin subcutaneous fat layer instead having a thick pelage that thermally insulates the animal (NOAA, 2006a) and can suffer from hypothermia when oiled.
Surfacing in fresh oil slicks can also have sub-lethal impacts on sensitive tissues (e.g. mucous membranes around eyes and nasal cavities) leading to corneal abrasions, conjunctivitis and ulcers (AMSA, 2014). It is also possible for hydrocarbon accumulation in fatty tissues due to the ingestion of contaminated prey (Brady et al. 2002). French-McCay (2009) estimates encounter with a 10-25 µm oil thickness carries a 75% probability of mortality to the species based upon the proportion of time the species spends at the sea surface.</td><td>Entrained oil presents fewer impacts to pinnipeds. While fur contact with entrained oil may occur, the entrained hydrocarbons will be at lower concentrations, due to dilution with water in the water column, and oiling effects to the fur not expected to be significant.
Pinnipeds are 'gulp feeders' and as such will ingest water during prey capture. Prey items consist of cephalopods and small fish, taken in water depths between 20-200 m. Entrained phase diesel within the upper water column is unlikely to impact on the species during foraging activities as the species is a benthic forager with food sources likely to be unaffected by entrained oil concentrations.</td></tr>
<tr><td colspan="2">Implication for the Survey (Impact Assessment):
Foraging pinnipeds are expected to be present in offshore open waters during the survey. Exposure may range from no effect to corneal abrasions, conjunctivitis and ulcers or oiling of fur. Given the rapid evaporation of diesel, the limited time (~24hrs) and spatial area (~31km from spill site) of the surface diesel slick at 10µm it is expected that that if present in the area, individual pinnipeds may be affected however no population level impacts would be expected.
From the above assessment, it is considered that impacts to pinniped species present in the survey area is MODERATE – 'Minor disruption to small portion of the population. Minor, temporary effects on critical habitats/activities. No threat to population viability'.</td></tr>
<tr><td>Seabirds</td><td>Coincident & adjacent</td><td colspan="2">A number of threatened, migratory albatross, petrel, shearwater and Caspian tern species, may overfly and forage within the Duntroon OA. There is overlap of the survey area with foraging BIAs for the short-tailed shearwater, Pacific Gull, Caspian tern (adjacent to OA), Australian fairy tern (adjacent to OA) and a number of additional species such as albatross and petrels. As the survey is located at least 50 km from the coastline, no nesting areas have been identified near the OA.
A number of listed marine bird species also may use the OA for foraging purposes. These species have been described in Section 3.7.8.</td></tr>
</table>

Receptor	Proximity to potential source of spill	Potential Impact	
		Surface Marine Diesel	Entrained Marine Diesel
Seabirds (Con't)	Coincident & adjacent	Pathways of hydrocarbon exposure such as immersion or oil ingestion can result in lethal and sub-lethal impacts in this species. Seabirds are particularly vulnerable to hydrocarbon spills owing to their high potential for contact at the sea surface where they feed or rest. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds. Ingestion of oil can be sub-lethal or acute depending on the type of oil, its weathering stage and inherent toxicity. This can occur directly when preening or by consuming contaminated prey. Effects may include tissue and organ damage, altered metabolism, pneumonia and reduced reproduction capability (AMSA, 2014). Exposure to hydrocarbons may have longer term effects, with impacts to population numbers due to decline in reproductive performance and malformed eggs and chicks, affecting survivorship and loss of adult birds. Direct contact with surface hydrocarbons can lead to irritation of skin and eyes. Oil-coated birds can suffer hypothermia, dehydration, drowning and starvation, and become easy prey. Smothering of feathers can also lead to excessive preening, diverting time away from other behaviours leading to starvation and dehydration. Preening of oiled feathers will also result in to ingestion of hydrocarbons and the associated impacts of toxicity and potential illness. The minimum threshold of oil predicted to result in harm to seabirds has been estimated by different researchers to lie between 10µm and 25µm (French et al, 1999). French-McCay (2009) identifies that a 10-25µm oil thickness has the potential to impart a lethal dose to intersecting wildlife and estimates a probability of 5% mortality to aerial divers such as albatross and petrel species if they encounter surface oil more than 10µm thick, given they overfly habitat most of the time and dive occasionally.	Seabirds may encounter entrained hydrocarbons leading to irritation of skin and eyes, and also lower levels via ingestion and the associated toxicity effects. Entrained oil does not pose the same risk as surface slicks with respect to smothering of feathers and subsequent ingestion during preening. Entrained oil within the upper water column are expected to be low in concentration and not expected to impact either the birds or the pelagic fish, a food source for migratory bird species, given the fish are extremely mobile in the marine environment (refer *fish impacts*).
		Implication for the Survey (Impact Assessment): Seabirds are expected to be present in offshore open waters during the Duntroon multi-client survey. Exposure may range from no effect to complete coating of the animal (leading to death). Given the rapid evaporation of diesel, the limited time and spatial area of the surface diesel slick at 10µm it is expected that individual birds may be affected (significant impact), however given the number of birds exposed, no population level impacts are expected. From the above assessment, it is considered that impacts to bird species present in the survey area is MODERATE – 'Minor disruption to small portion of the population. Minor, temporary effects on critical habitats. No threat to population viability'.	
Fish (including Sharks)	Coincident & adjacent	A number of EPBC-listed fish species are recorded as being present in the survey area. This includes the threatened white shark which is known to have a transitory presence in the survey area as it moves to seasonal feeding ground around pinniped colonies, the migratory porbeagle and shortfin mako. The survey area has a minor overlap with the BIA (foraging) for the white shark. A number of commercial fish species are also present in or in continental shelf waters adjacent to the survey area. These are described in **Section 3.7.4**.	

Receptor	Proximity to potential source of spill	Potential Impact	
		Surface Marine Diesel	Entrained Marine Diesel
Fish (including Sharks) (Con't)	Coincident & adjacent	Sharks are not as well studied from a toxicological standpoint as bony fish so impacts of oil exposure are largely unknown. Large sharks may be exposed to oil via transport of material across the gills or skin or ingestion of contaminated food items. Large fish have been known to avoid oiled areas, but it is not known whether sharks have the same behaviour (Hook et al, 2016). In the open ocean, most pelagic species are highly mobile and demersal fish live relatively deep in the water column and are unlikely to contact surface spills. Fish and sharks do not generally break the sea surface however it is possible that individuals may feed at the surface. Given the limited period a diesel slick is present after a spill, its limited areal extent and the low frequency of breaches at the surface, impacts to fish and shark species by ingestion is small.	Entrained hydrocarbon droplets can physically affect fish and sharks exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest and therefore demersal fish communities are not expected to be impacted. Shark: Shark species inhabit all levels of the water column and feed on fish and seals. Impacts to sharks may occur through direct contact with entrained hydrocarbons contaminating tissues and internal organs or indirect contact via the food chain (consumption of prey). Sub-lethal impacts in adult fish include altered heart and respiratory rates, gill hyperplasia, enlarged liver, a reduction in growth, fin erosion, impaired endocrine systems, behavioural modifications and alterations in feeding, migration, reproduction, swimming, schooling and burrowing behaviour (Kennish, 1996). For commercial shark and fish stock this also includes tainting (refer *commercial fishing*). Fish: The water-soluble fraction (dissolved phase) containing the aromatic fraction is the most important component when assessing impacts to fish. Benzene, the most toxic of the compounds, has a LC_{50} of approximately 10-200 ppm (CEDRE, 2000). It is noted that observed concentration of dissolved phase compounds below slicks typically range from a few ppm to less than 0.1 ppm (IPIECA, 2000). Marine diesel has low levels of aromatics which are rapidly lost from the spill (~24hrs), and fish species, if exposed, would need substantially long exposure times (e.g. 96 hrs) for impacts to be realised. Fish Eggs/Larvae: There is potential for localised mortality of fish eggs and larvae due to reduced water quality and toxicity. Eggs, larvae and young fish are comparatively sensitive to oil (particularly dispersed oil), as demonstrated in laboratory toxicity tests (AMSA, 2011), however there are no case histories to suggest that oil pollution has significant effects on fish populations in the open sea. This is partly because any oil-induced deaths of young fish are often of little significance compared with natural losses each year through natural predation and given fish spawn over large areas (AMSA, 2011). The adjacent continental shelf region supports a significant finfish fishery (sardine and anchovy) with peak spawning periods for the species during January to March. Sardine and anchovy eggs and larvae are widely distributed in shelf waters during that time with higher densities in areas of high zooplankton mass (predominantly on shelf areas to the west of Kangaroo Island and Eyre Peninsula) (Dimmlich et al. 2004; cited in Pattiaratchi, 2007).

Receptor	Proximity to potential source of spill	Potential Impact	
		Surface Marine Diesel	Entrained Marine Diesel
Fish (including Sharks) (Con't)	Coincident & adjacent	Implication for the Survey (Impact Assessment): • Pelagic free-swimming fish and sharks are not expected to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2010)[122]. Given the limited areal and temporal presence of the spill and the limited numbers of fish potentially affected, impacts are assessed as SLIGHT – *Possible incidental effects to flora and fauna in a locally affected environmental setting*. • Impacts on eggs and larvae entrained in the upper water column are not expected to be significant given the temporary period of water quality impairment, the distance offshore where the spill may occur, and the limited areal extent of the spill. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations. Impact is assessed as SLIGHT – *localised, temporary effects. Recovery in the timescale of days to weeks*.	
Benthic fauna (sub-tidal invertebrates)	Coincident	In the Duntroon survey area water depths vary from 100 m to 3500 m. Benthic fauna present include porifera, ascidians, bryozoans and commercial species such as lobster and deep-sea crab. Benthic invertebrates are generally protected from direct oiling by the buoyant nature of hydrocarbons, although the depth of oil penetration in the water column is dependent on turbulence (Jewett et al., 1999; cited in ECOS 2001). Crab and Southern Rock Lobster species are typically located in water depths greater than 20m, so oiling impacts are expected to be limited. The most toxic component of oil to benthic sessile organisms is soluble aromatics. Lethal exposures are primarily attributed to water soluble PAHs, specifically the substituted naphthalene (C2 and C3) as the higher C-ring compounds become insoluble and not bioavailable. Available toxicity (lethal) data for marine invertebrates from ANZECC (2000) identifies the following 96hr LC50 concentrations for naphthalene (a key primary PAH dissolved phase toxicant and the only detected PAH present in WSH crude): For the bivalve mollusc, *Katelysia opima*, a concentration of 57,000ppb; and for six species of marine crustaceans, a concentration between 850-5700ppb. Exposure to microscopic oil droplets may also impact biota either mechanically (especially filter feeders) or as a conduit for exposure to semi-soluble hydrocarbons (which might be taken up by the gills or digestive tract) (McCay-French, 2009). *Given these species live relatively deep in the water column and are unlikely to contact surface spills or be exposed entrained hydrocarbons, impact to this fauna from a limited size, diesel surface spill is not expected*.	
Plankton	Coincident & adjacent	Primary production by plankton (triggered by upwelling events) is an important component of the region's primary marine food web. Planktonic communities are generally mixed including phytoplankton and secondary consuming zooplankton (crustaceans (e.g. copepods)), and the eggs and larvae of fish and invertebrates (refer **Section 3.7.2**).	
		Exposure to hydrocarbons at surface or in the water column can result in changes in species composition with declines or increases in one or more species or taxonomic groups (Batten, 1998). Phytoplankton may also experience decreased rates of photosynthesis (Goutz *et al*., 1984; Tomajka, 1985). For zooplankton, direct effects of contamination may include suffocation, changes in behaviour, or environmental changes that make them more susceptible to predation (Chamberlain and Robertson, 1999). Seasonal plankton productivity is critical to krill production which supports mega-fauna presence in the area. Entrained oil may result in lethal and sub-lethal impacts to a portion of plankton in the affected area where surface or entrained concentration thresholds are exceeded.	

[122] Source: ITOPF Technical Information Paper No 3: Oil Spill Effects on Fisheries (2010)

Receptor	Proximity to potential source of spill	Potential Impact	
		Surface Marine Diesel	Entrained Marine Diesel
		Implication for the Survey (Impact Assessment): Numerous studies on the influence of oil on plankton communities has been carried out, including one study by Varella et al (2006) which compared results from the Prestige oil spill with other published studies. Despite the limitations of the review (oil type, environmental conditions, etc.) it was not possible to demonstrate any significant effects on planktonic communities and changes were in the range of natural variability. Variations in the temporal scale of the ocean appear to have a greater influence on plankton communities than the direct effect of spilt hydrocarbons. As plankton is widely but patchily distributed and dispersed through the upper layers of the water column it is expected that current induced drift would rapidly replace any oil affected populations (ECOS, 2001). Once background water quality conditions are re-established, planktonic communities will rapidly re-establish due to high population turnover with and short generation time which buffers the potential for long-term population declines (ITOPF, 2011). Based on the limited areas temporarily affected by surface and entrained oils, impacts are short-term, recoverable and localised and not expected to have a significant impact on plankton populations located in megafauna foraging grounds. Impact is assessed as SLIGHT – localised, temporary and recovery in the timescale of days to weeks.	
Socio-economic			
Commercial Shipping	Coincident & adjacent	A portion of the Duntroon survey area is coincident with a commercial shipping land from Investigator Strait to Cape Leeuwin.	
		Commercial shipping transit through residual oil sheens are not expected to be adversely affected. Cruise vessels transiting the area to Kangaroo Island may travel through areas of visible sheen however the areal extent of the visible sheen will be small and have negligible impact to tourists on the vessel. It is not expected that this impact will be attributed to Kangaroo Island or its image for 'no pollution'.	Entrained phase hydrocarbons are not expected to impact this receptor.
		Implication for the Survey (Impact Assessment): Impacts to commercial shipping is assessed as SLIGHT – slight to negligible effects on aesthetic, economic or recreational values.	
Commercial Fishing	Coincident (but primarily adjacent)	Impacts to fish species from diesel spills are covered in 'Offshore Marine – Fish'. Note commercial species which may be targeted in the Duntroon OA (e.g. crab) are demersal in the area and not expected to be affected by upper water column hydrocarbons. Commercial fishing which may be undertaken in the OA involving pelagic species include SBT, King George whiting, snapper, sardines, shark, scalefish and charter boat fishing. The inshore area adjacent to the OA has higher levels of fishing including abalone (to 40 m water depth).	
		Significant levels of surface oil can foul vessels and equipment used to catch commercial fish, and transfer contaminants to the catch. For fisheries operating in the survey area, this would occur when demersal trawl/line and trap or pots are retrieved through surface slicks to the vessel. An oil spill may lead to temporary closure of the area to fishing.	Entrained hydrocarbons can have impacts to fish and fish eggs (as per fish above). This may reduce catch rates and render fish unsafe for consumption leading to financial loss. Seafood safety is a concern in any spill incident. Actual or potential contamination of seafood can affect commercial and recreational fishing and can impact seafood markets long after any actual risk to seafood from a spill has subsided (NOAA, 2002) which can have economic impacts to the industry. Studies have indicated that fish tainting may occur when exposed to diesel at low hydrocarbon concentrations (~250 ppb) (Davis et al. 2002). Tainting is reversible but, whereas the uptake of oil taint is frequently rapid, the depuration process where contaminants are metabolised and eliminated is slower (weeks to months) (ITOPF, 2004) making commercial species unpalatable. Fish have a high capacity to metabolise hydrocarbons while crustaceans (such as lobster and crab) have a reduced ability (NOAA, 2002). An oil spill may lead to temporary closure of the area to fishing.

<table>
<tr><th rowspan="2">Receptor</th><th rowspan="2">Proximity to potential source of spill</th><th colspan="2">Potential Impact</th></tr>
<tr><th>Surface Marine Diesel</th><th>Entrained Marine Diesel</th></tr>
<tr><td>Commercial Fishing</td><td>Coincident (but primarily adjacent)</td><td colspan="2">Implication for the Survey (Impact Assessment):
• Given the commercial fishing equipment which is used in proximity to the OA on the continental shelf, impacts associated with its contamination is assessed as MINOR – Minor effects on aesthetic, economic or recreational values.
• Given the level of commercial fishing recorded in the Duntoon OA and the limited time and extent of impact, impacts associated with exclusion are assessed as SLIGHT – slight to negligible effects on aesthetic, economic or recreational values.
• Given the species which may be affected by a diesel spill on the adjacent continental shelf (particularly with respect to tainting) and the limited time and extent of impact, impacts associated with tainting is assessed as MINOR – minor effect on aesthetic, economic or recreational values (full recovery expected).</td></tr>
<tr><td rowspan="3">Charter Operators</td><td rowspan="3">Adjacent</td><td colspan="2">As described in Section 3.7.2, most charter vessel operators are present around Port Adelaide, Kangaroo Island and the Eyre Peninsula.</td></tr>
<tr><td>Charter vessels may be temporarily excluded from fishing areas as a result of the spill (exclusion or visible sheens). This may restrict access to areas which contain fishing, diving, sightseeing or marine mammal watching leading to financial loss.</td><td>Levels of entrained oil in fish may reduce recreational fishing and diving in the area (refer commercial fisheries and fish).</td></tr>
<tr><td colspan="2">Implication for the Survey (Impact Assessment):
Given the localised and temporary nature of the spill and its limited spatial area, impacts to charter vessel activities due to exclusion or reduced fishing and diving access will be temporary (if affected). Alternate locations to undertake activities are available. On this basis, the impact is assessed as MINOR – minor and temporary effects on aesthetic, economic or recreational values.</td></tr>
</table>

Table 6-78: Potential Impacts of surface and entrained diesel to environmental sensitivities (shoreline)

<table>
<tr><th rowspan="2">Receptor</th><th rowspan="2">Proximity to potential source of spill</th><th colspan="3">Potential Impact</th></tr>
<tr><th>Surface Marine Diesel</th><th>Entrained Marine Diesel</th><th>Shoreline Marine Diesel</th></tr>
<tr><td colspan="2">Predictive Modelling Summary</td><td colspan="3">Predicted impacts from modelling (ADIOS2 and previous Lightning modelling) identifies the following:
Visual sheens predicted mostly within 95 km of the spill site with excursions to 199 km. Spill site could occur anywhere in the OA. Surface oil trajectories predominantly aligned with prevailing current direction WNW-ESE.
Surface oiling at >10µm will mostly lie within 10 km of the spill site, with some excursions up to approximately 35 km.
Entrained phase oil may extend approximately 208 km from the spill site, prevailing in the current direction WNW-ESE. The majority of entrained phase hydrocarbons are expected to remain offshore based upon prevailing current regimes. However, in the presence of moderate winds (i.e. > 12 knots) or breaking waves, visible surface oil may entrain in the upper water column reducing sheens resulting in low levels of hydrocarbon entrainment in coastal (shoreline) waters.</td></tr>
<tr><td colspan="5">Shoreline Fauna</td></tr>
<tr><td rowspan="2">Pinniped Colonies (within 10µm surface oil radius from spill site)</td><td rowspan="2">Rocky (south) Island: 10 km NNE (nearest colony) (NZ fur seal breeding colony, small Australian sea lion breeding colony).

Greenly Island: 28 km NNE (NZ fur seal & sea lion haul-out area).</td><td colspan="3">The impacts and effects of oil exposure to pinnipeds is described in Table 6-77.

The NCVA recognises the nearest critical sea lion critical breeding habitat to the Duntroon OA as Four Hummocks Island located approximately 36 km from the nearest OA boundary and Liguanea Island located 43 km north of the OA.</td></tr>
<tr><td>Surface oiling at 10µm may reach waters surrounding Rocky (south) Island. There is less probability that 10µm surface oiling will reach Greenly Island. It is possible that pinnipeds foraging in proximity to these islands may encounter thresholds which may lead to lethal or sub-lethal impacts (refer to pinnipeds (marine) Table 6-64).</td><td>As above for pinnipeds (marine) entrained phase oil is not significant for the species.</td><td>Rocky (south) Island and Greenly Island shoreline are predominantly cliffs. Rocky (south) Island has a reef 400m from the western side of the island. These landforms, as a result of tide and wave influence, do not accumulate significant shoreline hydrocarbon loadings.

Direct oiling of fur seal pups can induce hypothermia by destroying their insulation layer although experimental knowledge has shown that even extreme oiling of pups does not always result in death (Volkmann et al, 1994).

Impacts to a fur seal breeding colony, after severe oiling, may be significant at a population level and recovery is expected to be moderate. A medium term impact of oiling was reported for the Australian Fur Seal following the Iron Baron oil spill (heavy bunker fuel oil) with the number of pups born on the adjacent Tenth Island reduced the year following the spill (Pemberton, 1998; cited in Salazar, 2003). For the Jessica Oil spill (bunker oil) , no major long term negative impacts were detected with population numbers decreasing in the first six months after the spill, but after that time falling within the range of natural variability for the region (Salazar, 2003).

For these islands, no significant shoreline accumulation is expected given the shoreline types. Ecological impacts to pinniped colonies from shoreline accumulation is not expected to be significant and assessed as a minor and temporary disruption to a small portion of poulation. No effects on critical habitats (MINOR consequence).</td></tr>
</table>

Receptor	Proximity to potential source of spill	Potential Impact		
		Surface Marine Diesel	Entrained Marine Diesel	Shoreline Marine Diesel
Pinniped Colonies	Other colonies: Waldegrove Islands (125 km NE) Cap Island (115 km NE) Investigator Group (70 km North) Rocky Island North (90 km NE) Liguanea Island (Lincoln NP) (42 km NE) Neptune Islands (49 km ENE)	Surface oil levels are predicted to fall below 1µm in these coastal areas. This is below the threshold for ecological impacts to species (refer to pinnipeds (marine) Table 6-64).	As above for pinnipeds (marine) entrained phase oil is not significant for the species. Additionally, significant levels of entrained phase oils are not expected inshore given the prevailing offshore current regime in the area.	Refer to the above assessment for shoreline marine diesel impacts to pinniped colonies. Shorelines present at colony locations are cliffs or sandy beaches. Diesel residues along sand beaches are expected to percolate into the sand structure (i.e. minimal surface residuals). Previous predictive modelling for Lightning MSS did not identify shoreline residues above 10 g/m^2. Impacts to pinniped colonies at these locations is expected to be incidental (SLIGHT consequence).
Bird colonies	Nearest Colonies: Whidbey Islands (48 km ENE) Avoid Bay (66 km NE) Neptune Islands (49 km ENE)	Impacts to birds from surface oil has been described in Marine- seabirds. Surface oil levels are predicted to fall below 1µm in these coastal areas. This is below the threshold for ecological impacts to species (refer to seabirds (marine) (Table 6-62)).	Impacts to birds from entrained oil has been described in Marine- seabirds. Significant levels of entrained phase diesel are not expected inshore given the prevailing offshore current regime in the area.	Residual hydrocarbon presents a risk to species utilizing the shoreline for foraging. Ground nesting species may also be impacted. Direct contact with surface hydrocarbons can lead to irritation of skin and eyes. Smothering can lead to reduced water proofing of feathers leading to hypothermia. Smothering of feathers can also lead to excessive preening, diverting time away from other behaviours leading to starvation and dehydration. Preening of oiled feathers will also result in to ingestion of hydrocarbons and the associated impacts of toxicity and potential illness Given the characteristics of marine diesel, it generally does not accumulate along sandy shorelines but percolates into the sand given its low viscosity. This may lead to localised impacts on inter-tidal invertebrates within the sand with subsequent indirect impacts to shore-line foraging birds (refer below – sandy beaches). Previous predictive modelling for Lightning MSS did not identify shoreline residues above 10 g/m^2. Ecological impacts to bird colonies/ shoreline bird species are expected to be *incidental to the local environment* (SLIGHT consequence).
Shoreline Habitats				

<table>
<tr><th rowspan="2">Receptor</th><th rowspan="2">Proximity to potential source of spill</th><th colspan="3">Potential Impact</th></tr>
<tr><th>Surface Marine Diesel</th><th>Entrained Marine Diesel</th><th>Shoreline Marine Diesel</th></tr>
<tr><td rowspan="2">Sandy Beaches</td><td rowspan="2">62km (nearest beach) (Sleaford Bay)</td><td colspan="3">Sandy beaches provide important habitats for foraging seabirds and shorebirds. They also provide habitat for polychaetes, molluscs, marine crustaceans, semi-terrestrial crustaceans and insects. Sand beaches are regularly cleaned by wave action and have low sediment total organic carbon and therefore low abundance of marine life (Hook et al., 2016).
The 100 g/m^{2}thresholds (considered a ‘stain’ or ‘film’, and equivalent to 0.1 mm) is assumed as the lethal threshold for invertebrates on hard substrates and sediments (mud, silt, sand, gravel) in intertidal habitats. A threshold of 100 g/m^2 oil thickness would be enough to coat the animal and likely impact its survival and reproductive capacity (French-McCay, 2009). Based on this, areas of heavy oiling would likely result in acute toxicity, and death, of many invertebrate communities, especially where oil penetrates into sediments through animal burrows (IPIECA, 1999).
Following the Sea Empress spill, populations of mud snails recovered within a few months, but some amphipod populations had not returned to normal after one year (IPIECA, 1999).</td></tr>
<tr><td>Phase not relevant to shoreline habitats.</td><td>Phase not relevant to shoreline habitats.</td><td>Surface hydrocarbons may accumulate on sandy beaches however diesel due to its low viscosity tends to percolate into the sand. Tidal/wave action continues to wash sand beaches leading to rapid rehabilitation. Visible oiling may not be as apparent as other oil types (crude, HFO).
Diesel may impact on the inter-tidal area by impacting on invertebrates. This in turn may have secondary impacts on the foraging shorebirds. Previous predictive modelling for Lightning MSS did not identify shoreline residues above 10 g/m^2. This is below the ecological impact level of 100g/m^2 where impacts to species survival may result (refer Table 6-74). Impacts to adjacent sandy beaches are localised and short-term with rapid recovery (MINOR consequence).</td></tr>
<tr><td>Inter-tidal and Sub-tidal Reefs</td><td>Rocky (south) Island: 10 km NNE
Neptune Islands (49 km ENE)</td><td colspan="3">Intertidal and sub-tidal reefs occur in shallow near shore waters within the wider Duntroon OA environment (closest is Rocky (south) Island). Inter-tidal and subtidal reefs contain animals such as abalone, barnacles, crabs, limpets, snails and worms. Inter-tidal invertebrate taxa exhibit a wide range of tolerances and responses to oil exposure. Sub-tidal reefs generally are not as impacted by hydrocarbons.
Mortality is a major impact from an oil spill through coating and toxicity of persistent residues. Sub-lethal impacts can result in altered respiration, growth, reproduction and behaviour to more specific processes such as calcification, moulting, ion transport and enzyme function to individual animals.
Oil spill impacts also typically result in changes in abundance, density, reproduction and recruitment, age structure, tolerance and population genetic structures within the invertebrate community (McFarlane and Burchett, 2003). Studies undertaken following the Amoco Cadiz spill identified that the inter-tidal invertebrates suffered heavy initial mortalities with the near disappearance of some species. This was followed by an invasion of opportunistic species with species richness gradually increasing 2-3 years after the spill where most species had reappeared and were undergoing normal seasonal fluctuations (Seymour & Geyer, 1992).
French-McCay (2009) predicts that benthic invertebrates in these environments impacted at thresholds above 100g/m^2 will undergo 99% recovery in approximately 3 years if impacted.</td></tr>
</table>

<table>
<tr><th rowspan="2">Receptor</th><th rowspan="2">Proximity to potential source of spill</th><th colspan="3">Potential Impact</th></tr>
<tr><th>Surface Marine Diesel</th><th>Entrained Marine Diesel</th><th>Shoreline Marine Diesel</th></tr>
<tr><td></td><td></td><td>Phase not relevant for sub-tidal reefs.

Inter-tidal Reefs: Physical coating by surface may cause lethal or sub-lethal impacts to sensitive biota. Those most vulnerable are species which become emergent (e.g. during low tide). Impacts of oil contact can include smothering, impaired feeding, fertilisation, larval settlement and metamorphosis, larval and tissue death and decreased growth rates. Narcotic effect of the oil can also be experienced causing snails, gastropods and grazing molluscs to lose grip on rocks (desiccate or become available to predators) (IPIECA, 1995).

Surface oil levels are predicted to fall below 1µm in most coastal areas (which are below thresholds for ecological impacts). Surface thresholds of 10 µm (10g/m²) may be experienced at Rocky (south) Island however exposure is expected short-duration and temporary due to tidal and wave action. Impacts are assessed as localised and temporary with a slight impact on ecological integrity or species composition (SLIGHT consequence)</td><td>Exposure to entrained hydrocarbons may cause lethal or sub-lethal impacts to sensitive biota.

For Rocky (south) Island inter-tidal and sub-tidal reefs may be contacted by limited 'weathered' entrained phase hydrocarbons. This may expose invertebrate species to elevated levels of toxic compounds however these impacts are expected to be localised, in the upper water column and temporary. A slight impact on ecological integrity or species composition might be expected (SLIGHT consequence).

For other affected inter-tidal and sub-tidal reefs, entrained phase exposures are expected to be weathered (lower toxicity) and lower in concentration (SLIGHT consequence)</td><td>Phase not relevant for sub-tidal reefs.

Accumulation of surface hydrocarbons on emergent reefs is expected to have similar impacts as described in surface oiling.

Given emergent reefs are subject to semi-diurnal inundation, accumulation impacts (if present) will be temporary. Impacts will be localised, temporary with only a slight impact of ecological integrity or species composition (SLIGHT Consequence).</td></tr>
<tr><td>Inter-tidal Rocky Platforms and Cliffs</td><td>Rocky (south) Island: 10 km NNE (closest)

Other islands:

Liguanea Island (in Lincoln NP)

Neptune islands (In Neptune Islands CP)

Four Hummocks Island & Whidbey Islands (in Thorny Passage MP)

Kangaroo Island (western areas)</td><td colspan="3">Rocky shores have a low sensitivity rating as hydrocarbons are generally quickly removed by incoming tides and waves. Cracks and crevices, rock pools, overhangs and other shaded areas provide habitat for soft bodied animals such as sea anemones, sponges and sea-squirts, and become places where oil can become concentrated as it strands ashore (Hook et al., 2016). Rich animal communities underneath the rocks are also the most vulnerable to oil pollution. The vulnerability of a rocky shoreline to oiling is dependent on its topography and composition as well as its position. A vertical rock wall on a wave-exposed coast is likely to remain unoiled if an oil slick is held back by the action of the reflected waves. Alternately, a gradually sloping boulder shore in a calm backwater of a sheltered inlet can trap oil which may penetrate deep down through the substratum. The complex patterns of water movement close to rocky coasts also tend to concentrate oil in certain areas. As on all types of shoreline, most of the oil is concentrated along the high tide mark while the lower parts are often untouched (IPIECA, 1995). Tidal flushing removes accumulated oil with the rate of weathering dependent on wave exposure, weather conditions and the shore characteristics.

The impact of oil on any marine organism depends on the toxicity, viscosity and amount of oil, on the sensitivity of the organism and the length of time it is in contact with the oil. Even where the immediate damage to rocky shores from oil spills has been considerable, it is unusual for this to result in long-term damage and the communities have often recovered within 2 or 3 years (IPIECA, 1995). This is because oil is not normally retained on rocky shores in a form or quantity that causes long-term impacts and also because most rocky shore species have a considerable potential for re-establishing populations. Many rocky shore animals have also been found to withstand heavy oiling, and it typically requires smothering by a viscous oil for a few tides to fatally impact barnacles and intertidal sea anemones. Limpets, littorinid snails and other grazing molluscs, however, are usually more susceptible, and a particularly toxic oil may cause a large number of fatalities. This may be a direct effect or through the narcotic effect of the oil which causes the animals to lose their grip on the rock and become available to predators or die of desiccation (IPIECA, 1995).</td></tr>
</table>

<table>
<tr><th rowspan="2">Receptor</th><th rowspan="2">Proximity to potential source of spill</th><th colspan="3">Potential Impact</th></tr>
<tr><th>Surface Marine Diesel</th><th>Entrained Marine Diesel</th><th>Shoreline Marine Diesel</th></tr>
<tr><td>Inter-tidal Rocky Platforms and Cliffs (Con't)</td><td>Rocky (south) Island: 10 km NNE (closest)
Other islands:
Liguanea Island (in Lincoln NP)
Neptune islands (In Neptune Islands CP)
Four Hummocks Island & Whidbey Islands (in Thorny Passage MP)
Kangaroo Island (western areas)</td><td>Surface oils may contact these islands at low concentrations (i.e. Rocky (South) Island at 10µm; other islands at 1µm), however given the continual tidal flushing and wave action, no significant accumulation (smothering effects) or impact from surface oil contact is expected (i.e. only localised temporary effects with slight impact on ecological integrity - SLIGHT consequence).</td><td>Entrained hydrocarbons are not expected to cause impacts to cliff features. For Rocky (south) Island inter-tidal rocky areas may be contacted by 'unweathered' entrained phase hydrocarbons. This may expose inter-tidal invertebrates to elevated levels of toxic compounds however the continued flushing by wave and tidal action is expected to limit impacts. These types of shorelines recover in short timeframes (as above). Impacts are expected to be localised and temporary with only a slight impact on ecological integrity or species composition (SLIGHT consequence).
For other affected inter-tidal areas, entrained phase exposures are expected to be weathered (lower toxicity) and lower in concentration given the greater period since the spill event (SLIGHT consequence)</td><td>Given the types of coastline encountered (as above), shoreline accumulations of hydrocarbon are expected to be temporary due to the wave and tidal exposure (SLIGHT consequence)</td></tr>
<tr><td>Seagrass/ Macroalgae</td><td>Thorny Passage Marine Park (Coffin Bay ~ 75km NE, seagrass; Rocky south island ~ 10 km NNE; macroalgae; Greenly Island 35 km NE macroalgae)
Investigator Marine Park (~97 km NNE)
Sir Joseph Banks Marine Park (~85 km NE)
Gambier Island Marine Park (~85 km ENE)
South Spencer Gulf Marine Park (~115 km ENE)
South Kangaroo Island Marine Park (~157 km east)</td><td colspan="3">Macroalgae are generally grown on intertidal and subtidal rocky substrata in shallow waters to 10 m depth. As such, they may be exposed to entrained and dissolved hydrocarbons, however are also susceptible to surface hydrocarbons in intertidal habitats. Seagrass species are found in sheltered embayments where there is not substantial movement in seabed sediments.

Smothering, fouling and asphyxiation are some of the physical effects that have been documented from oil contamination in marine plants (Blumer, 1971; Cintron et al., 1981). In macroalgae, oil can act as a physical barrier for the diffusion of carbon dioxide across cell walls (O'Brian & Dixon, 1976). The effect of hydrocarbons however is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to algae, which will vary depending on the oils physical state and relative 'stickiness'. The morphological features of macroalgae, such as the presence of a mucilage layer or the presence of fine 'hairs' will influence the amount of hydrocarbon that will adhere. A review of field studies conducted after spill events by Connell et al (1981) indicated a high degree of variability in the level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. The rapid recovery of algae was attributed to the fact that for most algae, new growth is produced from near the base of the plant while the distal parts (which would be exposed to the oil) are continually lost. Other studies have indicated that oiled kelp beds had a 90% recovery within 3-4 years of impact, however full recovery to pre-spill diversity may not occur for long periods after the spill (French-McCay, 2004).

Intertidal macroalgal beds are more prone to oil spills than subtidal beds because although the mucous coating prevents oil adherence, oil that is trapped in the upper canopy can increase the persistence of the oil, impacting upon site-attached species. Additionally, when oil sticks to dry fronds on the shore, they can become overweight and break as a result of wave action (IPIECA, 2002). Hook et al (2016) on the other hand states that kelp is typically relatively resistant to oil, though the fauna associated with it may be more sensitive.

Equally, sub-tidal seagrass is unlikely to be affected by surface oiling as it will pass over the vegetation with no ill effects (ITOPF, 2011). Intertidal sea-grasses are more vulnerable to physical oil effects and smothering, however unless the oil is retained within the sea-grass meadows for a sustained duration (i.e. within the rhizome), most studies report no long-term impacts (Ziemann et al, 1984, Jacobs, 1988; cited in Wilson, 2010). Keller and Jackson (1991; cited in French McCay, 2009) in a review of recovery rates for Florida seagrass beds identified recovery rates of 6-12 months if there is leaf damage and 5 years to decades if rhizome damage is severe and no planting is performed. Hydrocarbon toxicity to macroalgae varies for the different macroalgal life stages, with water-soluble hydrocarbons more toxic to macro-algae (Van Overbeek & Blondeau, 1954; Kauss et al., 1973; cited in O'Brien and Dixon, 1976). Toxic effect concentrations for hydrocarbons and algae have varied greatly among species and studies, ranging from 0.002–10,000 ppm (Lewis & Pryor, 2013). The sensitivity of gametes, larva and zygote stages however have all proven more responsive to petroleum oil exposure than adult growth stages (Thursby & Steele, 2003; Lewis & Pryor, 2013).

Macrophytes, including seagrasses and macroalgae, require light to photosynthesise. So in addition to the potential impacts from direct smothering or exposure to entrained and dissolved hydrocarbons, the presence of entrained hydrocarbon within the water column can affect light qualities and the ability of macrophytes to photosynthesise.</td></tr>
</table>

Receptor	Proximity to potential source of spill	Potential Impact		
		Surface Marine Diesel	Entrained Marine Diesel	Shoreline Marine Diesel
		In offshore (non-sheltered) areas such as islands, macroalgae contacted by residual MDO hydrocarbons is unlikely to be significantly impacted. While locations such as Rocky (south) island may experience relatively 'unweathered MDO' the exposure will be localised, temporary, unlikely to affect rhizomes and removed through tide and wave action. Accordingly, impacts to offshore macroalgae is expected to have localised and tempory impacts with full recovery. For sheltered areas (such as Coffin Bay) where inter-tidal sea grass is present, surface oil is predicted to be below 1µm and surface and entrained oil weathered. Impacts, if they occurred would be expected to be temporary, localised and recoverable (SLIGHT Consequence).	Significant levels of entrained phase diesel are not expected inshore given the prevailing offshore current regime in the area. On this basis, any impacts to seagrass in sheltered coastal environments is not anticipated (SLIGHT consequence). For offshore environments, entrained phase exposure to macroalgae is expected to be temporary, water exchange rapid and the mucous coating preventing adherence (SLIGHT Consequence).	Previous predictive modelling for Lightning MSS did not identify shoreline residues above 10 g/m^2. This is below the ecological impact level of 100g/m^2 where impacts to species survival may result (refer Table 6-74). Impacts to seagrass/macroalgae is expected to be *localised and temporary with only slight impacts of ecological integrity expected* (SLIGHT consequence).
Saltmarsh	Sir Joseph Banks Marine Park (~85 km NE) Thorny Passage Marine Park (Coffin Bay ~ 75km NE)	Oil can adhere readily to saltmarsh and recovery times are variable depending upon the level of impact. For temperate species there is seasonal die-back, and during spring and summer (growing season) the species are more susceptible (IPIECA, 1994). Impacts are related to oil toxicity (lighter, non-weathered products causing more impacts such as MDO) or smothering (physical effect). Oil loading also determines recovery times. For light to moderate oiling with little penetration into the sediments, the plant may be killed in part, but recovery can take place from the underground systems – generally good recovery in 1-2 years. Oiling of shoots with substantial penetration into the sediments with damage to underground systems may delay recovery (~7years). With thick deposits of oil, vegetation is likely to be killed by smothering and the recovery period for species can be significant (~20years) (IPIECA, 1994).		
		Surface oil exposure at this location is expected to be limited to visual sheens. No significant impacts to vegetation from surface oil predicted.	Any entrained phase hydrocarbon contact at this location will be low concentration and weathered. No significant impacts predicted.	Previous predictive modelling for Lightning MSS did not identify shoreline residues above 10 g/m^2 in these coastal areas. This is below the ecological impact level of 100g/m^2 where impacts to species survival may result. Impacts associated with a Duntroon OA spill would be expected to be similar in impact levels. No significant impacts expected.
Socio-Economic				
Commercial Fishing (including abalone)	Adjacent coastal waters.	Within the adjacent coastal areas are significant small pelagic fish, abalone and rock lobsters. These are targeted both commercially and recreationally (fish and crustacean impacts are discussed in the marine environment – Table 6-77). Abalone is a gastropod (i.e. grazer) and not a filter-feeder. Filter feeders actively bioconcentrate hydrocarbon residues. Effect pathways include dissolved/entrained phase contact leading to toxic impacts to the species or direct impact to its food sources (i.e. algal communities). Sublethal hydrocarbon concentrations can lead to narcosis (death-like appearance when the organism has not actually died). The invertebrates often recover but are more vulnerable to predators or being swept away by currents. Other sublethal effects of oil on invertebrates include developmental problems such as slow growth and deformities (Fingas, 2001). Singer et al (1998) undertook a study on the acute effects of the water accommodated fraction (WAF) of Prudhoe Bay crude oil with respect to larval abnormalities (i.e. shell deformation) for the red abalone (*Haliotis rufescens*). This was a non-lethal endpoint test undertaken for 48hrs where actual oil concentrations ranged from 13.93 to 46.77mg/l Total Hydrocarbon Content (THC) (C_7-C_{30}). Median-effect concentrations could not be calculated for the WAF as the highest effects seen only affected 12% of the population. It is noted in literature that early life stages in species are often more sensitive than the adults of the same species (Bejarano et al 2013).		

Receptor	Proximity to potential source of spill	Potential Impact		
		Surface Marine Diesel	Entrained Marine Diesel	Shoreline Marine Diesel
		Commercial fishing impacts from surface oil are described in "Marine – fish/sharks" and "Socio-economic – Commercial Fishing" (refer Table 6-77) Surface oil thicknesses are predicted to fall below 1µm in coastal areas where fishing occurs. This is below the threshold for ecological impacts to any species however visible sheens (if present) may result in temporary community concerns. Impact is assessed as MINOR – *minor and temporary effects on aesthetic, economic or recreational values*	Commercial fishing impacts from entrained oils are described in "Marine – fish/sharks" and "Socio-economic – Commercial Fishing" (refer Table 6-77) Significant levels of entrained phase MDO are not expected inshore given the prevailing offshore current regime in the area. Any impacts to commercial fishing (including abalone) would be expected to be localised and temporary with *slight to negligible effects on aesthetic, economic or recreational values*. (SLIGHT consequence).	NA
Charter Operators (Recreational Fishing)	Adjacent coastal waters.	As per Commercial Fishing above.	As per commercial fishing above	NA
Aquaculture	Coffin Bay (Oysters) (~75 km NE) Port Lincoln (Oysters, Abalone, finfish) (~80 km NNE)	Aquaculture is present on the Eyre Peninsula at Coffin Bay and Port Lincoln (oysters, abalone, SBT, finfish). Impacts from oil spills to fish and abalone have been described previously. Research on the Oyster *Crassostrea virginica* identifies that the species rapidly assimilates petroleum hydrocarbons (Kennish, 1996). Studies have identified that the response of gametes, developing eggs and larvae of oysters to crude at hydrocarbon concentrations of 1 to 1000ppm were toxic to fertilization and hampered the swimming ability of the larvae (Kennish, 1996). Additionally, PAHs are toxic to oyster gametes, embryos, larvae, juveniles and adults and result in lethal and sub-lethal effects (e.g., impaired reproductive success) (Kennish, 1996).		
		Surface oil thicknesses are predicted to fall below 1µm in coastal areas where aquaculture occurs. This is below the threshold for ecological impacts to species however visible sheens (if present) may result in temporary community concerns. Impact is assessed as MINOR – *minor and temporary effects on aesthetic, economic or recreational values*	Significant levels of entrained phase MDO/MGO are not expected inshore given the prevailing offshore current regime in the area. Any impacts to aquaculture would be expected to be negligible to SLIGHT – *slight to negligible effecst on aesthertic, economic or recreational values*.	Not Applicable as oysters are in frames in water column.
Aboriginal Heritage	Memory Cove Wilderness Protection	These protected areas all records items of cultural significance within their boundaries. This includes remains of campsites and stone fishtraps; aboriginal artifacts and heritage sites.		

Receptor	Proximity to potential source of spill	Potential Impact		
		Surface Marine Diesel	Entrained Marine Diesel	Shoreline Marine Diesel
	Area (61 km NE) Coffin Bay NP (~75 km NE) Flinders Chase NP (100 km east) Cape Torrens and Western River Wilderness Area (109 km east) Innes National Park (115 km east) Lake Newland Conservation Reserve (150 km ENE)	Sea surface oil is not expected to contact aboriginal heritage items.	Entrained hydrocarbon is not expected to contact aboriginal heritage items.	Shoreline residue is not expected to contact aboriginal heritage items.
Coastal Shipwrecks	Adjacent coastline	Submerged shipwrecks are present along the eastern coast of Lincoln National Park (Memory Cove to Cape Catastrophe),Wanna (located adjacent to Sleaford Bay), West Kangaroo marine Park (SA); Sir Joseph Banks Group Marine Park and South Spencer Gulf Marine Park (refer **Section 3.2.2**).		
		Surface oiling is not expected to impact on sub-tidal shipwrecks.	The low levels of entrained hydrocarbon are not expected to have significant impact on shipwrecks or the species they support such as fish and sessile benthos species (negligible to slight impact on protected values).	Not Applicable
Recreational Water Sports (Diving, swimming, surfing)	Adjacent Coastline	Diving (tourism) (White shark cage diving & shipwreck (heritage) trail): Anchorages for shark diving occur on the eastern coastlines of Northern Neptune Island in water depths of approximately 12-18m away from the prevailing westerly winds and swell. The western coastline is only suitable in summer during easterly wind regimes[123] [124] (and calm seas) for these activities. Shipwrecks within the EMBA are located in coastal areas on the Eyre Peninsula and Neptune Islands. Swimming /Surfing: Many sections of the adjacent coastline have remote surf beaches which are locally accessible. Other coastline types include rock platforms with backing cliffs which are not conducive to swimming and surfing activities.		

[123] Rodney Fox Shark Expeditions, 2014 available at https://www.rodneyfox.com.au/index.php/selectedContent/21965891
[124] Shark Cage Diving – Calypso Star Charters, 2014 available at http://www.sharkcagediving.com.au/shark-tours/dive-locations/

Receptor	Proximity to potential source of spill	Potential Impact		
		Surface Marine Diesel	Entrained Marine Diesel	Shoreline Marine Diesel
		Modelling predicts a low probability of oil sheen intersecting the Neptune Islands and along the southern Eyre Peninsula coastline. Such levels of hydrocarbon exposure, while not predicted to affect the ecological integrity of the receiving environment, may trigger a localised stakeholder response to potential contamination of wilderness environments. This may lead to a temporary cessation of all diving activities in the spill-affected area for the duration of the sheen (~ days). Impact is assessed as minor – *minor and temporary effects on aesthetic, economic or recreational values*. No long-term impacts are predicted (MINOR consequence)	The low levels of entrained hydrocarbon are not expected to have significant impact on recreational sports (negligible to slight impact).	NA
Recreational Boating	Adjacent coastline	Impacts as per recreational water sports above however cancellation of activities is not expected with only slight to negligible effects on economic or recreational values (SLIGHT consequence).	Entrained hydrocarbons not expected to have a significant impact on this receptor.	NA
Charter Boat (ecotourism)	Adjacent coastline	Impacts as per recreational water sports above, however cancellation of activities is not expected with only slight to negligible effects on economic or recreational values (SLIGHT consequence).	Entrained hydrocarbons not expected to have a significant impact on this receptor.	NA
Tourism (Visual Aesthetics, Landscapes including cruise ships)	Lincoln National Park (57 km NNE) Sir Joseph Banks Group CP (105 km NE) Flinders Chase NP (100 km east) Innes NP (115 km east)	Kangaroo Island and Eyre Peninsula are renown for their landscape vistas of unspoilt natural beauty. Significant income is generated from tourism in these areas (refer Section 3.8.2).		
		Modelling predicts a low probability of oil sheen intersection at these locations. Such levels of hydrocarbon exposure, while not predicted to affect the ecological integrity of the receiving environment, may trigger a localised stakeholder response to potential contamination of wilderness environments. This may lead to temporary tourism concerns for the duration of the sheen (~ hours - days). Impact is assessed as MINOR – *minor and temporary effects on aesthetic, economic or recreational values*. No long-term impacts are predicted.	Entrained hydrocarbons not relevant to this receptor.	Shoreline residues, if present, are expected to be small and below thresholds for shoreline cleanup. No visual impacts expected and no significant impact to visiting tourists.
Yacht Racing	Adjacent Coastline	The annual Blue water classic between Adelaide and Port Lincoln is held in February each year and timing does not coincide with Duntroon survey activities. This race is undertaken between Adelaide and Port Lincoln inside of the barrier islands (Thistle, Wedge, Neptune). No predicted impacts.		
Protected Areas (refer Section 3.2)		Potential impacts of surface and entrained oil on individual conservation value receptors listed in Commonwealth Marine Reserves or State Marine/Terrestrial Parks are assessed in Table 6-80 (Commonwealth) and Table 6-81 (State).		
KEFs (refer Section 3.2)		An assessment of impacts on KEFs within the EMBA is provided in Table 6-79.		

Commonwealth Recovery Plans:

Management actions contained in threatened species conservation/recovery plans have been assessed with respect to diesel spills from the Duntroon multi-client survey and the following management actions are listed within those plans with respect to oil spills:

- *Recovery Plan for the Australian Sea Lion (Objective 4.1): Improve the understanding of, and where necessary mitigate, the threat posed to Australian Sea Lion populations by oil spills by implementing jurisdictional oil spill strategies as required.*

  Oil spill response within this EP is integrated with Commonwealth legislative requirements (e.g. SOPEP/OPEP linking to NATPLAN) and meets this requirement.

- *Recovery Plan for Marine Turtles in Australia 2017-2027 (Objective 4C*):
  - *Objective 4C: Lists current management strategy as regulation under the OPGGSA by NOPSEMA and the National Plan for Maritime Environmental Emergencies as detailing arrangements, policies and principles for managing maritime environmental emergencies*
  - *Action Area A4: Ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reef).*

  As above, oil spill response within this EP is integrated with Commonwealth legislative requirements (e.g. SOPEP/OPEP linking to NATPLAN) and includes scientific monitoring. This action meets this requirement.

- Threatened species conservation advices also lists oil spill/marine pollution as a threat to the following species:
  - Hooded Plover (oil spills): Relevant action is to ensure oil spill plans reflect effective rehabilitation (action is met via the SA oiled wildlife plan implemented via DEWNR);
  - Fairy Tern (oil spills pose a threat to species breeding habitat): Relevant action is to ensure that appropriate oil spill contingency plans are in place for breeding sites vulnerable to oil spills;
  - Greater sand plover, lesser sand plover, curlew sandpiper, eastern curlew, bar-tailed godwit (pollution within habitat/human disturbance activities): No specific actions for oil spill, however any shoreline activities must consider the presence of shoreline birds.

  Oil spill response recognises these species and their response requirements. Species have been recognised in shoreline response activities (i.e. scientific monitoring which may need to be initiated), particularly with respect to habitat disturbance.

6.10.3.3 Impacts to KEFs

The Duntroon oil spill EMBA overlaps KEFs within the region (refer **Section 3.3.2**). KEFs are of regional importance for either a region's biodiversity of its ecosystem function and integrity. In accordance with the Significant Impact Guidelines (Matters of NES), relevant criterion on which to determine whether impacts will be significant with respect to oil spill impacts are:

- The action will not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an inverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results;
- Have a substantial adverse effect on a population of marine species or cetacean including its lifecycle (for example breeding, feeding, migration, life expectancy) and spatial distribution;
- Result in a substantial change in water quality which may impact on diversity, ecological integrity, social amenity or human health; or

- Result in persistent organic chemicals or other potential chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected.

Table 6-79 provides an assessment against these parameters for KEFs present in the EMBA.

Table 6-79: Oil Spill Impact Assessment of KEFs

KEF	Ecosystem Sensitivity	Threats	Description of Impact
Ancient Coastline	The ancient coastline 'escarpment' between 90-120 m creates topographic complexity , facilitate upwellings (enhanced productivity) and have benthic diversity (habitats and demersal fish species which connect the shelf to the slope environments). The western GAB is dominated by sponge communities of significant biodiversity and structural complexity.	No pressures of concern. Pressures of potential concern include: • Changes in sea temperature • Changes in oceanography • Physical habitat modification • Extraction of living resources	The Duntroon OA has minor overlap with KEF areas defined as the ancient coastline. The Duntroon survey does not interact with the seabed and accordingly does not physically modify the KEF. An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. benthic habitats (sponges) and demersal fish) has been undertaken within this EP. Spill impacts to benthic receptors has been assessed in Table 6-77 (Benthic Fauna) and Table 6-78 (Fish including sharks). As identified in those sections, due to the surface nature of the spill and the depth to benthic fauna in the OA, no impacts are predicted to the habitat. Also impacts to fish, given their mobility in the environment and limited exposure to surface residues, any impacts will be localised, temporary and recoverable with no impacts at a population level expected. MDO is a light distillate with a small fraction of persistent (but degradable) hydrocarbons. No persistent organic chemicals are expected to accumulate in the marine environment. On this basis, the spill of MDO to the environment does not result in disruption/destruction of an important habitat area; does not have an adverse impact of a population of marine species (as defined by this KEF); does not result in water quality changes which impact on the ecological functioning of the KEF; or result in persistent organic chemicals accumulating in the environment. On this basis, ecological integrity of this KEF and its functioning is not expected to be significantly affected by an MDO spill as defined by the EPBC significant impact criteria.
Kangaroo Island Pool, canyons and adjacent shelf-break & Eyre Peninsula Upwelling	This is a major area of productivity supporting areas of zooplankton biomass utilised by small pelagic fish which in-turn are prey for higher trophic levels (e.g. SBT, sharks, etc.). The pygmy blue whale is seasonally present within the KEF during summer/ autumn feeding on krill.	Pressures of concern are changes in sea temperature and oceanography. Pressures of potential concern include: • Ocean acidification • Noise pollution • Extraction of living resources • Bycatch • Oil Pollution	The Duntroon OA overlaps with this KEF. An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. zooplankton, small pelagic fish) with respect to a MDO spill has been undertaken in this section. Spill impacts to zooplankton been assessed in Table 6-77 (plankton), Table 6-77 (fish including sharks) and Table 6-77 (cetaceans). As identified in those sections impacts to plankton (including krill) are localised, temporary and rapidly recoverable with observed changes in the range of natural variability. Pelagic fish impacts are also predicted to be localised, temporary and recoverable. Impacts to other higher trophic species which feed upon this prey are described in Table 6-77 (cetaceans, pinnipeds, turtles, seabirds). Impacts to these species from the limited size MDO spill are assessed as minor and temporary to a small proportion of the population only. Effects are recoverable. The localised and temporary impact nature of a MDO spill in the Duntroon OA, does not result in disruption/destruction of an important habitat area; does not have an adverse impact of a population of marine species (as defined by this KEF); does not result in water quality changes which impact on the ecological functioning of the KEF; or result in persistent organic chemicals accumulating in the environment. On this basis, ecological integrity of this KEF and its functioning is not expected to be significantly affected by an MDO spill as defined by the EPBC significant impact criteria.

KEF	Ecosystem Sensitivity	Threats	Description of Impact
Mesoscale Eddies (pelagic KEF)	Mesoscale eddies are important transporters of nutrients and meso-zooplankton communities and become hot-spots for a complex range of higher trophic levels. These eddies play a critical role in determining species distribution and transport coastal phyto-plankton communities offshore and removing larval fish from the continental shelf offshore (decreasing fishery productivity). These KEFs are thought to attract a range of organisms ar higher trophic levels (marine mammals, seabirds, SBT).	Pressures of concern are changes in sea temperature and oceanography. Pressures of potential concern include: • Ocean acidification	The Duntroon OA overlaps with the Eyre Peninsula meso-scale eddy KEF. This system is pelagic and is a physical forcing system which transports and distributes nutrients (not affected by Duntroon survey) and biological resources regionally. As such the Duntroon survey does not affect this KEF system, however on an indirect basis may affect the biological resources which are transported within the system. As per previous KEF entries, Duntroon survey activities have assessed impacts to biological resources within the affected MDO EMBA. Table 6-77 assesses spill impacts to plankton, pelagic fish species and other higher trophic species which feed upon these prey items such as pinnipeds, turtles, avifauna and cetaceans. Impacts to these species from the limited size MDO spill are assessed as minor and temporary to a small proportion of the population only. Effects are recoverable. Accordingly, the localised and temporary impact of a MDO spill in the Duntroon OA, does not result in disruption/destruction of an important habitat area; does not have an adverse impact of a population of marine species (as defined by this KEF); does not result in water quality changes which impact on the ecological functioning of the KEF; or result in persistent organic chemicals accumulating in the environment. On this basis, ecological integrity of this KEF and its functioning is not expected to be significantly affected by an MDO spill as defined by the EPBC significant impact criteria.
Benthic Invertebrate community of the eastern GAB shelf (spatial boundary not defined)	Benthic invertebrate communities of the eastern GAB shelf are highly biodiverse, soft sediment ecosystems. Surface sediments are dominated by heterozoan carbonate fragments comprising bryozoans, porifera, rhodoliths and other invertebrates .	No pressures of concern. Pressures of potential concern include: • Changes in sea temperature • Changes in oceanography • Ocean acidification	The Duntroon OA may overlap the benthic invertebrate community of the eastern GAB shelf. This system consists of sessile benthic habiats (sponges, ascididans, bryozoans) and other invertebrates which rely on the habitat such as crustaceans. An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. benthic habitats (sponges)) has been undertaken within this EP. As identified in Table 6-77 (Benthic invertebrates), due to the surface nature of the spill and the depth to benthic fauna in the OA, no impacts are predicted. On this basis, ecological integrity of this KEF and its functioning is not expected to be significantly affected by an MDO spill as defined by the EPBC significant impact criteria.
Small pelagic fish of the south-west region	Bioregion occurs in the GAB and the fisheries of the Gulf of St Vincent and Spencer Gulf. It refers to shoaling, epipelagic fish supported by summer upwelling events in the Eyre pelagic ecosystem. Fluctuations in abundance of small pelagic fish have serious implications for the functioning of pelagic ecosystems.	Pressures of concern are changes in sea temperature and oceanography. Pressures of potential concern include: • Ocean acidification	The Duntroon OA lies adjacent to this KEF based upon assessment of SA fisheries data. An assessment of the ecosystem sensitivities affecting ecosystem functioning (i.e. zooplankton, small pelagic fish) with respect to a MDO spill has been undertaken in this section. Spill impacts to zooplankton been assessed in Table 6-77 (plankton) and Table 6-77 (fish including sharks). As identified in those sections impacts to plankton (including krill) are localised, temporary and rapidly recoverable with observed changes in the range of natural variability. Pelagic fish impacts are also predicted to be localised, temporary and recoverable. The localised and temporary impact nature of a MDO spill in the Duntroon OA, does not result in disruption/destruction of an important habitat area; does not have an adverse impact of a population of marine species (as defined by this KEF); does not result in water quality changes which impact on the ecological functioning of the KEF; or result in persistent organic chemicals accumulating in the environment. On this basis, ecological integrity of this KEF and its functioning is not expected to be significantly affected by an MDO spill as defined by the EPBC significant impact criteria.

KEF	Ecosystem Sensitivity	Threats	Description of Impact
Shelf Rocky Reefs and hard substrates	On the continental shelf, rocky reefs and hard grounds provide attachment sites for macroalgae and sessile invertebrates, increasing the structural diversity of shelf ecosystems. The reefs provide habitat and shelter for fish and are important for aggregations of biodiversity and enhanced productivity	No pressures/threats identified.	This KEF is a non-spatially defined KEF in the SE marine region which lies adjacent to the Duntroon OA. As per the Benthic Invertebrate community of the eastern GAB shelf (spatial boundary not defined) and Ancient Coastline KEF assessment, impacts to benthic habitats (including associated fish) given the surface nature of the MDO spill is not expected. On this basis, ecological integrity of this KEF and its functioning is not expected to be significantly affected by an MDO spill as defined by the EPBC significant impact criteria.

6.10.3.4 Commonwealth and State Marine Reserves

The Duntroon multi-client survey will be undertaken in the Western Eyre CMP (IUCN VI - multiple-use zone and special use zone). A significant diesel spill within this CMP will on a short-term basis (~24 hrs) carry surface oil at levels >10µm (ecological impact) and entrained phase exposure concentrations greater than 70.5 ppb (95% species effects level).

A significant spill may also affect the:

- Western Kangaroo Island CMP (possible visible sheens, entrained phase);
- Southern Kangaroo Island CMP (possible visible sheens, entrained phase);
- Great Australian Bight CMP (possible visible sheens, entrained phase)
- Murray CMR (possible visible sheens, entrained phase); and
- South Australian Marine Reserves (possible visible sheens and entrained phase):
    - Neptune Islands Marine Park;
    - West Kangaroo Island Marine Park
    - Thorny Passage Marine Park;
    - Investigator Marine Park;
    - Sir Joseph Banks Group Marine Park;
    - Gambier Island Group Marine Park;
    - South Kangaroo Island Marine Park.

The conservation values of each of these reserves is described in **Section 3.2** and the potential effects of a significant diesel spill to those values has been assessed in this section.

<u>Commonwealth Marine Parks</u>

Table 6-80 details the relevant zonings, management objectives and conservation values of the CMPs which may be affected by spill residues from a Duntroon survey spill.

Petroleum activities are allowable in Multiple Use Zones and Special Use Zones (IUCN category VI) in accordance with Class Approvals (Mining Operations).

Management plans allow for the South-west Network of Marine Reserves allow actions required to respond to unplanned oil pollution incidents, including environmental monitoring and remediation in all zones without an authorisation issued by the DMP. This is provisional on actions being undertaken in accordance with this EP and the DMP being notified in the event of oil pollution in a marine park or where an oil spill response action must be undertaken.

In the south-east marine park network, oil pollution response, environmental monitoring and remediation activities are allowable under existing authorisations in IUCN VI zones in accordance with an accepted EP. If an oil pollution incident affects other IUCN Category VI zones, consultation is required with the DNP.

As part of the risk assessment, while impacts were assessed as moderate to slight, application of controls identified in Table 6-85 makes any spill incident highly unlikely and the residual risk varies from medium to low (depending of species affected). These controls will ensure that the Duntroon survey spill risk is reduced to a level which is ALARP and acceptable..

Appendix M demonstrates that the proposed Duntroon survey will be carried out in a manner which aligns and does not conflict with the management prescriptions for these CMPs..

<u>State Marine and Terrestrial Parks</u>

State Marine Reserves: The South Australian government has developed the South Australian Representative System of Marine Protective Areas "*to establish and manage a comprehensive, adequate* *and representative system of MPAs to contribute to the long-term ecological viability of marine and estuarine systems, to maintain ecological processes and systems, and to protect Australia's biological diversity at all levels*" (Bryars et al, 2016 p2).

These parks have been set aside to protect the biological diversity of the state's coastal, estuarine and marine environments while allowing ecologically sustainable use of the area's natural resources (National Parks SA, 2016). An assessment of the environmental, economic and social values of these parks with respect to residual acoustic sound is provided in Table 6-59.

Conservatively, it has been estimated via modelling that weathered residues (surface sheens, entrained phase hydrocarbons) may be experienced at the Neptune Island Group Marine Park, Thorny Passage Marine Park, West Kangaroo Island Marine Park, Investigator Marine Park, Sir Joseph Banks Marine Park, Gambier Islands Group Marine Park, South Spencer Gulf Marine Park and Kangaroo island Marine Park. It is possible for sheens > 10µm and higher levels of entrained phase hydrocarbon to intersect portions of Thorny Passage Marine Park (Rocky (south) Island) and Greenly Island).

An assessment of diesel spill impacts on the conservation values of these marine parks is provided in Table 6-81. The assessment concludes that any residual impacts in these state marine parks will be temporary, localised and recoverable and does not significantly impact on conservation values of these marine reserves.

Management plans have been developed for these State marine reserves and provide a list of management strategies to conserve the applicable natural values. An evaluation of residual spill impacts from the Duntroon survey against these management objectives is provided in Table 6-82. The review did not identify that the proposed Duntroon survey would conflict with the management objectives of those reserves. DEWNR have been consulted as part of the collation of this EP (refer **Section 9**).

State Terrestrial Reserves: An assessment of diesel spill impacts for State terrestrial reserves is provided in **Appendix M** as it relates to the inter-tidal area which may be affected by spill residues. The assessment concludes that any residual impacts in these state marine parks will be temporary, localised and recoverable and does not significantly impact on conservation values of these terrestrial reserves.

Management plans have been developed for these State terrestrial reserves and provides a list of management strategies to conserve the applicable natural values. An evaluation of residual spill impacts from the Duntroon survey against these management objectives is provided in **Appendix M**.

Table 6-80 Management Principles and Conservation Values assessment of CMP's affected by a Duntroon Survey MDO Spill (DNP,2018; DNP, 2013)

<table>
<tr><th>CMR</th><th>Zonation</th><th>Potential Oil Spill Impact</th><th>Distance to Nearest OA Boundary</th><th>Objective of Zone</th><th>IUCN Reserve Management Principles [EPBC Regulations 2000 (Schedule 8)]</th><th>Values</th><th>Principle Attainment</th></tr>
<tr><td rowspan="2">Western Eyre CMP</td><td>Multiple Use Zone (IUCN VI) (16,107 km^2)
OA: 8,200 km^2 (overlap)</td><td>Surface: >10µm
Entrained phase: > 70.5 ppb x 96 hrs</td><td>Within Survey area</td><td>Provide for the ecologically sustainable use and the conservation of ecosystems, habitats and native species.</td><td rowspan="2">General Administrative Principle 4: The integrity of a reserve zone is best conserved by protecting it from disturbance and threatening processes. Potential adverse impacts should be minimised as far as practicable.
Zone should be managed for the ecologically sustainable use of natural ecosystems based upon the following principles:
• Biological diversity and other natural values should be protected and maintained in the long-term;
• Management practices applied to ensure the ecological sustainable use of the reserve or zone;
• Management of the reserve or zone should contribute to regional and national development to the extent it is consistent with these principles.</td><td rowspan="2">Important foraging area for the:
• Australian sea lion;
• Threatened white shark;
• Threatened blue and migratory sperm whale;
• Seabirds;
Examples of westernmost ecosystems of Spencer Gulf shelf Province and easternmost GAB shelf transition and Southern Province.
Five KEFs:
• Ancient coastline (90-120m) – benthic biodiversity and productivity where coastline forms prominent escarpment
• Kangaroo Island Pool, canyon and adjacent shelf-break & Eyre Peninsula upwelling – area of nutrient rich upwellings enhancing productivity and seasonal aggregations of marine species;
• Meso-scale eddies – important transporters if nutrients and plankton communities;
• Benthic invertebrates communities of the eastern GAB shelf – soft sediement benthic invertebrate communities;
• Small Pelagic Fish of southwest marine region – trophic link between plankton and larger fin-fish preadators.
<u>Cultural</u>: Sea country is valued for indigenous cultural identity, health and well-being.
<u>Heritage</u>: No listings in CMP
<u>Social and Economic Values</u>: Commercial tourism, commercial fishing, recreation and mining are important in the CMP.</td><td rowspan="2">Table 6-77 provides an assessment of spill impacts to these foraging species. For cetaceans, the Australian sea lion and migratory seabirds MDO spill impacts are assessed as disrupting a small portion of the population with minor effects on critical habitats. Impacts to the white shark as assessed as localised and slight. Given the localised, temporary and recoverable nature of the spill individual animals only may be affected, however this is not expected to lead to population level effects. On this basis the controls applied ensure the protection of these conservation values.
An assessment of the survey activity on the ecological integrity of ecosystems present in the Duntroon OA has been undertaken in Table 6-79. On the basis of this assessment, the Duntroon activity does not result in ecological integrity impacts to KEFs.
Given biological diversity and ecological sustainability of the area is maintained, and with management measures adopted to avoid spatial conflicts with commercial fisheries, there is no predicted significant impacts to social and economic values.</td></tr>
<tr><td>Special Purpose Zone (IUCN VI) (24,196 km^2)
OA: 1620 km^2 (overlap)</td><td>Surface: >10µm
Entrained phase: > 70.5 ppb x 96 hrs</td><td>Within Survey area</td><td>Provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species, while applying special purpose management arrangements for specific activities.</td></tr>
</table>

CMR	Zonation	Potential Oil Spill Impact	Distance to Nearest OA Boundary	Objective of Zone	IUCN Reserve Management Principles [EPBC Regulations 2000 (Schedule 8)]	Values	Principle Attainment
Western Eyre CMP (Con't)	Marine National Park (IUCN Category II) (17,437 km^2)	Surface: >10µm Entrained phase: > 70.5 ppb x 96 hrs	27 km north	Provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.	The zone should be protected and managed to conserve its natural condition according to the following: • Natural and scenic areas of national and international significance should be protected for spiritual, scientific, educational, recreational or tourism purposes;	Values are the same as Western Eyre CMP - Multiple Use and Special Purpose Zone (as above).	Impacts to marine area is temporary, localised and recoverable and not expected to affect natural and scenic areas of national and international significance.
					• Representative examples of physiographic regions, biotic communities, genetic resources and native species should be perpetuated in as natural state as possible to provide ecological stability and diversity		Potential impacts to species and biotic communities have been shown to have only temporary, localised impacts to individual species maintaining ecological stability and biodiversity within the survey area where the spill impacts are predicted to be greatest. IUCN management principle is met.
					• Visitor use should be managed at a level which will maintain the zone in a natural or near natural state		N/A – covered by Park Management
					• Management should seek to ensure that exploitation or occupation inconsistent with these principles does not occur.		N/A – covered by Park Management.
					• Respect maintained for the ecological, geomorphological, sacred and aesthetic attributes which the reserve or zone was assigned to this category.		Survey activities within the Duntroon OA will not affect this value in the National Park Zone.
					• Needs of indigenous people should be taken into account including subsistance resource use to the extent that they do not conflict with these principles.		Consultation has occurred with all relevant Aboriginal stakeholders (refer **Section 9**). Survey activities within the Duntroon OA will not affect this value in the National Park Zone.

CMR	Zonation	Potential Oil Spill Impact	Distance to Nearest OA Boundary	Objective of Zone	IUCN Reserve Management Principles [EPBC Regulations 2000 (Schedule 8)]	Values	Principle Attainment
Western Eyre CMP (Con't)	Marine National Park (IUCN Category II) (17,437 km^2)	Surface: >10µm Entrained phase: > 70.5 ppb x 96 hrs	27km north	Provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.	• Aspirations of traditional owners of the land, continuing land management practices, protection and maintenance of cultural heritage and the benefits of traditional owner enterprises, established in the reserve or zone, consistent with these principles should be recognised and taken into account.	Values are the same as Western Eyre CMP - Multiple Use and Special Purpose Zone (as above).	Consultation has occurred with all relevant Aboriginal stakeholders (refer **Section 9**). Survey activities within the Duntroon OA will not affect this value in the National Park Zone.
Western Kangaroo Island CMP	Special Purpose Zone (IUCN VI)	Surface: >0.5µm Entrained phase: > 70.5 ppb x 96 hrs	47 km east	Provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species, while applying special purpose management arrangements for specific activities	As above for Western Eyre "Special Purpose Zone" and "Multiple Use Zone"	Note the conservation values for the Western Kangaroo Island CMP are a subset of the Western Eyre CMP (as follows): Important foraging area for the: • Australian sea lion; • Threatened white shark; • Threatened blue and migratory sperm whale; • Migratory seabirds – Pacific gulls, black-faced cormorants, and caspian tern. Important seasonal calving buffer habitat for threatened southern right whale. Examples of westernmost ecosystems of Spencer Gulf shelf Province and Southern Province. Two KEFs: • Ancient coastline (90-120m) • Kangaroo Island Pool, canyon and adjacent shelf-break & Eyre Peninsula upwelling. <u>Cultural</u>: Sea country is valued for indigenous cultural identity, health and well-being. <u>Heritage</u>: No listings in CMP <u>Social and Economic Values</u>: Commercial tourism, commercial fishing, recreation and mining are important in the CMP.	Assessment is as per the Western Eyre Marine National Park Zone. Table 6-77 provides an assessment of spill impacts to these species. Surface oiling present in the Western Kangaroo Island CMP is predicted to be below ecological impacts thresholds for all species identified. No significant impacts to foraging or calving activities predicted. Incidental impacts are predicted associated with entrained hydrocarbon within the water column. An assessment of the survey activity on the ecological integrity of KEFs present in the Duntroon OA has been undertaken in Table 6-79. On the basis of this assessment which identified ecological integrity is maintained in the KEFs within the Duntroon OA, KEF ecological integrity is maintained in the Western Kangaroo island CMP.
Western Kangaroo Island CMP	Marine National Park (IUCN Category II)	Surface: >0.5µm Entrained phase: > 70.5 ppb x 96 hrs	60 km east	Provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.	As above for Western Eyre "National Park Section"		On the basis of the above assessment, the ecosystem is therefore protected and conserved with habitats and native species maintained in as natural a state as possible.

CMR	Zonation	Potential Oil Spill Impact	Distance to Nearest OA Boundary	Objective of Zone	IUCN Reserve Management Principles [EPBC Regulations 2000 (Schedule 8)]	Values	Principle Attainment
Southern Kangaroo Island CMP	Special Purpose Zone (IUCN VI)	Surface: >0.5µm Entrained phase: > 70.5 ppb x 96 hrs	155 km east	Provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species, while applying special purpose management arrangements for specific activities	As above for Western Eyre "Special Purpose Zone" and "Multiple Use Zone"	Note the conservation values for the Southern Kangaroo Island CMP are a subset of the Western Eyre CMP (as follows): Important foraging area for the: • Australian sea lion; • Threatened white shark; • Seabirds including fairy terns and black-faced cormorants Important seasonal calving habitat for threatened southern right whale. Examples of westernmost ecosystems of Spencer Gulf shelf Province and Southern Province. Two KEFs: • Kangaroo Island Pool, canyon and adjacent shelf-break & Eyre Peninsula upwelling. Cultural: Sea country is valued for indigenous cultural identity, health and well-being. Heritage: No listings in CMP Social and Economic Values: Commercial tourism, commercial fishing and recreation are important in the CMP.	Assessment is as per the Western Eyre Marine National Park Zone. Table 6-77 provides an assessment of spill impacts to these species. Surface oiling present in the Southern Kangaroo Island CMP is predicted to be below ecological impacts thresholds for all species identified. No significant impacts to foraging or calving activities predicted. Incidental impacts are predicted associated with entrained hydrocarbon within the water column. An assessment of the survey activity on the ecological integrity of KEFs present in the Duntroon OA has been undertaken in Table 6-79. On the basis of this assessment which identified ecological integrity is maintained in the KEFs within the Duntroon OA, KEF ecological integrity is maintained in the Southern Kangaroo island CMP. Given biological diversity and ecological sustainability of the area is maintained, and with management measures adopted to avoid spatial conflicts with commercial fisheries, there is no predicted significant impacts to social and economic values.

CMR	Zonation	Potential Oil Spill Impact	Distance to Nearest OA Boundary	Objective of Zone	IUCN Reserve Management Principles [EPBC Regulations 2000 (Schedule 8)]	Values	Principle Attainment
Great Australian Bight CMP	Multiple Use Zone (IUCN VI) [Note: Spills from Duntroon survey are only expected to affect this zone of the GAB CMP]	Surface: >0.5µm Entrained phase: > 70.5 ppb x 96 hrs	130 km west	Provide for the ecologically sustainable use and the conservation of ecosystems, habitats and native species.	As above for Western Eyre "Special Purpose Zone" and "Multiple Use Zone".	Note the conservation values for the Southern Kangaroo Island CMP are a subset of the Western Eyre CMP (as follows): BIAs for: • Seabirds (foraging); • Australian sea lion; • Threatened white shark; • Pygmy Blue and Sperm whales. Important seasonal calving habitat for threatened southern right whale. Examples of ecosystems of GAB Shelf Transition (characterised by an extensive area of flat continental shelf with invertebrate communities amongst the most diverse in the world) and the Southern Province. Two KEFs (refer Table 6-57 for assessment of ecological integrity and assessment of adverse effects on populations): • Ancient coastline between 90-120m depth; • Benthic invertebrate community of the eastern GAB • Small pelagic fish of the SW marine bioregion. <u>Cultural</u>: Sea country is valued for indigenous cultural identity, health and well-being. <u>Heritage</u>: No listings in CMP <u>Social and Economic Values</u>: Commercial tourism, commercial fishing, mining and recreation are important in the CMP.	Assessment is as per the Western Eyre Marine National Park Zone. Table 6-77 provides an assessment of spill impacts to these species. Surface oiling present in the GAB CMP is predicted to be below ecological impacts thresholds for all species identified. No significant impacts to foraging or calving activities predicted. Incidental impacts are predicted associated with entrained hydrocarbon within the water column. An assessment of the survey activity on the ecological integrity of KEFs present in the Duntroon OA has been undertaken in Table 6-79. On the basis of this assessment which identified ecological integrity is maintained in the KEFs within the Duntroon OA, KEF ecological integrity is maintained in the GAB CMP. Given biological diversity and ecological sustainability of the area is maintained, and with management measures adopted to avoid spatial conflicts with commercial fisheries, there is no predicted significant impacts to social and economic values.

CMR	Zonation	Potential Oil Spill Impact	Distance to Nearest OA Boundary	Objective of Zone	IUCN Reserve Management Principles [EPBC Regulations 2000 (Schedule 8)]	Values	Principle Attainment
Murray CMP	Multiple Use Zone (IUCN VI) [Note: Spills from Duntroon survey are only expected to affect this zone of the Murray CMP]	Surface: >0.5µm Entrained phase: > 70.5 ppb x 96 hrs	126 km SE	Provide for the ecologically sustainable use and the conservation of ecosystems, habitats and native species.	As above for Western Eyre "Special Purpose Zone" and "Multiple Use Zone".	Examples of ecosystems, habitats and communities associated with: the • Spencer Gulf Shelf Province; the Southern Province; the West Tasmanian Transition; and associated with sea-floor features: abyssal plain/deep ocean floor canyon escarpment knoll/abyssal hill shelf slope terrace Features with high biodiversity and productivity: • Bonney coast upwelling • shelf rocky reefs and hard substrate Important foraging areas for: • blue, sei and fin whales • Australian sea lion • wandering, black-browed, yellow-nosed and shy albatrosses, great-winged petrels, flesh-footed and short-tailed shearwaters, and white-faced storm petrel Important breeding area for: southern right whale Important migration area for: humpback whale	Assessment is as per the Western Eyre Marine National Park Zone. Table 6-77 provides an assessment of spill impacts to species. Surface oiling present in the Murray CMP is predicted to be below ecological impacts thresholds for all species identified. No significant impacts to foraging or calving activities predicted. Incidental impacts are predicted associated with entrained hydrocarbon within the water column. An assessment of the survey activity on the ecological integrity of KEFs present in the Duntroon OA has been undertaken in Table 6-79. The Bonney upwelling lies outside the oil spill EMBA. On the basis of this assessment which identified ecological integrity is maintained in the KEFs within the Duntroon OA, KEF ecological integrity is maintained in the Murray CMP. Given biological diversity and ecological sustainability of the area is maintained, and with management measures adopted to avoid spatial conflicts with commercial fisheries, there is no predicted significant impacts to social and economic values.

Table 6-81: Assessment of impacts on conservation values of the Marine Parks affected by spill residues from a Duntroon Oil Spill (SA)

Conservation Value	Assessment of Impact
Neptune Island Group MP (DNRE, 2010a) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels*]	
Physical influences include full exposure to high wind, wave and swell energy; transition from western warm currents to the cool, temperate southeastern waters; the warm Leeuwin current from the west; and the cool Flinders Current from the southeast.	Residual spill impacts does not influence the physical processes at Neptune Islands. No impact expected to this conservation value.
Habitat Variety: Shoreline class data has not been established for the Neptune Islands. The island group comprises of granite mountains rising steeply from deep water exposed to high wind, wave and swell environments. Habitats include the exposed island environments above the reach of the tides, while at the shoreline, intertidal reefs extend down into deep water and sandy seafloor habitats.	Residual spill impacts to these habitats have been assessed (refer Table 6-77). Conservation value is not affected.
Marine Species: The Marine Park supports a variety of marine and coastal species including fish and sharks, some of which have been identified as ecologically important. This includes: • A range of fish species, including many of commercial importance, inhabit areas around these islands including snapper, trevally, wrasse, Western Australian salmon, gummy shark, whaler shark and Australian herring (tommy ruff). • The Neptune Islands have been identified by CSIRO as an important area for the nationally vulnerable white shark, particularly for feeding. The shortfin mako, porbeagle and other shark or ray species of conservation concern recorded in the area include the coastal stingaree, whitespotted spurdog, spotted wobbygong, bronze whaler, blue shark, smooth hammerhead, school shark and dusky whaler. • The western blue groper, identified as being of conservation concern, inhabits reefs of the Neptune Islands. These fish species have been identified as a long-living, site attached species, which are particularly vulnerable to fishing pressure. Various reef fishes which are of conservation concern, including several wrasse species, harlequin fish and western blue devil are found in the area.	An assessment of residual spill impacts to fish species is provided in Table 6-77. Any residual spill impacts to fish species are predicted to be localised, temporary and recoverable. Conservation valuues is not affected.
Marine Species: The Marine Park supports a variety of marine and coastal species including marine mammals some of which have been identified as ecologically important. This includes: A breeding population of the nationally and state listed Australian sea lion lives within the Neptune Islands, and about half the Australian population of New Zealand fur seals are known to inhabit the South and North Neptune Islands. It is believed to be the State's most important pup production site for the Australian sea lion ("threatened" status).	An assessment of residual spill impacts to shoreline pinniped species is provided in Table 6-78. Spill residues fall below ecological impact levels. Conservation value is not affected.
Marine Species: The Marine Park supports a variety of marine and coastal species including birds which have been identified as ecologically important. This includes: Seabirds protected under international treaties, such as the Caspian tern, crested tern and short-tailed shearwater roost and nest on the Neptune Islands. The Cape Barren goose and peregrine falcon breed and nest on the islands. In addition the state endangered fairy tern is known to breed on South Neptune Island and the state rare rock parrot also occurs on the islands.	An assessment of residual spill impacts to seabird species is provided in Table 6-78. Residual impacts from shoreline hydrocarbon loadings and sea surface thicknesses do not trigger ecological impacts within this marine park. Conservation value not affected.
Marine Species: The Marine Park supports a variety of marine and coastal species including invertebrates, some of which have been identified as ecologically important. This includes: The turrid shell and the typhine shell have been recorded from waters around the Neptune Islands. Both are believed to be uncommon and possibly endemic. Reefs around the island are used by one or more of the life stages of various commercially or recreationally important species such as southern rock lobster, southern calamari, greenlip and blacklip abalone and purple sea urchins.	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. Any residual spill impacts to fish species are predicted to be localised, temporary and recoverable. Conservation value is not affected.

Conservation Value	Assessment of Impact
Commercial Fishing: Commercial fishing which operates in the Neptune Islands Marine Park are the Northern Zone Rock Lobster Fishery, Sardine Fishery, Marine Scalefish Fishery and Abalone Fishery.	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. Any residual spill impacts to commercial fish species are predicted to be localised, temporary and recoverable. Conservation value is not affected.
Transport and Infrastructure: Transport and infrastructure provide an important economic contribution to the region, providing for maritime activities such as: shipping ports for import and export of goods; boat ramps for launching of recreational or commercial vessels; jetties for fishing; and breakwaters and groynes for coastal management	No impact is expected from visible sheens to this conservation values.
Local Tourism: The regular presence of great white sharks in the area has led to a world-renown shark viewing industry, with two operators conducting cage diving tours, one based in Port Lincoln and one in Adelaide. Charter fishing is also conducted around the islands	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause a minor impact to tourism activities, however the impact will be temporary, localised and recoverable. No long-term impact to this conservation value is expected.
Aboriginal Heritage: Little is known about the Aboriginal heritage for the Neptune Islands Group Marine Park. However the Government is aware that there may be confidential Aboriginal heritage sites in South Australia's coastal areas. Future management plans will ensure these heritage sites are appropriately respected. Aboriginal aspirations for this area are not known by the Department of Environment and Natural Resources	Residual spill impacts at the Neptune Islands will not affect the aboriginal heritage values present at the location. No impacts expected to this conservation value.
European Heritage: The relatively intact lighthouse complex on South Neptune Island, which includes the keepers' cottages, fences, store buildings, water tanks, graves and the foundations of the original lighthouse, was established in 1901. The lighthouse has been returned to Port Adelaide, but the remaining structures illustrate the isolation and self sufficient lifestyle of one of the state's more isolated lightstations. It is listed on both the State Heritage Register and the Register of the National Estate. A number of wrecks have occurred around the southern islands, including the Frances (1840) which is protected but not found, and the Venus (1946) and Yandra (1959) which are not protected.	Residual spill impacts will not affect the european heritage values present at the location given their seabed location. No impacts expected to this conservation value.
Recreational Activities: Due to the remoteness of this park, there are limited recreational activities undertaken here, other than white shark cage diving and charter fishing.	This value is assessed as part of the "local tourism" conservation value.
Thorny Passage MP (DNRE, 2012) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels except at Rocky (south) Island and possibly Greenly Island*]	
Environmental Values – Habitats: Thorny Passage Marine Park comprises various habitats including the sheltered bays and inlets, reefs, seagrass meadows, tidal sandflats of Coffin Bay, rugged rocky coastlines with exposed, steep headlands and cliffs, exposed, high- 5 energy surf beaches, reefs, offshore islands and large areas of sandy seafloor habitat.	Residual spill impact does not influence the physical processes at Thorny Passage Marine Park. No impact expected to this conservation value.
Environmental Values – Species: Marine life is influenced by the warm Leeuwin Current originating in Western Australia, the cold Flinders Current from the south east and cold, nutrient-rich upwellings originating in deep water off the continental shelf, creating a haven for marine life and many endemic and iconic species (Baker 2004). Iconic species include the white shark, Australian sea lion, southern bluefin tuna, 13 whale species; site attached reef fish such as western blue groper and western blue devil and many nationally and internationally protected shorebird and seabird species (Baker 2004).	Table 6-77and Table 6-78 assess spill impacts to shark, pinniped, fish, cetacean and bird species. Surface oiling at 10µm may reach waters surrounding Rocky (south) Island. There is less probability that 10µm surface oiling will reach Greenly Island. It is possible that pinnipeds foraging in proximity to these islands may encounter thresholds which may lead to lethal or sub-lethal impacts, however this exposure is localised, temporary and unlikely to cause an impact at a population level (i.e. individuals affected). Conservation value is retained. For other areas of the MP, residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.

Conservation Value	Assessment of Impact
Economic Values: Thorny Passage Marine Park supports an aquaculture industry predominantly based on Pacific oysters farmed in Coffin Bay. Abalone is also farmed in this area.	Table 6-78 assesses impacts to inter-tidal invertebrates and aquaculture. Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic Values: Commercial fisheries operating in the Thorny Passage Marine Park include the Western Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the West Coast Prawn Fishery, the Sardine Fishery, the Marine Scalefish Fishery, the Miscellaneous Fishery (Urchin) and the Charter Fishery.	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. 'Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected
Economic Values: Tourism is an important contributor to the region. Key activities include recreational and charter fishing, scenic cruises, diving, four-wheel driving and expedition cruise ships.	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities, however the impact will be slight, localised, temporary and recoverable. No long-term impact to this conservation value is expected.
Social Values: The Nauo and Barngala Aboriginal people have traditional associations with areas of the marine park. There are two Native Title claims which include areas of the marine park; the Barngala Native Title Claim (1996) and the NauoBarngala Native Title Claim (1997)	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social values: In 1802 Matthew Flinders named Cape Catastrophe and Memory Cove after the loss of eight of his crew within the area. The significance of this site is recognised by its inclusion in the State Heritage Register.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: Archaeologically significant whaling stations, shipwrecks and jetties are found within the Thorny Passage Marine Park. Several sections of the coastline are recognised as geological monuments.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: Thorny Passage Marine Park is a popular destination for a wide range of beach and water sport activities and nature appreciation, such as bird watching and sightseeing.	An assessment of residual spill impacts to tourism values is provided in Table 6-78Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities however the impact will be temporary, localised and recoverable. No long-term impact to this conservation value is expected.
Investigator MP (DNRE, 2012b) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels*]	
Environmental Values - Physical: The Investigator Marine Park is influenced by the warm Leeuwin Current, the cool Flinders Current and seasonal nutrient-rich upwellings, creating a unique 5 and varied ecosystem.	Residual spill impact does not influence the physical processes at Investigator Passage Marine Park. No impact expected to this conservation value.
Environmental Values – Habitats: The park consists of steeply rising offshore islands, cliffs and high energy surf beaches along the mainland coast.	Residual spill impacts to these habitats have been assessed (refer Table 6-78). Conservation value is not affected
Environmental Values – Species: The diverse habitats support a wide range of flora and fauna, including a number of endemic species and species of conservation importance. One of these is the light emitting golden roughy, which has only been found in the Investigator Marine Park. Other iconic species include the western blue groper which utilises the habitat as a nursery area, Australian sea lions and New Zealand fur seals which breed and haul out on the islands.	Table 6-77 and Table 6-78 assess spill impacts to pinniped and fish species. Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.

Conservation Value	Assessment of Impact
Economic values – Fisheries: Four commercial fisheries operate in the Investigator Marine Park: Western Zone Abalone Fishery, the Northern Rock Lobster Fishery, the Marine Scale-fish Fishery and the Charter Fishery.	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. 'Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected
Economic values – Tourism: Tourism is an economic contributor to the region. Key activities include recreational and charter fishing, scenic cruises, scuba diving and expedition cruise ships. A popular annual shore-based fishing competition attracts a large number of recreational fishers into the area.	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities; however, the impact will be slight, localised, temporary and recoverable. No long-term impact to this conservation value is expected. Conservation value is not affected
Social values: The Wirangu and Nauo-Barngarla Aboriginal people have traditional associations with areas of the marine park and parts of the Nauo-Barngala Native Title Claim (1997) are included in areas of the Investigator Marine Park	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: The Investigator Marine Park has European heritage values including whaling stations, wrecks and remains of pastoral and agricultural enterprises on Flinders Island	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: Some areas within the Investigator Marine Park are listed on the Register of the National Estate. Point Drummond is listed as a geological monument.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
West Kangaroo Island MP (DEWNR, 2012g) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels*]	
Environmental Values – Physical: The southern and western coasts of the park are highly exposed to strong winds and large swells and experience seasonal nutrient-rich upwellings. The park's shoreline is dominated by rugged, exposed cliffs and headlands interspersed by pocket beaches. Reefs extend from intertidal wave-cut shore platforms along most of the coastline and transition to sandy seafloor habitats in deeper waters	Residual spill impact does not influence the physical processes at West Kangaroo Island Marine Park. No impact expected to this conservation value.
Environmental Values – Habitats: The marine park includes the estuaries of rivers flowing from the adjacent Flinders Chase National Park. The catchments of two of these, the Breakneck and Rocky Rivers, are entirely contained within the terrestrial park and are listed as Wetlands of National Importance	Residual spill impacts to these habitats are unlikely to be impacted due to the low levels of residual hydrocarbon expected. Coastal habitats have been assessed (refer Table 6-78). Conservation value is not affected.
Environmental Values – Species: Three species of pinnipeds (seals and sea lions) are found within this park. Cape du Couedic has ten recorded breeding sites for New Zealand fur seals (NZFS) and another occurs on North Casuarina Islet. Together, these sites create the second largest concentration of NZFS on Kangaroo Island. North Casuarina Islet is also a site for Australian sea lions to haul-out, and occasionally breed, as well as a significant breeding site for Australian fur seals. Fish species of conservation concern found in the park include the long-lived and site-attached western blue groper, harlequin fish and the western blue devil.	Table 6-77 and Table 6-78 assess spill impacts to pinniped and fish species. Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic values - Tourism: Notable tourist destinations adjacent to the Western Kangaroo Island Marine Park include the Flinders Chase National Park visitor centre, Admirals Arch and Remarkable Rocks which experience high levels of visitation each year. The Cape Borda Light station at the north-west corner of the island is also popular. Tourism is therefore an important economic contributor to the region as well as providing a significant employment opportunity for the Kangaroo Island population	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities; however, the impact will be slight, localised, temporary and recoverable. No long-term impact to this conservation value is expected. Conservation value is not affected.
Economic values – Commercial Fishing: Commercial fisheries operating in the Western Kangaroo Island Marine Park include the Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Sardine Fishery, Charter Fishery and the Marine Scalefish Fishery (Gulf St Vincent/Kangaroo Island). These fisheries are important to regional economies of the area both directly, through employment in each fishery, and indirectly, through a range of additional services such as processing, local transport, marketing, local retail and food services.	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. Residual hydrocarbons are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.

Conservation Value	Assessment of Impact
Social Values: The MP is rich in European exploration and settlement history and contains a number of protected shipwreck sites and State and Commonwealth Heritage listed lighthouses and associated jetty, store and landing sites. The spectacular coastal formations of Admirals Arch at Cape du Couedic and the Remarkable Rocks are recognised as Geological Monuments, as are sites at Harveys Return, West Bay and Ravine des Casoars.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: One of the primary social values of this marine park is its wilderness, both on land and at sea. Wild weather and large southern ocean swells cause dangerous sea conditions that can only be accessed in large vessels. The steep terrain and cliffs make the shore largely inaccessible except by walking trails along rivers, and cliff top lookouts at Cape Borda and Cape de Couedic reinforce the sense of wild isolation in this park. On the north coast, rugged cliffs, rising to 260m between Cape Torrens and Scott Cove, create spectacular views to Yorke Peninsula and the Althorpe Islands (DENR 2010).	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value
Sir Joseph Banks Group MP (DEWNR, 2012b) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels*]	
Environmental Values – Habitat: The Sir Joseph Banks Group MP encompasses a group of 20 low lying islands and waters adjacent to Tumby Bay, a Wetland of National Importance. The MP contains habitats including islands, shallow reefs, sheltered sandy bays and rocky limestone shores, seagrass meadows, saltmarsh communities and deep-water habitats of lower Spencer Gulf.	Residual spill impacts to these habitats are unlikely to be impacted due to the low levels of residual hydrocarbon expected. Coastal habitats have been assessed (refer **Table 6-66**). Conservation value is not affected.
Environmental Values – Species: These habitats support a wide range of flora and fauna including many species of national importance. Dangerous Reef hosts one of the largest breeding colonies of Australian sea lions in the world (Goldsworthy and Page 2009; Shaughnessy and Goldsworthy 2007) and pregnant female white sharks are often found in the area, perhaps due to the abundance of their sea lion prey. The iconic King George whiting utilises the area as breeding and nursery grounds and the endemic leafy sea dragon inhabits the inshore seagrass beds (Baker 2004). The Sir Joseph Banks Group MP also hosts a variety of invertebrate species and a number of bird species which are protected under international treaties (Baker 2004).	Table 6-77 and Table 6-78 assess spill impacts to pinniped, fish and bird species. Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic Values – Commercial Fishing: The Lower Eyre Peninsula aquaculture zone policy exists in this marine park. Southern bluefin tuna, mussels, abalone and other finfish farming occurs in the policy area. The Western Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Spencer Gulf Prawn Fishery, Sardine Fishery, Marine Scalefish Fishery and Charter Fishery are commercial fisheries which operate within the Sir Joseph Banks Group Marine Park	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. Residual hydrocarbons are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic Values – Tourism: Tourism is an important economic contributor to the region. Key activities include recreational and charter fishing, charter sailing and diving, marine mammal watching and scenic cruises	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities; however, the impact will be slight, localised, temporary and recoverable. No long-term impact to this conservation value is expected. Conservation value is not affected.
Social Values: The Nauo-Barngarla Aboriginal people have traditional associations with areas of the marine park. The Barngala Native Title Claim (lodged in 1996) includes parts of the Sir Joseph Banks Group Marine Park	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: Matthew Flinders explored the islands of the Sir Joseph Banks Group in 1802. Grazing and farming was later carried out until the 1960s when the group was declared a Conservation Park. Shipwrecks and building "remains" can be found within the marine park (Robinson et al. 1996)	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: The Sir Joseph Banks Group Marine Park is popular for recreational shore and boat fishing, diving, swimming, camping, sightseeing and beach activities	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Gambier island Group MP (DEWNR, 2012d) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels*]	

Conservation Value	Assessment of Impact
Environmental values – Habitat: The Gambier Islands Group Marine Park is influenced by high exposure to wind, wave and swell energy combined with cool and warm currents and saline waters. The park comprises various habitats from exposed cliffs and rocky shores to long sandy beaches and seagrass meadows. These habitats support a wide range of flora and fauna including many species of conservation importance	Residual spill impacts to these habitats are unlikely to be impacted due to the low levels of residual hydrocarbon expected. Coastal habitats have been assessed (refer **Table 6-78**). Conservation value is not affected.
Environmental values – Species: Commercially important fish species including King George whiting, trevally, Western Australian salmon and Australian herring (tommy ruff) inhabit the waters around the islands at one or more stages of their lives. Red and brown macroalgae and invertebrates are abundant in the waters surrounding the islands and the islands themselves are important habitat for Australian sea lions and seabirds of conservation concern (Baker 2004)	Table 6-77 and Table 6-78 assess spill impacts to fish, invertebrates, macroalgae, pinnipeds and seabirds. Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic Values – Commercial Fishing: Commercial fisheries operating in the Gambier Islands Group Marine Park include the Sardine Fishery, Charter Fishery, Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Marine Scalefish Fishery and Spencer Gulf Prawn Fishery.	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. Residual hydrocarbons are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic Values – Tourism: A jetty, lighthouse and an airstrip are located on Wedge Island to facilitate tourism and local access. Diving, fishing charters and sightseeing occur in the waters around the islands and holiday accommodation is available on the island	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities; however, the impact will be slight, localised, temporary and recoverable. No long-term impact to this conservation value is expected. Conservation value is not affected.
Social Values: The traditional associations of Aboriginal people with the marine park are unknown	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: Matthew Flinders named Wedge Island in 1802 referring to its wedge shape. The island was used for pastoral activities and guano mining and relics of the settlement history still remain on the island. During the Second World War a RAAF radar base was established on the island and a jetty was built in the 1940s (Robinson et al. 1996). A number of ships were wrecked within the area and a lighthouse is now situated on the highest point of the island.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: The remoteness of the Gambier Islands Group Marine Park limit recreational activities. However, fishing, diving, snorkelling and swimming are activities known to occur within the area.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
South Spencer Gulf MP (DEWNR, 2012e) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels*]	
Environmental Values – Habitat: The Southern Spencer Gulf Marine Park is influenced by varying seafloor depths and wind and wave exposures, which have shaped the changing coastline. Low energy beaches backed by extensive sand dunes, shallow embayments dominated by seagrass meadows and low-profile reefs dominate the habitats on the north coast of the park from Hardwicke Bay to Corny Point. The remainder of the park from Corny Point to Foul Bay and part of the North coast of Kangaroo Island comprises various habitats from exposed cliffs, offshore islands and headlands fronted by high energy intertidal reefs and rocky shore platforms to both sheltered and high energy sand beaches backed by sand dunes (Baker 2004). The sheltered embayment of Hardwicke Bay containing extensive seagrass meadows is a significant feature of this park.	Residual spill impacts to these habitats are unlikely to be impacted due to the low levels of residual hydrocarbon expected. Coastal habitats have been assessed (refer **Table 6-78**). Conservation value is not affected.
Environmental value – species: The sheltered embayment of Hardwicke Bay supports a long expansive beach is home to nesting hooded plovers. The Althorpe Islands Conservation Park includes a haul out site for the vulnerable Australian sea lion and the New Zealand fur seal. Cliff habitats throughout the park provide important nesting sites for endangered seabirds.	Table 6-78 assesses spill impacts to shorebirds, pinniped colonies and seabirds. Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.

Conservation Value	Assessment of Impact
Economic Values – Commercial Fishing: Commercial fisheries operating in the Southern Spencer Gulf Marine Park include the Spencer Gulf Prawn Fishery, the Central Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the Sardine Fishery, the Marine Scalefish Fishery and the Charter Fishery	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. Residual hydrocarbons are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic Values – Tourism: Tourism is an important economic contributor to the region. Key activities include recreational and charter fishing, charter sailing, recreational diving and expedition cruise ships.	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities; however, the impact will be slight, localised, temporary and recoverable. No long-term impact to this conservation value is expected. Conservation value is not affected.
Social Values: The Narungga Aboriginal people have traditional associations with areas of the marine park. An Indigenous Land Use Agreement (ILUA) exists over areas of the marine park and a fishing ILUA is also under development. The Ngarrindjeri and Kaurna Aboriginal people may have had traditional associations with Kangaroo Island. During the nineteenth century, Ngarrindjeri, Kaurna and Tasmanian Aboriginal women were brought to the island by sealers for their knowledge and labour to assist with the hunting. This renewed an Aboriginal link with the island that had been broken for approximately 5000 years.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: The Southern Spencer Gulf marine park is rich in European history and many ships were wrecked in Investigator strait or the south west coast of Yorke Peninsula. At least 40 known shipwrecks lie in the park, 26 of which are included in the Investigator Strait Maritime Heritage Trail. The lighthouse keepers' cottages, jetty and flying fox on Althorpe Island are listed in the State Heritage Register.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: The coastline of the Southern Spencer Gulf Marine Park is among the highest ranked areas of coastal scenic quality in the state.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Southern Kangaroo Island MP (DEWNR, 2012f) [*If contacted by surface oils, surface oil is likely to be at visible levels and the entrained phase at low levels*]	
Environmental Values – Habitat: This region of Kangaroo Island is fully exposed to the strong winds and large swells of the Southern Ocean that have shaped its rugged coastline over thousands of years. Exposed cliffs, rocky headlands and wave-cut shore platforms dominate the park with high energy sandy beaches and dunes at Seal Bay and Bales Beach. Fringing and deep-water reefs are interspersed by sandy seafloor whilst the slightly more sheltered waters of D'Estrees Bay support the only significant seagrass bed on the south coast of the island.	Residual spill impacts to these habitats are unlikely to be impacted due to the low levels of residual hydrocarbon expected. Coastal habitats have been assessed (refer Table 6-77 **a**nd Table 6-78). Conservation value is not affected.
Environmental Values – Species: The most iconic feature of this park is the breeding colony for the vulnerable Australian sea lion at Seal Bay. The park also includes the two largest New Zealand fur seal colonies on Kangaroo Island at Cape Gantheaume and Berris Point. The rugged and remote coastline provides the ideal habitat for nesting seabirds such as osprey and the endangered white-bellied sea eagle, whilst the beaches are home to nesting hooded plovers. The entire coastline of the Cape Gantheaume Conservation Park is listed as a Wetland of National Importance with shorebirds, including migratory waders, present from October to March each year.	Table 6-78 assesses spill impacts to shorebirds, pinniped colonies and seabirds. Residual spill impacts are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Economic Values - Tourism: Seal Bay is renowned for its up-close view of Australian sea lions and is a very popular destination for Kangaroo Island tourists each year. Tourists to the Cape Gantheaume Conservation Park also enjoy marine activities such as boating, fishing, scuba diving and snorkelling (TOMM, 2010).	An assessment of residual spill impacts to tourism values is provided in Table 6-78. Any visible sheen entering the marine park (during calm weather) may cause localised minor impacts to tourism activities; however, the impact will be slight, localised, temporary and recoverable. No long-term impact to this conservation value is expected. Conservation value is not affected.

Conservation Value	Assessment of Impact
Economic Values – Commercial Fishing: Commercial fisheries operating in the Southern Kangaroo Island Marine Park include the Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Marine Scalefish Fishery (Gulf St Vincent/Kangaroo Island), Charter Fishery and the Giant Crab Fishery. These fisheries are important to regional economies of the area both directly, through employment in each fishery, and indirectly, through a range of additional services such as processing, local transport, marketing, local retail and food services.	An assessment of residual spill impacts to invertebrates, fish species and commercial fishing impacts is provided in Table 6-77. Residual hydrocarbons are predicted to fall below ecological thresholds. Any impacts are slight, localised, temporary and recoverable. Conservation value is not affected.
Social Values: The early European history of the Southern Kangaroo Island Marine Park is based on exploration, whaling and sealing, resulting in a number of shipwrecks. The southern Kangaroo Island coastline was mapped and named by French explorers Nicolas Baudin and Louis Freycinet in 1803, a year after the island's discovery by Matthew Flinders. A whaling station was established at the southern end of D'Estrees Bay in the early 1840s. The archaeological remains scattered along the coast north of Point Tinline are protected as part of the state heritage listed D'Estrees Bay whaling site. The first steamship wreck in South Australia, the Osmanli struck the reef off Point Tinline in 1853 and the You Yangs struck a reef somewhere near Quin Rock in 1890 and was eventually washed ashore near Cape Gantheaume.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.
Social Values: Cape Gantheaume Conservation Park is popular with surfers, fishers and campers. Cape Gantheaume Wilderness Protected Area is only accessible by foot by a rugged coastal trek from D'Estrees Bay around the headland to Bales beach.	Residual hydrocarbons (entrained and visible sheens) are not expected to impact on this conservation value.

Table 6-82: Management Objectives for South Australian Marine Parks.

Action Area	Action	Management Objective Met
Neptune Islands Group MP, Western Kangaroo Island MP, Investigator MP, Thorny Passage MP, Sir Joseph Banks MP, Gambier Island Group MP, South Spencer Gulf MP, South Kangaroo Island MP.		
Protection		
1	Manage activities and uses in the marine park in accordance with zoning and special purpose area provisions.	Not applicable –responsibility of marine reserve management.
2	Actively influence activities and uses within and adjacent to the marine park to help mitigate threats to marine biodiversity and marine habitats.	PGS has actively consudeted with DEWR on this activity. DEWR has provided feedback (refer **Section 9**)
3	Consider additional protections and/or temporary restrictions where necessary in circumstances of urgency — (a) to protect a listed species of plant or animal, or threatened ecological community; or (b) to protect a feature of natural or cultural heritage significance; or (c) to protect public safety	Not applicable –responsibility of marine reserve management. PGS has assessed impacts to species, cultural heritage and public safety from operations. Impacts, through the controls adopted, result in minimal disturbance to these values.
4	Introduce a permitting system to provide for the following activities (where not otherwise authorised): − scientific research in a sanctuary or restricted access zone; − tourism operations in a sanctuary zone; − competitions and organised events in a sanctuary zone; − commercial film-making (including sound recording and photography) in a sanctuary zone; and − installation of vessel moorings in a sanctuary zone	Not applicable –responsibility of marine reserve management.
Stewardship through Community Involvement		
5	Provide for public appreciation, understanding and enjoyment of the marine park.	Not applicable –responsibility of marine reserve management.
6	Create and promote opportunities for sustainable nature-based tourism in the marine park.	Not applicable –responsibility of marine reserve management.
7	Provide education to support the implementation of the marine park.	Not applicable –responsibility of marine reserve management.
8	Seek to involve local communities and stakeholders in the day-to-day management and monitoring of the marine park.	Not applicable –responsibility of marine reserve management.
9	Work cooperatively with Aboriginal communities to conserve country, plants, animals and culture.	Not applicable –responsibility of marine reserve management.
Performance Assessment, Knowledge and Review		
10.	Develop and implement a monitoring, evaluation and reporting (MER) program that measures the effectiveness of this marine park management plan and its contribution to South Australia's marine parks network (2011 baseline), and that: − is designed to measure the effectiveness of the management plan in delivering the predicted outcomes to inform adaptive management; − includes linkages to relevant state, national and international monitoring, evaluation and reporting frameworks; − sets out targets and indicators linked to strategies and outcomes for monitoring, which include ecological, socio-economic, environmental and management elements; − monitors the delivery of education, research and governance mechanisms; and − assesses the effectiveness of compliance activities.	Not applicable –responsibility of marine reserve management.
11	Foster partnerships to support the implementation of the MER Program incorporating opportunities for community and stakeholder involvement.	Not applicable –responsibility of marine reserve management.
12	Ensure outcomes of the MER Program and research outcomes are made publicly available and inform decision making and periodic review of this management plan.	Not applicable –responsibility of marine reserve management.
13	Conduct priority research and foster research partnerships to assess the integrity of knowledge frameworks that underpin the predicted outcomes.	Not applicable –responsibility of marine reserve management.

Action Area	Action	Management Objective Met
14	Encourage Aboriginal people, local communities and stakeholders to preserve traditional and historic knowledge and, where appropriate, share this knowledge with others.	Not applicable –responsibility of marine reserve management.
Compliance		
15	Develop and implement a compliance strategy for the marine park that: – is cost-efficient; – is focussed on sanctuary zones and other conservation priorities; – complements existing compliance efforts; – maximises voluntary compliance; and – includes measures to address serious or repeat non-compliance	Not applicable –responsibility of marine reserve management.

6.10.3.5 *Spill Frequency*

Vessel Collision

Analysis of oil spill frequency data for eastern GAB waters from vessel incidents (i.e. area coincident with the Duntroon survey) identifies the following frequency of spills (all vessels from all causal pathways including collision) over 100 tonnes as low at 0.0001 to 0.001 (1 event every 1000 - 10,000years)[126] (DNV, 2011). While DNV (2011) compares the frequencies to Australian averages, the report states that in absolute terms, oil spill frequencies in all Australian sub-regions are considered low to very low.

Additionally, based upon a review of the Australian Transport Safety Bureau's (ATSB) marine safety database[127], there have been no instances of collision, grounding or sinking of a petroleum activity related survey vessel in Australian waters for the past 30 years.

Refuelling Spill

DNV, in a review of spill frequencies for ship-to-ship transfers of hydrocarbons, identified that in the UK the spill frequency over 1 tonne was 1 incident in 2000 lightering operations or a frequency of 5 x 10^{-4} per transfer operation. This result was consistent with US data (DNV, 2011). Based on this data, the likelihood of a refuelling spill is assessed as highly unlikely.

6.10.3.6 *Spill Mitigation*

The Duntroon survey and support vessels will operate under an approved Shipboard Oil Pollution Emergency Plan (SOPEP) (or equivalent for class) in accordance with MARPOL 73/78 Annex I requirements and as required by the *Protection of the Sea (Prevention of Pollution by Ships) Act 1983* Section 11A. Information contained in the SOPEP includes personnel responsibilities for the deployment and maintenance of response equipment; the emergency plan in case of pollution; communications/contacts required in the event of a spill (i.e. AMSA details); measures to control and limit the oil flow; and the required forms to be completed and transmitted to regulatory authorities.

For a vessel collision incident resulting in a spill, the actions taken by the vessel master would typically include:

- Make safe the vessel and crew;
- Immediate notification to AMSA (in Commonwealth waters) in the event of a vessel collision and/or possible oil spill advising on location, oil spill volume, nearby sensitivities, etc.;
- Implement SOPEP remedial measures to limit volumes spilt (i.e. close water tight doors, check bulkheads; assess damage; determine whether vessel separation will increase spillage; isolation of penetrated tanks; possible tank lightering, etc.);

[126] Reference: DNV (2011) – Figure 3.2 (page 21)
[127] http://www.atsb.gov.au/publications/safety-investigation-reports.aspx?s=1&mode=Marine&sort=OccurrenceReleaseDate&sortAscending=descending&occurrenceClass=&typeOfOperation=&initialTab=

- AMSA, as vessel-based marine oil spill Control Agency in Commonwealth marine waters, activates the National Plan for Maritime Environmental Emergencies (NATPLAN) (2017) to respond to oil spill threats. AMSA will determine the appropriate response strategy for the spill type, location and environmental sensitivities which are threatened via a Net Environmental Benefits Assessment (NEBA).

All vessels are required to undertake routine SOPEP testing/drills to ensure all crew are trained in the response requirements. The SOPEP is routinely reviewed and updated such that the document remains relevant and current.

Operational and scientific monitoring to be adopted in the event of a spill is described in Section 7.7.2.5 and **Appendix E**.

6.10.4 Risk assessment

Table 6-83 provides the risk assessment for a potential significant diesel spill as a result of a vessel collision during survey activities.

Table 6-83: Vessel collision oil spill ERA

Aspect	Diesel spill due to vessel collision (fuel tank leak/rupture)
Impact Summary	Marine pollution possibly leading to injury or death of marine fauna or seabirds.
Extent of Impact	Visible oil – approximately 166 km northwest from the spill site Entrained phase – approximately 172 km northwest/southeast of the spill site.
Duration of Impact	Temporary (days to weeks) and recoverable.
Level of certainty of impact	HIGH. Oil spill impacts have been extensively studies and impacts are well documented.
Species affected within survey environment	Whales (protected and listed), turtles (protected), pinnipeds (protected and listed), fish (pelagic, commercial), sharks (protected), marine invertebrates, plankton, tourism
Risk Decision Framework Context	**B** (*The activity is a standard operation and well understood, it is not new to the area and good practice is well defined. However probabilistic modelling has been performed to assess potential impacts*)

Incident: Vessel Collision						
Impacted Receptor	Risk With Controls Failure (Inherent)			Risk with controls (Residual)		
	Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Cetaceans (foraging)	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Turtle (migrating)	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Pinnipeds (foraging)	Moderate	Possible	Medium	Moderate	Highly Unlikely	Medium
Seabirds (foraging)	Moderate	Possible	Medium	Moderate	Highly Unlikely	Medium
Sharks (foraging)/fish	Slight	Possible	Medium	Slight	Highly Unlikely	Low
Plankton	Slight	Possible	Medium	Slight	Highly Unlikely	Low
Commercial Shipping	Slight	Possible	Medium	Slight	Highly Unlikely	Low
Commercial Fishing	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Charter Operations	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Pinniped Colonies	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Shoreline bird colonies	Slight	Possible	Medium	Slight	Highly Unlikely	Low
Sand Beaches	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Reef Systems	Slight	Possible	Medium	Slight	Highly Unlikely	Low
Inter-tidal Platforms/Cliffs	Slight	Possible	Medium	Slight	Highly Unlikely	Low
Seagrass	Slight	Possible	Medium	Slight	Highly Unlikely	Low

Coastal Fishing*	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Aquaculture	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Recreational Water Sports	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Tourism	Minor	Possible	Medium	Minor	Highly Unlikely	Low
Incident: Refuelling Spill						
Impacted Receptor	**Risk With Controls Failure (Inherent)**			**Risk with controls (Residual)**		
	Consequence	**Likelihood**	**Risk**	**Consequence**	**Likelihood**	**Risk**
Damage to marine species[128]	Minor	Possible	Medium	Minor	Highly Unlikely	Low

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	**CONTROL TYPE**	**PRACTICABLE AND IMPLEMENTED**	**JUSTIFICATION**
Controls assessment for the prevention of commercial shipping spatial conflicts (refer Table 6-67*) also apply to vessel collision with significant diesel spill and should be read in conjunction with this table.*			
Survey and support vessels use approved navigation systems.	Engineering	YES	Good Industry Practice – well defined and established standard practices adopted by the offshore petroleum sector
Survey vessel has an implemented and tested SOPEP	Administrative	YES	Good Industry Practice – well defined and established standard practices adopted by the offshore petroleum sector
Fuel used will be marine diesel (alternates such as HFO are more persistent in a spill event)	Substitute	YES	
Crew has been trained in shipboard oil spill response	Administrative	YES	
Oil pollution plan and Emergency Response Plan in place and integrated with NATPLAN requirements.	Administrative	YES	
Seismic will only occur outside protected (commonwealth marine reserve) areas	Eliminate	NO	This would leave large gaps in survey data coverage which could not be acquired at any time. PGS would be unable to meet seismic data delivery requirements of clients. No environmental gain is likely based upon the assessment of potential impacts on sensitive receptors in this EP.
Use of vessels with smaller tank sizes	Substitute	NO	May lead to delays in data acquisition or a smaller vessel only capable of towing a smaller array which would be unable to meet the efficiency requirements of the survey. PGS would be unable to meet the seismic data delivery requirements of clients. More refuelling events would also be required leading to additional risk.
The MSS vessel could consider carrying less fuel in each tank	Substitute	NO	This would result in less endurance capability (hence potentially more port calls, associated fuel consumption in transit activities and an increase to survey duration) or increased vessel-to-vessel refuelling which carries a higher spill risk.

[128] Given the reduced areal extent of this spill and other factors such as vessel/array sound which would deter sound sensitive species, consequence has been assessed at minor – small and temporary disruption to small proportion of the population. No effects on critical habitats/activities. No tourism or commercial fishing impacts are expected from a spill of this size in the survey location.

Use of alternate fuels (solar, wind, biofuels).	Substitute	NO	Alternate fuel sources have not been commercially proven for use in large vessels.
Refuelling at sea is subject to the PGS Operations Offshore Bunkering Procedures and PGS Bunker Delivery – Quantity and Quality Control	Administrative	YES	PGS procedures in line with industry standards.
No at-sea refuelling	Eliminate	NO	Substantial additional cost of $1.25M per instance to shutdown survey and steam to port to refuel.
Eliminate the potential for refuelling impacts within areas where there may be high aggregations of marine fauna.	Eliminate	YES	Spatial buffers for refuelling activities placed around BIAs and Rocky (South) Island where pinniped colonies are located.
Eliminate refuelling activities within Commonwealth Marine Reserve areas	Eliminate	Yes	Spatial buffer for refuelling activities placed around the Western Eyre CMR.

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
Controls identified for the prevention of commercial shipping spatial conflicts (refer Table 6-67*) also apply to vessel collision with diesel spill and should be read in conjunction with this table.* *Oil spill response EPOs/EPSs are provided in Section 6-11.*		
PREPAREDNESS		
EPO25: No vessel spills to the marine environment **MC**: Incident records verify zero spills to the marine environment.	**EPS70**: MDO/MGO shall be used to fuel the vessel.	Bunker records verify marine diesel is utilised as fuel on-board the vessels. Responsibility: Vessel Master
	EPS71: Vessels selected for the MSS activity will provide: • Valid and current class certification; • Crew details which meet (STCW95) requirements; • Records showing maintenance performance requirements are satisfied; • Safety Audit with evidence of corrective action completion (as appropriate).	Records verify selected vessel has met these criteria. Responsibility: PGS Project Manager
	EPS72: Vessels have a current approved current SOPEP (appropriate to class) consistent with the *IMO Guideline for the Development of Shipboard Marine Pollution Emergency Plans (or equivalent according to class).*	Copy of current and MARPOL certified SOPEP (or equivalent according to vessel class) available on-board survey vessels. Responsibility: Vessel Masters
	EPS73: Spill response equipment (bins/kits) are located in proximity to hydrocarbon spill areas and replenished if required.	Inspections records verify spill response kits are positioned in accordance with the SOPEP and checked for contents routinely. Responsibility: Vessel Masters.
	EPS74: Personnel are trained and competent in spill response procedures.	Training records demonstrate personnel are trained and competent. Responsibility: Vessel Manager and Vessel Master.
	EPS75: Appropriate crew (including MFOs, marine, deck and bridge crew) must attend an environmental induction containing basic information on oil spill response measures.	Induction material includes responsibilities for response and notification protocols. Completed forms verify crew attendance. Responsibility: Vessel Master.

	EPS76: SOPEP is implemented and tested for the survey vessel prior to commencing the survey. This test will involve a vessel-based drill and testing of communications for notifying the RCC, at or near the survey location prior to the activity.	Records verify drills have been undertaken in accordance with vessel drills matrix. Record of SOPEP test prior to survey commencement is available. Responsibility: Vessel Masters
EPO26: No spills from refuelling operations during survey. **MC**: Incident records verify zero spills to the marine environment from refuelling.	**EPS77:** Approval must be obtained from the Vessel Manager before any at sea refuelling can occur.	Records verify that approval has been given for at sea refuelling to commence by Vessel Manager. Completed" Bunkering Offshore" Checklist. Responsibility: Vessel Manager, Vessel Master and Chief Engineer
	EPS78: Refuelling at sea is subject to the PGS Marine Operations Offshore Bunkering Procedures and PGS Bunker Delivery – Quantity and Quality Control, and the following additional requirements: • Refuelling of vessels will be undertaken under favourable wind and weather conditions as determined by the Vessel Masters; • Refuelling will commence during daylight hours only; • A Job Hazard Analysis (JHA) or equivalent will be in place and reviewed prior to each fuel transfer; • All valves and flexible transfer hoses certified for use; and • Dry break couplings (or similar) in place for all flexible hydrocarbon transfer hoses.	The following records verify refuelling practices have been implemented: • Vessel logs verify date and route taken during refuelling activity; • Bunkering records verify time and date of bunkering; • JHA Records complete for activity; • Equipment certificates available for equipment.
	EPS79: Refuelling activities will not occur within 30 km of the sperm whale (foraging) BIAs, white shark (foraging) BIA, Australian sea lion (male foraging BIA) or within the Western Eyre CMP.	Records verify that spatial buffers are maintained during survey operations. Responsibility: Vessel Master

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking is considered broadly acceptable. If the risk control measures are consistent with applicable standards, then no action is required to reduce the risk further unless a reasonably practicable measure is available. The risk shall be managed in accordance with good industry practice. A MEDIUM risk ranking is broadly acceptable if the risk cannot be reasonably reduced without gross disproportionate sacrifice.

Hierarchy of Controls	**Eliminate**: • Vessels selected meet Class and safety audit requirements. • Refuelling activities will have spatial separation of 30 km to fauna aggregation areas (BIAs, pinniped colonies) and within the Western Eyre CMP. **Substitute:** • Fuel source used on the survey vessels is MDO/MGO (low persistence in the marine environment). **Engineer:** • MSS vessels carry radar, AIS and ARPA to ensure that marine hazards can be identified in a timely manner and have navigation safety devices (Navigation lights, Radio, Foghorns) to warn third party vessels of presence. **Isolate:** • Survey utilises support/scout vessels to identify possible third-party impacts and warn shipping of the hazard. • Dry-break couplings used on transfer hoses during bunkering. **Administrative:** • Marine warnings implemented for all vessels which may utilise the area (AHO, AMSA RCC). • Crews maintain 24/7 watch with STCW95 competencies. • Bunkering is undertaken during suitable weather conditions in accordance with approved procedures. • Current vessel SOPEP available to respond to vessel-based oil spills with response equipment contained on-board. Crew are drilled in SOPEP response requirements. • Survey specific oil spill drill undertaken prior to survey commencement.
Compliance with International Conventions, Legislation, Codes and Standards	*This legislation is in addition to the legislation detailed in preventing commercial shipping spatial conflicts (refer Table 6-67).* International Conventions: • International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78 – Annex I (Oil)) Legislation: • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Section 11A – Shipboard Oil Pollution Emergency Plan, S9 – Prohibition of discharge of oil or oily mixtures) ○ Marine Order 91 (Marine Pollution Prevention – Oil) 2006 (Implements MARPOL 73/78 Annex I requirements • *Australian Maritime Safety Authority Act 1990* • *EPBC Act 1999 and EPBC Regulations 2000 (IUCN Principles)* • National Plan for Maritime Environmental Emergencies (AMSA, 2014).
Good Industry Practice	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the risk of collision with other vessels and impacts from events such as spills to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management measures and marine safety procedures for the survey in accordance with legislative requirements/guidelines; • Having an appropriate emergency response plan. **IAGC:** The Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) objectives for emergency response plan familiarisation (Section 8.3 – Prestart Operations) and for spill leak response (Section 8.6 – Hazardous Materials) is met.
Professional Judgement:	Alternate controls identified and implemented where practicable. Controls adopted cover multiple levels on the control hierarchy.
Engineering Risk Assessment:	Modelling has been undertaken to assist in establishing the possible extent of impact from a significant diesel spill in the survey area.
Cost Benefit Analysis	Not Applicable – Risk Decision Framework is Category B.
Demonstration of Acceptability	
Policy compliance	The management strategy for prevention of significant oil spills from vessel collision reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Contest: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholders have raised any concerns associated with vessel spills.

External Context: Environment	The external environment is a BIA for whale and pinniped species and the white shark. Many protected migratory birds (albatross and petrel) also forage within the oil spill EMBA. Table 6-77 provides an assessment of spill impacts to these species and identifies that the spill impacts from a limited volume, short-term MDO spill is not significant at a population level (i.e. does not trigger any EPBC significance criteria) for marine species. Marine diesel rapidly evaporates and weathers. Long-term impacts to fauna that encounter diesel are unlikely given localized impacts. Shoreline impacts are not expected to be above ecological thresholds. An assessment of the MDO to the functioning of KEFs within the EMBA has determined that the spill will not lead to a significant impact on the marine environment in accordance with the EPBC Guideline 1.1 (Matters of National Environmental significance) (refer Table 6-79). From an environmental context perspective impacts to the environment are not significant against EPBC Significance criteria (therefore acceptable).

Legislative criteria & standards	Compliant with the following legislation:
	• *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Section 11A – Shipboard Oil Pollution Emergency Plan*)*
	  ○ Marine Order 91 (Marine Pollution Prevention – Oil) 2006 (Implements MARPOL 73/78 Annex I requirements*)*
	• *Navigation Act 2012* (Chapter 3 – Vessel Safety) and subordinate legislation:
	  ○ Marine Order 3 (Seagoing Qualifications)
	  ○ Marine Order 21 (Safe Navigation and Emergency Procedures)
	  ○ Marine Order 27 (Safety of navigation and radio equipment)
	  ○ Marine Oder 30 (Prevention of Collisions)
	  ○ Marine Order 58 (Safe Management of Vessels)
	• *EPBC Act 1999 and EPBC Regulations 2000 (IUCN Principles)*
	• *Australian Maritime Safety Authority Act 1990:*
	  ○ National Plan for Maritime Environmental Emergencies (AMSA, 2014).

External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation advices.	This assessment of impacts to conservation values within CMP/State marine reserves for an MDO spill has been undertaken in Table 6-80**,** Table 6-81**,** Table 6-82 and CMR/State Reserve Management prescriptions in **Appendix M**. The assessment concluded that any residual impacts in these reserves will be temporary, localised and recoverable and does not significantly impact on conservation values of the reserves or their management objectives. Duntroon survey activity and its controls adopted meet or are consistent with CMR management prescriptions for the South-west and south-east Marine Parks Netweork Management Plans (DMP, 2013; DMP, 2018) and for the State marine reserves which might be intersected. Species recovery plans and conservation advices have been considered within this assessment and relevant actions adopted into spill response strategies and plans (refer **Section 6.10.3.2**). From a conservation plan perspective, all relevant threats to protected species or protected places have been observed in the planning for oil spills. Impacts to species and reserves from an MDO spill do not significantly affect their conservation values or management objectives (therefore acceptable).
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Operational and Scientific monitoring as described in **Section 7.7** and **Appendix E**.	
Records relevant to Disruption to Commercial Shipping (refer **Section 6-8**). Vessel selection Assessment against EP requirements Inspection Records (spill kit replenishment) SOPEP and SOPEP Drill records Campaign-specific Exercise Report Induction and Induction records Bunkering Procedures (& associated Job Hazard Assessments, Master approval & completed checklists) Vessel log Equipment certificates (dry-break coupling) PMS Records Incident Records (notification and investigation)	

6.11 Risk: Oil Spill Response

6.11.1 Hazard

Implementation of oil spill response options (e.g. monitor and evaluate, contain and recover, etc.) may incur environmental impacts which devalue the measures designed to mitigate spill impacts on the environment.

6.11.2 Known and potential impacts

In responding to an oil spill, impacts may include additional vessel traffic and associated emissions, exhaust gases, noise and light, generation of waste contaminated with diesel, toxic impacts from the deployment of dispersant and inappropriate management of oil contaminated flora and fauna.

6.11.3 Evaluation of environmental impacts

Table 6-84 provides an assessment of the available spill response options available to AMSA through NATPLAN (2017) arrangements, the response option effectiveness on diesel, and the potential positive and negative impacts of adopting the individual oil spill response strategies. The preferred strategies are highlighted within that table.

Given the offshore location of the survey, and the very low persistence of this fuel type which disperses naturally and readily evaporates, the response strategy of monitor and evaluate would be most suitable – i.e. to allow spills to disperse naturally, and to monitor the position and trajectory of any surface slicks. Should monitoring and evaluation indicate that significant numbers of marine fauna are likely to be impacted, oiled wildlife response strategies, such as wildlife cleaning and/or hazing, may be considered. All response strategies outlined in Table 6-84 would be managed by AMSA as the appropriate Control Agency. The responsibility of assessing the appropriateness of any response strategy outlined and its implementation, also lies with AMSA as Control Agency (refer 'Oil Pollution Emergency Plan' **Section 7.7.2**).

Adoption of a monitor and evaluate surveillance strategy may lead to sound disruption impacts from aviation/vessels (refer Section 6.2) or increased potential for vessel interaction with air-breathing mammals (refer Section 6.15). Control strategies outlined in those sections to minimise impacts and risks to ALARP and acceptable levels, reflecting legislative requirements, will be adopted during any response activity.

Commonwealth Recovery Plans:

The relevance of management actions contained in following threatened species conservation/recovery plans have been assessed with respect to diesel spill response from the Duntroon multi-client survey. This assessment is provided in Section 6.10 and should be read in conjunction with this section.

Table 6-84: Response Option Impact Assessment

Response Strategy	Response Option Effectiveness on oil type	Impacts		Applicability to Duntroon Survey Location
		Positive	Negative	
Source Control	**Very Effective.** Forseeable scenarios are cotained in the vessel SOPEP which is maintained current and tested routinely.	• Oil loading to the environment is reduced.	• No negative aspects identified	Strategy will be adopted on-board vessel in accordance with SOPEP.
Monitor & Evaluate (Natural weathering)	**Effective:** Response option, based upon the nature and scale of the incident is suitable for all spills. Visual methods from the available local platforms for observation are appropriate and feasible. Monitor and evaluate is employed to provide situational awareness and inform other response strategies.	• No negative impacts from response option implementation • Provides for situational awareness to inform a response.	• Does not reduce acute and chronic or smothering effects from spill • Potential for longer-term impacts on water quality and inter-tidal resources. • Increased vessel or aviation activity increasing disturbance/collision with fauna	Response option would be suitable for marine diesel spill on Duntroon survey area.
Physical Breakup	**Effective:** Response option assists with increasing surface area of oil droplets and increasing biodegradation and dispersal.	• Enhances natural degradation process.	• Increased vessel activity increasing disturbance/collision with fauna • Possible emulsification	Response option may be suitable for marine diesel spill on Duntroon survey area.
Dispersant Application	**Not Effective:** Marine diesel undergoes rapid weathering and rapidly spreads to form thin layers or sheens. In order for dispersant to be effective, dispersants must encounter relatively thick layers of oil. These conditions do not persist with marine diesel for long periods. ITOPF (2011) advises that dispersant droplets tend to "punch through" these thin oil fils into underlying water and cause herding rather than dispersion.	• No positive aspects identified.	• Increased chemical loading and toxicity on the environment • Additional vessel and/or aviation support increasing disturbance/collision with fauna • Aerial dispersant application is undertaken close to sea surface (high risk activity). • Weather-condition dependent.	Response option is not expected to be adopted on the Duntroon survey area.
Contain and Recover	**Not Effective:** As above, marine diesel spreads rapidly to thin surface thicknesses (i.e. <10 µm). Thicknesses of 25 µm+ are required for effective containment.	• Oil removal from the environment. • Prevents intersecting fauna from becoming oiled.	• Additional vessel movement increasing disturbance/collision with fauna • Labour intensive, large logistical response, large waste volumes • Safety of personnel offshore • Weather dependent	Response option is not expected to be adopted on the Duntroon survey area.

Response Strategy	Response Option Effectiveness on oil type	Impacts		Applicability to Duntroon Survey Location
		Positive	Negative	
In-situ Burning	**Not Effective:** As above, marine diesel spreads rapidly to thin surface thicknesses (i.e. <10 µm). In-situ burning is not effective on small thickness of oil.	• Oil removal from the environment. • Prevents intersecting fauna from becoming oiled.	• Additional vessel movement increasing disturbance/collision with fauna • Labour intensive, large logistical response, large waste volumes • Safety of personnel offshore • Weather dependent	Response option is not expected to be adopted on the Duntroon survey area.
Protect & Deflect	**Marginally Effective:** As above, marine diesel spreads rapidly to thin surface thicknesses (i.e. <10 µm). Potection maybe suitable for protected areas.	• Oil removal from the environment. • Prevents intersecting fauna from becoming oiled.	• Additional vessel movement increasing disturbance/collision with fauna • Potential damage to inter-tidal and benthic habitats • Labour intensive, large logistical response, large waste volumes • Weather dependent	Response option is not expected to be adopted on the Duntroon survey area. Coastline is primarily inter-tidal rock platforms backed by cliffs with small stretches of sand beach. Oil residues reaching shorelines are predicte to be at 1µm.
Shoreline Clean-up	**Marginally Effective:** Marine diesel due to its low viscosity tends to percolate into sands with visibility impacts not as apparent as other hydrocarbon types. Options such as water washing may be suitable for beaches where diesel has made contact. Cliffs and inter-tidal platforms have inherent access issues and the natural wave washing against these landform types naturally degrades diesle without intervention.	• Oil removal from the environment. • Prevents intersecting fauna from becoming oiled.	• Additional disturbance to invertebrates in sand through water washing activities • Potential damage to endangered and sensitive shoreline species (e.g. Australian Fairy Tern – refer Section 3.6.8) • Labour intensive, large logistical response, large waste volumes • Weather dependent	Response option is not expected to be adopted on the Duntroon survey area. Coastline is primarily inter-tidal rock platforms backed by cliffs with small stretches of sand beach. Shoreline residues were predicted to be less than 10g/m^2.
Oiled Wildlife Response	**Effective:** Option allows for the recovery and rehabilitaion of oiled wildife (primarily birds).	• Prevents or reduces oiling of wildlife. • Aids recovery of oiled wildlife.	• Additional vessel movement increasing disturbance/collision with fauna • Approaching marine fauna could dive into spill as a result of activity • Pre-emptive capture may result in reduced survival	Response option is not expected to be adopted on the Duntroon survey area. Coastline is primarily inter-tidal rock platforms backed by cliffs with small stretches of sand beach. Shoreline residues were predicted to be less than 10g/m^2.

6.11.4 Risk assessment

Table 6-85 provides the risk assessment for any oil spill response, within the control of PGS, recognising that AMSA is the control agency for mitigating spill impacts. PGS would assist AMSA when needed in these activities.

Table 6-85: Oil Spill Response ERA

<table>
<tr><th>Aspect</th><td colspan="6">Responding to a marine diesel spill from the Duntroon survey area (i.e. monitor and evaluate)</td></tr>
<tr><th>Impact Summary</th><td colspan="6">Increased vessel and aviation movement from oil spill response activities</td></tr>
<tr><th>Extent of Impact</th><td colspan="6">Areas within the EMBA determined by predictive modelling</td></tr>
<tr><th>Duration of Impact</th><td colspan="6">Short-term (days).</td></tr>
<tr><th>Level of certainty of impact</th><td colspan="6">HIGH: Responses of marine fauna to vessel and aviation movements have been extensively studied and published in scientific papers.</td></tr>
<tr><th>Values potentially affected within the survey environment</th><td colspan="6">Whales (protected and listed), pinnipeds (protected and listed).</td></tr>
<tr><th>Impact decision framework context:</th><td colspan="6">A (Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined). Risk assessment decision making based upon LCS, GIP and PJ.</td></tr>
<tr><th rowspan="2">Impacted Receptor</th><th colspan="3">Risk With Controls Failure (Inherent)</th><th colspan="3">Risk with controls (Residual)</th></tr>
<tr><th>Consequence</th><th>Likelihood</th><th>Risk</th><th>Consequence</th><th>Likelihood</th><th>Risk</th></tr>
<tr><td colspan="7">Refer Section 6.2 (Sound Impacts – Vessels/Aviation) and Section 6.15 (Collision risk with marine mammals) for control measures.</td></tr>
</table>

<table>
<tr><th colspan="4">ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)</th></tr>
<tr><th>CONTROL MEASURE</th><th>CONTROL TYPE</th><th>PRACTICABLE AND IMPLEMENTED</th><th>JUSTIFICATION</th></tr>
<tr><td>Accepted SOPEP is in place</td><td>Administrative</td><td>YES</td><td>Good Practice – well defined and established standard procedures adopted by the offshore petroleum sector.</td></tr>
<tr><td>Implementation of NATPLAN</td><td>Administrative</td><td>YES</td><td></td></tr>
<tr><td>Vessel records that SOPEP drills have been conducted</td><td>Administrative</td><td>YES</td><td></td></tr>
<tr><td>Prompt spill reporting to AMSA</td><td>Administrative</td><td>YES</td><td></td></tr>
<tr><td>Stakeholder consultation in event of a spill</td><td>Administrative</td><td>YES</td><td></td></tr>
<tr><td>Insurance policies to cover cost of environmental monitoring or clean-up post spill</td><td>Administrative</td><td>YES</td><td></td></tr>
<tr><td>Assessment of implementation of SOPEP and AMSA NATPLAN</td><td>Administrative</td><td>YES</td><td></td></tr>
<tr><td>Implementation of OPEP independent of AMSA</td><td>Administrative</td><td>NO</td><td>Substantial additional cost and lead time of 6 months in planning and implementation with no additional benefit as AMSA have suitable arrangements in place.</td></tr>
</table>

<table>
<tr><th colspan="3">ENVIRONMENTAL CONTROLS AND PERFORMANCE MEASUREMENT</th></tr>
<tr><th>EPO</th><th>EPS</th><th>MEASUREMENT CRITERIA</th></tr>
</table>

EPO27: Oil spill response implemented in accordance with accepted plans to minimise impact from spilled hydrocarbon. **MC:** Records verify correct implementation.	**EPS79:** Survey vessel has SOPEP in-place on-board vessel and is implemented in the event of a spill.	SOPEP is current and available on-board. Incident Records Responsibility: Vessel Master
	EPS80: Trained personnel implement SOPEP	Training records verify crew are trained and competent in SOPEP implementation. Responsibility: Vessel Master
	EPS81: Consultation is undertaken prior to survey and notices issued with relevant stakeholders including: • Safety Authorities (e.g. AHS) • Commercial fisheries • Individual companies • Industry bodies.	Consultation records verify that notices have been issued in accordance with **Section 9.** Responsibility: Vessel Manager
	EPS82: All ship-sourced hydrocarbon spills are reported to AMSA without delay (1 hr)	Incident reports verifying reporting of spills to AMSA. Responsibility: Vessel Master
	EPS83: Reporting to regulatory agencies (AMSA, Director National Parks, NOPSEMA and SA DPC) occurs within the 2 hrs of the spill incident.	Incident reports verifying reporting of spills to AMSA. Responsibility: Vessel Manager
	EPS84: Implementation of NATPLAN by AMSA	Incident reports verifying reporting of spills to AMSA. Responsibility: Vessel Manager
	EPS85: Oil spill drills completed as per procedures.	Vessel records verify that spill drills have been carried out according to drills program. Responsibility: Vessel Master
	EPS86: Vessel Manager liaises (at intervals commensurate with the nature and extent of the spill incident) with parties involved in emergency response to evaluate effectiveness of the response (and determine the occurrence of impacts). These may include: • Site Representative • AMSA • SA DPTI • Director National Parks Implement Operational & Scientific Monitoring Plan (OSMP) as required (refer **Section 7.7**)	Telephone records and meeting notes of contact verify that emergency response communications have been undertaken. OSMP records verify implementation Responsibility: Vessel Manager
	EPS87: Insurance policies in place to cover any post spill monitoring or clean-up (refer **Section 7.7**).	Insurance documentation is available. Responsibility: Vessel Manager

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking is broadly acceptable. If the risk control measures are consistent with applicable standards, then no action is required to reduce the risk further unless a reasonably practicable measure is available. The risk shall be managed in accordance with good industry practice.

Hierarchy of Controls	Eliminate: Elimination controls identified for leaking tanks, refuelling spills etc. within SOPEP. Substitute: *No substitution controls for oil spill response implementation have been identified as practicable.* Engineer: *No engineering controls for oil spill response implementation have been identified as practicable.* Isolate: Isolation controls identified for leaking tanks, refuelling spills etc. within SOPEP. Administrative: SOPEP will be implemented to reduce the amount of oil escaping to the environment. Trained personnel implement SOPEP Oil spill drills and exercises completed prior to survey commencement Marine warning notices issued in accordance with consultation feedback. Operational and scientific monitoring implemented (as needed) to establish impacts and remedial options.
Compliance with International Conventions, Legislative Codes and Standards	Compliance with: International Conventions: • International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 (OPRC) • United National Convention on the Law of the Sea 1982 (UNCLOS) • International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78 – Annex I (Oil)) • International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001 Legislation (Commonwealth): • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Section 11A – Shipboard Oil Pollution Emergency Plan) o Marine Order 91 (Marine Pollution Prevention – Oil) 2006 (Implements MARPOL 73/78 Annex I requirements • *Australian Maritime Safety Authority Act 1990* • *Protection of the Sea (Civil Liability for Bunker Fuel Pollution Damage) Act 2008* • *Environment Protection and Biodiversity Conservation Act 1999 and EPBC Regulations 2000* Standards: • National Plan for Maritime Environmental Emergencies (AMSA, 2017). • South Australian Marine Spill Contingency Plan (SAMSCAP) (DTPI, 2016)
Good Industry Practice	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the impact from events such as spills to a level which is ALARP and acceptable by demonstrating: • The adoption of appropriate management procedures for the activity; and • Having an appropriate emergency response plan. **IAGC**: The Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) objectives for spill leak response (Section 8.6 – Hazardous Materials) is met.
Professional Judgement:	All controls identified are administrative feeding into an Australian-wide response strategy which is administered by AMSA, fully resources and regularly practiced. For the nature and scale of this spill, these arrangements are considered appropriate.
Engineering Risk Assessment:	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The risk management strategy for deck spills reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.

PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	External stakeholder consultation has been undertaken (refer **Section 9**). No issues or concerns have been raised with respect to oil spill response.
External Context: Environment	The survey area is in deep offshore Commonwealth waters.
Legislative criteria & standards	Compliant with the following legislation: • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Section 11A – Shipboard Oil Pollution Emergency Plan) ○ Marine Order 91 (Marine Pollution Prevention – Oil) 2006 (Implements MARPOL 73/78 Annex I requirements • *Australian Maritime Safety Authority Act 1990* • *Protection of the Sea (Civil Liability for Bunker Fuel Pollution Damage) Act 2008* • *Environment Protection and Biodiversity Conservation Act 1999* • *EPBC Regulations 2000* ((IUCN principles contained in Schedule 8).
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices.	An assessment of impacts associated with spill events associated with the Duntroon multi-client survey has been undertaken in Section 6.10 against relevant CMP conservation values and IUCN management principles; and relevant South Australian Marine Park conservation values and management objectives. This assessment identified that the Duntroon survey spill risk is reduced to a level which is ALARP and acceptable and does not conflict with management prescriptions for these reserves (refer **Appendix M**). This oil spill response assessment contributes to the demonstration of ALARP for oil spill risk.
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking oil spill response activities. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Operational and Scientific monitoring as described in **Section 7.7** and **Appendix E**.	
Records	
SOPEP and SOPEP Drill records Incident Records (notification and investigation) Emergency Response Records (Telephone logs, etc.) Consultation records. OSMP Implementation Records Insurance Policy	

6.12 Risk: Deck spill

6.12.1 Hazard

Packaged chemicals/oils used on-board during seismic operations are limited to small quantities of cleaning products, solvents, cable fluid, hydraulic oils, paints and primers, and lithium batteries. These chemicals/oils could potentially leak during storage and/or handling and enter the marine environment through the deck drainage system. Chemicals (e.g. solvents and detergents) will typically be stored in small containers between 5 to 25 litres and stored/used in internal areas where any leak would be retained on-board and cleaned-up in accordance with the SOPEP (or equivalent for vessels< 400 GRT) and associated spill clean-up procedures. Some spills may occur when small containers of chemicals are being used in open areas, where there is a risk of entering the sea if spilled. The realistic worst-case spill volume is assessed at 25 litres.

6.12.2 *Known and potential impacts*

The known and potential environmental impacts of chemical or oil releases to the marine environment are:

- Pollution of surrounding surface waters; and
- Toxicity to marine biota (fish, plankton).

6.12.3 *Evaluation of environmental impacts*

Chemical inventories on-board the survey vessels are minimised to the extent practicable. Given the package sizes of chemicals and oils, the volume of liquid which could be released is limited to the volumes of individual containers stored on deck and likely to be small.

On-board deck drainage consists of two distinct areas:

- Drainage from bunded areas (containing chemicals/oils and areas at high risk of spills) which are isolated from the open deck area; and
- Open deck areas which handle ‘uncontaminated’ water runoff (wash down water, rainwater and sea-spray) and drain directly to the marine environment.

Vessels operate with Safety Data Sheets (SDS) available for chemicals on-board which detail the clean-up requirements for any spills. Crew are trained in spill clean-up requirements.

For infrequent activities (e.g. vessel refuelling) temporary bunding is put in place to prevent spills from entering the marine environment (refer Section 6.10).

Packaged oils/chemicals released to the sea may cause water quality reduction with either direct or indirect effects on marine organisms. Impacts would be limited to the immediate area surrounding the release point, prior to the dilution with the surrounding seawater. In the open ocean environment of the survey area, it is expected that a release would be rapidly diluted and dispersed, and therefore any pollution would be temporary and localised (‘SLIGHT’ consequence). With the on-board controls implemented (e.g. inspection, bunding, spill clean-up procedures) such incidents are considered unlikely and the residual risk is assessed as LOW.

<u>Commonwealth Recovery Plans:</u>

A review of the management actions and objectives listed in threatened species conservation/recovery plans that may be present in the survey area and applicable to the threats posed by the survey activity have been assessed in **Section 3.7**. No management actions, as contained in the recovery/management plans, are considered relevant to deck spills except for the following:

- *Recovery Plan for the Australian Sea Lion (Objective 4.1): Improve the understanding of, and where necessary mitigate, the threat posed to Australian Sea Lion populations by oil spills by implementing jurisdictional oil spill strategies as required.*

  Oil spill response within this EP is integrated with Commonwealth legislative requirements (e.g. SOPEP/OPEP linking to NATPLAN) and meets this requirement.

- *Recovery Plan for Marine Turtles in Australia 2017-2027 (Objective 4C*):
  - *Objective 4C: Lists current management strategy as regulation under the OPGGSA by NOPSEMA and the National Plan for Maritime Environmental Emergencies as detailing arrangements, policies and principles for managing maritime environmental emergencies*
  - *Action Area A4: Ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to ‘slow to recover habitats’, e.g. nesting habitat, seagrass meadows or coral reef).*

  As above, oil spill response within this EP is integrated with Commonwealth legislative requirements (e.g. SOPEP/OPEP linking to NATPLAN) and includes scientific monitoring. This action meets this requirement.

PGS has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement.

<u>Marine Reserves (Conservation Values and Management Principles)</u>:

PGS has undertaken and an assessment of MDO spill discharge impacts against the South-west Marine Parks Network Management Plan (DNP, 2017) prescriptions, Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-80). This larger spill assessment was found not to significantly impact on conservation values and management objectives within the CMP. In addition, it did no conflict with the prescriptions detailed in the Management Plan. Given packaged chemical deck spills from decks are smaller in volume and impact, CMP conservation values and objectives associated with such a spill is slight, recoverable and consistent with the management principles for sustainable long-term use of the area. ALARP and acceptability is demonstrated in Table 6-86.

6.12.4 Risk assessment

Table 6-86 provides the risk assessment for the potential deck spills within the survey area from survey activities.

Table 6-86: Deck spill ERA

Aspect	Discharge of chemicals/oils overboard to the marine environment.
Impact Summary	Localised decrease in water quality with possible toxicity impacts to marine biota (e.g. fish plankton).
Extent of Impact	Localised water quality impacts around spill release point (from constantly moving vessel).
Duration of Impact	Short-term (minutes to hours) and recoverable (due to rapid dispersion and dilution).
Level of certainty of impact	HIGH. Impacts from chemical and hydrocarbon spills to the marine environment are well studied and documented
Species affected within survey environment	Marine species (fish and plankton) which are not protected widely distributed and only as small proportion of the total population are potentially affected.
Impact Decision Framework Context	**A** (*Nothing new or unusual, represents business as usual, well understood activity, good practice is well defined)*. Risk assessment decision making based upon LCS, GIP and PJ.

Risk with controls failure (inherent)					
Consequence	Slight	Likelihood	Possible	Risk	MEDIUM (3)

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Compliance with Protection of the Seas (Prevention of Pollution from Ships) Act 1983 and Marine Order – Part 94 – Packaged Harmful Substances	Administrative	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector.
All storage facilities are designed so to contain spillages. This includes scupper plugs beside all deck drainage points leading overboard so drains can be blocked in the event of a spill.	Isolate	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector.
SDSs are available for all hazardous materials aboard the survey and support vessels.	Administrative	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector.

Implemented and tested SOPEP for both survey and support vessels.	Administrative	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector.
Spill response bins/kits located in close proximity to storage areas for prompt response in the event of a spill or leak.	Administrative	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector.
All crew participate in an environmental induction prior to survey commencement to understand their responsibilities with respect to chemical handling and spill clean-up.	Administrative	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector.
No hazardous materials will be used aboard either the survey or support vessel.	Eliminate	NO	Hazardous materials (e.g. hydraulic fluid, lubricating oils, cleaning chemical, paints, solvents, batteries, etc.) are required for the safe and efficient operation of the survey and support vessels. Suitable chemicals which fulfil the required performance characteristics of these chemicals are required.

Risk with controls (residual)					
Consequence:	Slight	Likelihood:	Highly Unlikely	Risk:	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	EPS	MEASUREMENT CRITERIA
EPO28: No release of packaged chemicals/oils through the deck system to the marine environment. **MC:** Incident records verify no chemical/oil spill through the deck system to the marine environment.	**EPS88:** All storage facilities are designed so to contain spillages. Any hydrocarbon storage or equipment located on-deck utilising hydrocarbons must be designed and maintained to have at least one barrier (i.e. deck edge lips or upstands) to contain and prevent deck spills entering the marine environment. This can include containment lips on deck (primary bunding) and/or secondary containment measures (bunding, containment pallet, transport packs, absorbent pad barriers) in place.	Inspection ensures hazardous materials are stored and handled in accordance with these requirements. Responsibility: Vessel Master/ Chief Engineer
	EPS89: All hazardous substances (as defined in NOHSC: 1008 [2004] - Approved Criteria for Classifying Hazardous Substances) aboard the survey and support vessels will have Safety Data Sheets (SDS) that are readily available on board.	Records verify the SDSs are available and correct for all hazardous materials on-board Responsibility: Vessel Master/ Party Chief
	EPS90: Spill response bins/kits are located in close proximity to storage areas for prompt response in the event of a spill or leak. The kits will be checked for their adequacy and replenished as necessary prior to the commencement of activities and on a regular basis thereafter.	Spill kits will be checked prior to commencement of activities (pre-mobilisation audit). Responsibility: Vessel Master Inspection records verify that spill response kits are close to storage areas and are checked/ replenished on a regular basis. Responsibility: Vessel Master

EPO28 No release of packaged chemicals/oils through the deck system to the marine environment. (Con't)	**EPS91:** The survey vessel/ support vessel over 400 GT must have an implemented and tested Shipboard Oil Pollution Emergency Plan (SOPEP) in place that complies with the requirements of: • Regulation 37 of MARPOL Annex I • Marine Order 91 (Marine pollution prevention – oil) 2014. Other vessels will have a SOPEP equivalent document for spills to deck.	Records demonstrate that the vessel has a SOPEP (or equivalent) in place Responsibility: Vessel Master
	EPS92: All crew participate in an environmental induction prior to survey commencement to understand their responsibilities with respect to chemical handling and spill clean-up.	Induction records verify that the deck crew have undertaken chemical handling and spill response training. Responsibility: Vessel Master
	EPS93: SOPEP drills are undertaken in accordance with the Vessel Drills Matrix (or equivalent) to ensure personnel is familiar with their role during an oil/chemical spill event.	Records verify SOPEP (or equivalent) drills have been undertaken. Responsibility: Vessel Master

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking is considered broadly acceptable. If the risk control measures are consistent with applicable standards, then no action is required to reduce the risk further unless a reasonably practicable measure is available. The risk shall be managed and continuously improved in accordance with good industry practice.
Hierarchy of Controls	Eliminate: ○ No elimination controls identified. Chemicals/oils are required on-board the vessel for equipment and safe vessel operations. Substitute: ○ Chemicals substituted with alternate products with higher environmental performance characteristics where equivalent performance can be demonstrated. Engineer: ○ No engineering controls identified Isolate: ○ Provision of bunding for all areas of possible spills. Administrative: ○ SDSs are available to all personnel to ensure correct chemical handling and storage. ○ Spill kits are strategically placed near high spill risk locations and kits are routinely inspected & maintained. ○ Crew are trained in chemical/oil spill response requirements. Spills are cleaned up immediately and contaminated material contained on-board for onshore disposal. ○ SOPEP (or equivalent document to vessel class) is tested at regular intervals.

Compliance with International Conventions, Legislative Codes and standards	Compliance with:
	○ International Conventions:
	  ○ International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73/78 – Annex I (Oil) and Annex III (Packaged Harmful Substances)
	○ Legislation (Commonwealth):
	  ○ *Navigation Act 2012* (Part 3 – *Vessels Polluting or Damaging the Australian Marine Environment* & Part 4 – *Directions Relating to Foreign Vessels*)
	  ○ *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*
	    ▪ Section 26AB – Prohibition of discharge by jettisoning of harmful substances into the sea and Section 26F
	    ▪ Section 9 – Prohibition of discharge of oil or oily mixtures
	  ○ Marine Order 91 (Marine Pollution Prevention – Oil).
	  ○ Marine Order 94 (Marine Pollution Prevention – Packaged Harmful Substances).
	○ Standards:
	  ○ International Maritime Dangerous Goods Code (IMDGC).

Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the impacts from spill events to the marine environment to a level which is ALARP and acceptable by demonstrating: • Appropriate management procedures are in place and implemented for the survey; and • An appropriate spill response plan is in place for the activity. **IAGC:** Controls for oil/chemical management and spill response for deck spills conform with the requirements detailed in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.6 – Hazardous Materials).
Professional Judgement	Alternate controls identified and implemented where practicable. Controls adopted cover multiple levels on the control hierarchy.
Engineering Risk Assessment	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The risk management strategy for deck spills reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised with regard to deck spill discharges.
External Context: Environment	The external environment is a BIA for whale, seabird pinniped species and the white shark. Many protected migratory birds (albatross and petrel) also forage within the spill EMBA. Table 6-77 provides an assessment of spill impacts to these species and identifies that the spill impacts from a limited volume, short-term MDO spill (a much larger spill) is not significant at a population level (i.e. does not trigger any EPBC significance criteria) for marine species. Marine diesel rapidly evaporates and weathers. Long-term impacts to fauna that encounter diesel are unlikely given localized impacts. Shoreline impacts are not expected from a deck spill. An assessment of the larger MDO to the functioning of KEFs within the EMBA has determined that the spill will not lead to a significant impact on the marine environment in accordance with the EPBC Guideline 1.1 (Matters of National Environmental significance) (refer Table 6-79). From an environmental context perspective impacts to the environment are not significant against EPBC Significance criteria (therefore acceptable).
Legislative criteria & standards	Compliant with (Commonwealth): • *Navigation Act 2012* • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* • Marine Order 91 (Marine Pollution Prevention – Oil); • Marine Order 94 (Marine Pollution Prevention – Packaged Harmful Substances); • EPBC Regulations 2000 (IUCN principles contained in Schedule 8).

External Context: Marine Reserves, Management Plans, Species Recovery plans and Conservation Advices	Any deck spill impacts are expected to be contained (locally) within the Western Eyre CMR. The Western Eyre CMR has been assessed for a large MDO spill in Table 6-80. The assessment concluded that any residual impact to this reserve will be temporary, localised and recoverable and does not significantly impact on conservation values of the reserve or its management objectives/ amnd management plan prescriptions. Deck spills are substantially smaller and therefore also will not significantly impact on conservation values or management objectives. Species recovery plans and conservation advices have been considered within this assessment and relevant actions adopted into spill response strategies and plans (refer **Section 6.10.3.2**). From a conservation plan perspective, all relevant threats to protected species or protected places have been observed in the planning for oil spills. Impacts to species and reserves from an MDO (or other) spill are not expected to significantly affect their conservation values or management objectives (therefore acceptable).
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Nil	
Incident Records Environmental Induction Records Vessel Inspection Records Pre-mobilization Audit Records Chemical/Oil Safety Data Sheets SOPEP Drill Reports	

6.13 Risk: Release of waste overboard (solid/non-biodegradable/hazardous)

6.13.1 Hazard

During the survey, small quantities of solid non-biodegradable and hazardous wastes may be produced. These wastes will be created, handled and stored on the vessels in accordance with each vessel's Garbage Management Plan, which adopted the waste minimisation hierarchy to avoid waste releases to sea.

Solid non-biodegradable wastes include:

- Paper and cardboard;
- Wooden pallets;
- Scrap steel, metal, aluminium, paint cans;
- Glass; and
- Plastics and ropes.

Hazardous wastes include:

- Hydrocarbon contaminated materials (e.g., oily rags, oil filters, hydraulic oils); and
- Batteries, empty paint cans, cleaning products, aerosol cans, fluorescent tubes.

6.13.2 *Known and potential impacts*

Potential impacts associated with the accidental release of solid/non-biodegradable wastes include:

- Disturbance (smothering or pollution) of seabed habitats;
- Injury, ingestion or entanglement by marine fauna (particularly plastics by turtles and seabirds);
- Hydrocarbon-contaminated wastes can result in localised water quality reduction (including toxics);
- Litter (visual pollution).

6.13.3 *Evaluation of environmental risk*

Solid non-biodegradable/hazardous wastes will be handled in accordance with the vessel's Garbage Management Plan which works to a 'no solid non-biodegradable/hazardous waste overboard' policy. In normal circumstances, no impacts to the marine environment should occur. However, accidental release to the marine environment is possible especially in rough ocean conditions when items may roll off or be blown (packaging materials) from the deck.

Assessment of individual impacts follows:

- In the instance of windblown material, the volume will be small however for materials such as plastic, impacts to individual animals (i.e. mortality) may occur. Given the presence of threatened species (turtles and seabirds) within the survey area, the worst-case possible impact has been assessed as mortality to a protected species (single animal) (SLIGHT impacts). With the on-board controls implemented impacts from such incidents are considered unlikely and the residual risk is assessed as LOW.
- Solid hazardous waste, such as paint cans containing paint residue and batteries would be expected to settle on the seabed if dropped overboard. Over time, this may result in the leaching of hazardous materials to the seabed, which may result in small localised areas of substrate becoming toxic and unsuitable for colonisation by benthic fauna (MINOR impacts). With the on-board controls implemented such incidents are considered highly unlikely and the residual risk is assessed as LOW.
- Hazardous wastes released to the sea may cause water quality reduction with either direct or indirect effects on marine organisms. Impacts would be limited to the immediate area surrounding the release, prior to the dilution with the surrounding seawater. In the open ocean environment of the survey area, it is expected that a release would be small in volume and rapidly diluted and dispersed. Therefore, pollution of the surrounding waters would be temporary, localised and recoverable (SLIGHT impact). With the on-board controls implemented such incidents are considered highly unlikely (refer to deck spill section) and the residual risk is assessed as LOW.

<u>Commonwealth Recovery Plans:</u>

The relevance of management actions contained in threatened species conservation/recovery plans have been assessed with respect to solid/hazardous waste overboard events from vessels during the Duntroon survey. No management actions, as contained in those recovery/conservation management plans are considered relevant to waste overboard events except for following which have requirements around marine debris:

- The Recovery Plan for the Australian sea lion (SEWPC, 2013) (Objective 2.3) require measures to mitigate the impacts of marine debris on Australian sea lion populations noting linkages with the *Threat Abatement Plan (TAP) for the Impact of marine Debris on Vertebrate Marine Life* (DEWHA, 2009a);
- The Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017) (Action A3) requires the implementation of the EPBC Act TAP for Marine Debris on Vertebrate Marine Life (DEWHA, 2009b);
- The Conservation advice for humpback whales (TSSC, 2015c) identifies entanglement as a threat (no specific action); and

- The Recovery Plan for threatened albatross and giant petrels (SEWPC, 2011) (Action S03) identifies marine debris as a threat requiring the “implementation of legislative requirements for garbage to prevent ingestion of marine debris from survey activities”.

For the purposes of the TAP, harmful marine debris refers to all plastics and other types of debris from domestic or international sources that may cause harm to vertebrate marine wildlife. This includes land-sourced waste and garbage (such as bags, bottles, ropes, fibreglass, piping, insulation, paints and adhesives), abandoned fishing gear from recreational and commercial fisheries (e.g. strapping bands, synthetic ropes, derelict fishing nets, floats, hooks, fishing line and wire trace), and ship-sourced, solid, non-biodegradable floating materials disposed of at sea (e.g. fibreglass, insulation). It does not include debris that is not harmful to marine wildlife such as floating wooden objects and metal objects which do not cause entanglement and are unable to be ingested. Fishing nets and lines under the control of fishers, and marine debris resulting from the legal disposal of garbage such as food, paper, rags, glass, metal and crockery at sea under the provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) are outside the scope of the TAP (DEWHA, 2009b). Plastics are targeted particularly for their durability and cigarette butts for their ability to leach toxic compounds.

Control measures adopted within the survey to prevent wastes considered as ‘marine debris’ from entering the marine environment are contained within this EP and reflect the TAP Objective 1 to ‘*contribute to the long-term prevention of the incidence of harmful marine debris* within the marine environment. All wastes, except those which are controlled by MARPOL (treated bilge, sewage and food-scraps) are returned to shore for disposal in accordance with state requirements. Onshore disposal activities are documented via State waste manifesting systems.

<u>Marine Reserves (Conservation Values and Management Principles)</u>:

An assessment of waste (marine debris) overboard incidents have been undertaken against the South-west Marine Parks Network Management Plan 2018 (DNP, 2018) prescriptions, the Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-87). With controls adopted, waste incidents overboard have a slight consequence, are not expected to impact at a population level on relevant conservation values of the CMR and are consistent with the Management Plan prescriptions (i.e. meeting MARPOL requirements) and principles for sustainable long-term use of the area (refer **Appendix M**). ALARP and acceptability is demonstrated in Table 6-87.

6.13.4 Risk assessment

Table 6-87 provides the risk assessment for a solid, non-hazardous/hazardous waste overboard incident within the survey area as a result of survey activities.

Table 6-87: Release of waste overboard ERA

Aspect	Release of solid hazardous/non-hazardous waste overboard to the marine environment.
Impact Summary	○ Localised decrease in water quality with possible toxicity impacts to marine biota (e.g. fish plankton). ○ Injury or damage to individual marine fauna through ingestion of plastics. ○ Localised seabed smothering or contamination by non-buoyant solid hazardous waste.
Extent of Impact	In general, localised impacts around point of discharge. Solid, buoyant materials will be dispersed by local currents and may travel long distances, but volumes will be small.
Duration of Impact	Short-term (water quality impact). Longer term (seabed smothering, species ingestion)
Level of certainty of impact	HIGH. Impacts from waste disposal overboard (particularly plastics) has been well studied and documented. This is verified through the production of regulatory guidelines for threat abatement from marine debris.
Species affected within survey environment	○ For water quality impacts: Plankton and Fish (not protected) ○ For benthic impacts (continental shelf environment): Porifera, ascidians and bryozoans. ○ For buoyant materials at the sea surface: Marine seabirds (protected) and turtles (protected).

Risk Decision Framework Context	**A** (*Nothing new or unusual, represents business as unusual, well understood activity, good practice is well defined*). Risk assessment decision making based upon LCS, GIP and PJ.				
Risk with controls failure (inherent)					
FAUNA Impact:	Slight	Likelihood:	Possible	Risk:	Medium (3)
SEABED Impact:	Minor	Likelihood:	Possible	Risk:	Medium (3)

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	**CONTROL TYPE**	**PRACTICABLE AND IMPLEMENTED**	**JUSTIFICATION**
Compliance with Protection of the Seas (Prevention of Pollution from Ships) Act 1983 and Marine Order – Part 95 – Garbage.	Administrative	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector.
All wastes will be segregated into clearly marked containers for onshore disposal in accordance with the Garbage Management plan. Containers shall have tightly fitting, secure lids to prevent solid wastes from blowing overboard.	Isolate	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector.
Waste storage areas shall be routinely inspected, and high levels of housekeeping maintained.	Administrative	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector.
All vessel crew are inducted into the garbage management arrangements on-board survey vessels.	Administrative	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector.
Immediate removal of the garbage from the survey vessel to a shore-based facility to prevent 'overboard' incidents.	Eliminate	NO	This would result in additional fuel usage (emissions increase) and increased risk associated with the increased number of waste transfer events between vessels. The additional impacts and risks are not considered a suitable alternative to secure storage on the survey vessel.
Incinerate all wastes generated on-board the survey vessel.	Eliminate	NO	Incineration of materials not listed within the Garbage Management Plan as being suitable for incineration may lead to toxic emissions and contaminated ash material to the environment. This may have health impacts to personnel and will be non-compliant with MARPOL legislation.
For wastes considered suitable for incineration according to the vessel's Garbage Management Plan, ensure that wastes are incinerated on an "as soon as practicable" basis.	Eliminate	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector.
Risk with Controls (residual)			

<table>
<tr><td>FAUNA Impacts:</td><td>Slight</td><td>Likelihood:</td><td>Unlikely</td><td>Risk:</td><td>LOW</td></tr>
<tr><td>SEABED Impacts:</td><td>Minor</td><td>Likelihood:</td><td>Highly Unlikely</td><td>Risk:</td><td>LOW</td></tr>
</table>

<table>
<tr><th colspan="3">ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS</th></tr>
<tr><th>EPO</th><th>EPS</th><th>MEASUREMENT CRITERIA</th></tr>
<tr><td rowspan="4">EPO29: No release of hazardous or solid wastes overboard during Duntroon survey activities to protect marine environment.

MC: Incident records verify no incidents of overboard hazardous or solid waste</td><td>EPS94: Survey vessels will operate under Vessel Garbage Management Plan(s) (applicable to vessels >100 GRT or certified to carry more than 15 people).

The Garbage Management Plan incorporates the requirements of IMO Resolution MEPC. 219(63) with respect to waste minimisation and garbage handling; and the restrictions on disposal of solid and hazardous waste (reflecting MARPOL Annex V).</td><td>Records verify that Survey Vessel Garbage Management Plan meets these IMO requirements.

<u>Responsibility</u>: Vessel Master</td></tr>
<tr><td>EPS95: Handling of solid and hazardous wastes on-board the survey and support vessels will comply with the requirements of Protection of the Seas (Prevention of Pollution from Ships) Act 1983, Marine Order – Part 95 – Garbage and ensure:
o No discharge of general operational or maintenance wastes or plastics or plastic products of any kind;
o Waste containers are covered with tightly fitting, secure lids to prevent any solid wastes from blowing overboard;
o All solid, liquid and hazardous wastes (other than bilge water, sewage and food wastes) are incinerated or compacted (if possible) and stored in designated areas before being sent ashore for recycling, disposal or treatment;
o Any liquid waste storage on deck must have at least one barrier (i.e. bunding) to prevent deck spills entering the marine environment. This can include containment lips on deck (primary bunding) and/or secondary containment measures (bunding, containment pallet, transport packs, absorbent pad barriers) in place;
o Correct segregation of solid and hazardous wastes.</td><td>Inspection records verify that hazardous and solid wastes are being stored and handled to prevent overboard incidents.

<u>Responsibility</u>: Vessel Master & PGS QCS</td></tr>
<tr><td>EPS96: Incinerator is compliant with MARPOL and IMO requirements and operated in accordance with established operating procedures that align with manufacturers' specifications.</td><td>IAPP Certificate verifies incinerator is IMO approved.

Manufacturers Specification and Operating Procedures are available for incineration activities.

<u>Responsibility</u>: Chief Engineer</td></tr>
<tr><td>EPS97: Crew members are inducted into garbage management procedures to minimise the potential for unpermitted wastes being discharged overboard and to ensure effective waste segregation.</td><td>Induction records verify that all crew personnel are aware of these requirements.

<u>Responsibility</u>: Vessel Master</td></tr>
</table>

<table>
<tr><th colspan="2">Demonstration of ALARP</th></tr>
<tr><td>Hazard Risk Criteria</td><td>A LOW risk ranking is considered broadly acceptable. If the risk control measures are consistent with applicable standards, then no action is required to reduce the risk further unless a reasonably practicable measure is available. The risk shall be managed and continuously improved in accordance with good industry practice.</td></tr>
</table>

Hierarchy of Controls	Eliminate: ○ In Garbage Management Plans, vessels adopt the waste minimisation hierarchy which looks at waste elimination, followed by reduction, recycling and treatment/disposal. Waste generation is eliminated wherever possible. Substitute: ○ Waste is incinerated where possible. Engineer: *No measures identified.* Isolate: ○ All waste storages are bunded to prevent waste overboard incidents ○ All wastes are containerised (with lids), labelled and stored in dedicated areas Administration: ○ Vessels adopt a "No Solid/Hazardous Waste Overboard" Policy during survey activities. ○ Waste storages are routinely inspected for housekeeping standards ○ All personnel are inducted into these requirements during vessel induction.

Compliance with International Conventions, Legislative Codes and Standards	Compliance with:
	○ International Conventions:
	  ○ International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78) – Annex V (Garbage) & Annex III (Packages Harmful Substances)
	○ Legislation:
	  ○ *Navigation Act 2012* (Part 3 – *Vessels Polluting or Damaging the Australian Marine Environment* & Part 4 – *Directions Relating to Foreign Vessels*)
	  ○ *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Section 26F - *Prohibition of discharge of garbage into the sea*)
	  ○ Marine Order 94 (Marine Pollution Prevention – Packaged Harmful Substances)
	  ○ Marine Order 95 (Marine Pollution Prevention – Garbage).
	  ○ EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8)
	○ Standards:
	  ○ International Maritime Dangerous Goods Code (IMDGC).

Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the risk of release of substances into the marine environment to a level which is ALARP and acceptable by: • Demonstrating appropriate management measures are in place and implemented; and • Wastes are disposed in accordance with statutory requirements and agreed procedures. **IAGC:** The stated controls are compliant with the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management). Compliance with the International Maritime Dangerous Goods Code (IMDGC).
Professional Judgement:	Alternate controls identified and implemented where practicable. Controls adopted cover multiple levels on the control hierarchy.
Engineering Risk Assessment.	Not Applicable – 'Risk Decision Framework Context' is Category A.
Cost Benefit Analysis	Not Applicable – 'Risk Decision Framework Context' is Category A.
Demonstration of Acceptability	
Policy compliance	The risk management strategy for waste overboard incidents reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSE&Q Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised with regard to waste overboard discharges.
External Context: Environment	Environment is highly dispersive and will rapidly dilute liquid materials and disperse buoyant materials. Solid, non-buoyant wastes will settle to the seabed. Localised effects are predicted to non-protected species (plankton, fish, porifora) which are widespread in the environment.

Legislative criteria & standards	Legislation:
	• *Navigation Act 2012*
	• *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*
	  • Marine Order 94 (Marine Pollution Prevention – Packaged Harmful Substances)
	  • Marine Order 95 (Marine Pollution Prevention – Garbage).
	• EPBC Regulations 2000 (IUCN Principles outlined in Appendix 8)
	Industry Practice:
	• APEA CoEP
	• IAGC Environment Manual

External Context: Marine Reserves, Management plans, Species Recovery Plans and Conservation advices	Western Eyre CMP: Any impact is expected to be contained (locally) potentially within the Western Eyre CMP. Impact does not conflict with prescriptions detailed in the South-west Marine parks Network Management Plan 2018, and meets, the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*waste loss does not compromise the long-term diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted reflect ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Species Recovery Plans: Measures adopted in this risk evaluation are consistent with the requirements outlined for marine turtles and the Australian sea lion for marine debris.
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Nil	
Vessel Garbage Management Plans Incident Records Garbage Record Book Crew Environmental Induction Records Vessel Inspection Records IAPP Certificate Manufacturers specification and operating procedures (incinerator)	

6.14 Risk: Seismic streamer loss

6.14.1 Hazard

Survey activities may result in the loss of towed equipment such as seismic streamers within the marine environment.

6.14.2 Known and potential impacts

The loss of a seismic streamer loss can have the following impacts:

- Create marine hazards leading to impacts to third party vessels (equipment damage); or
- Benthic habitat impacts through physical contact.

6.14.3 *Evaluation of environmental risk*

The solid streamers utilised in the Duntroon multi-client survey are positioned in the water column by depth controllers ('birds'). The streamers are also fitted with pressure activated, self-inflating buoys designed to bring the equipment to the surface is accidentally lost during a survey. As the steamer sinks it passes a certain water depth (hydrostatic pressure equivalent to ~40 m depth) at which point the buoys inflate (via a compressed CO_2 gas cartridge) and brings the equipment back to the surface where it can be retrieved by the seismic or support vessel.

A tail-buoy is connected to each of the streamers to provide both a hazard warning (lights and radar reflector) of each submerged towed streamer between the tail-buoy and vessel, and to act as a platform for the positional systems of the streamer (i.e. housing a Differential Global Positioning System (GDPS) receiver).

In the event of streamer detachment from the vessel the following impacts may be expected:

- Equipment hazard in the water column may be caught in vessel propulsion systems and cause damage to vessels (MODERATE consequence – social criteria); or
- Localised and slight impact of ecological integrity of benthic habitat (SLIGHT consequence – environmental criteria).

Implementation of the controls detailed in Table 6-88 ensures that the loss of seismic streamers to the environment is highly unlikely. The residual risk associated with streamer loss in the environment is assessed as low.

Note that equipment loss (such as seismic streamers) into the marine environment is not considered as 'debris under the "Threat Abatement Plan for the Impacts of marine debris on vertebrate marine life" (SEWPC, 2009) (refer **Section 6.13**) as the definition excludes '*debris that is not harmful to marine wildlife such as floating wooden objects and metal objects that do not cause entanglement and are unable to be ingested*'.

Commonwealth Recovery Plans:

The relevance of management actions contained in threatened species conservation/recovery plans have been assessed with respect to streamer loss from the survey vessels during the Duntroon multi-client survey. No management actions, as contained in those recovery/conservation management plans are considered relevant to streamer loss events.

Marine Reserves (Conservation Values and Management Principles):

An assessment of streamer loss has been undertaken against the South-west Marine parks Network Management Plan 2018 (DNP, 2018) prescriptions, the Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-88). The loss of the streamer (if unable to be recovered) would have only a slight impact in the CMP and is not expected to result in a significant impact to the CMP conservation values. With controls adopted, this risk of streamer loss is assessed as low. The impact does not conflict with the management prescriptions and principles for sustainable long-term use of the area (refer **Appendix M**). ALARP and acceptability is demonstrated in Table 6-88.

6.14.4 *Risk assessment*

Table 6-88 provides the risk assessment for a potential seismic streamer loss within the survey area as a result of survey activities.

Table 6-88: Seismic streamer loss ERA

Aspect	Loss of towed equipment (seismic streamer) in the marine environment.
Impact Summary	Marine hazard, causing potential damage to third party vessels. Localised benthic habitat disturbance.
Extent of Impact	Localised impact around the loss area.
Duration of Impact	Short-term (streamer retrieved), long-term (equipment not recovered).

Level of certainty of impact	HIGH. The effects of loss of seismic streamers have been studied and measures to prevent their loss to the environment enhanced.		
Species affected within the survey environment	Benthic habitats (porifora, bryozoans and ascidians) - common within the eastern GAB.		
Risk Decision Framework Context	A (nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.). Risk assessment decision making is based upon LCS, GIP and PJ.		
Risk with controls failure (inherent)			
Marine Hazard	CONSEQUENCE: MODERATE (3)	LIKELIHOOD: POSSIBLE (3)	RISK: MEDIUM (2)
Benthic Habitat Disturbance:	CONSEQUENCE: SLIGHT (1)	LIKELIHOOD: POSSIBLE (3)	RISK: MEDIUM (3)

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)

CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Procedures used to deploy and retrieve seismic streams to prevent loss	Administrative	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector.
Streamer equipment is fit-for-purpose	Administrative	YES	
Streamers are fitted with equipment which allows for recovery (streamers self-inflating)	Engineering	YES	
Where-ever possible lost in water equipment will be recovered	Eliminate	YES	
Recording and reporting of incidents involving loss of equipment (e.g. streamer loss)	Administrative	YES	
Seismic operations cease until all lost equipment is located/ recovered	Eliminate	NO	Substantial survey downtime, in addition to the value of the streamer lost (~$1-$5M). Little benefit given the water depths and limited sensitivity of benthic habitats in the survey area.

Risk with Controls (Residual)

Marine Hazard	CONSEQUENCE: MODERATE	LIKELIHOOD: HIGHLY UNLIKELY	RISK: MEDIUM (2)
Benthic Habitat Disturbance:	CONSEQUENCE: SLIGHT	LIKELIHOOD: HIGHLY UNLIKELY	RISK: LOW (1)

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS

EPO	EPS	MEASUREMENT CRITERIA
EPO30: Avoid streamers impacting on the seabed, benthic habitats or creating hazards to other marine users in the environment.	**EPS98**: Survey vessels will operate under approved procedures for streamer deployment and retrieval and these procedures are adhered to at all times.	Approved procedures are available and used on-board. Responsibility: Survey Party Chief

MC: Incident records verify no loss of streamers to the environment.	**EPS99:** Streamer equipment (bridles and harnesses) are routinely maintained and inspected for wear and tear to ensure the equipment is fit-for purpose and will not detach during MSS activities.	Inspection records verify streamers are fit-for-purpose. Responsibility: Survey Party Chief
	EPS100: Streamers will be fitted with the following equipment while they are deployed from the MSS vessel to allow for easy retrieval: • Self-inflating recovery devices • Surface marker buoys • Secondary retaining devices • Radar Reflectors	Equipment deployed meets minimum specification requirements. Responsibility: Survey Party Chief
	EPS101: Support vessels will search for and retrieve in-water equipment loss (where possible). Detailed records maintained of any loss of in-water equipment. If equipment loss is irretrievable maintain records of the circumstances that prohibited equipment recovery.	Dropped objects recorded in incident report and vessel log. Responsibility: Survey Party Chief
	EPS102: Marine stakeholder notifications (VHF Channel 16) are made in the event of an in-water equipment loss.	Vessel log records notification on loss of streamer. Responsibility: Vessel Master
	EPS103: Loss of equipment will be reported to AMSA as soon as possible of the potential hazard to other mariners.	Incident report to AMSA. Responsibility: Vessel Master
	EPS104: All marine stakeholder complaints associated with the in-water equipment loss will be recorded and actioned (as appropriate).	Incident record of complaint. Responsibility: Survey Party Chief

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking (benthic habitat) is broadly acceptable. If risk control measures are consistent with applicable standards, then no action is required to reduce further unless a reasonably practicable measure is available. Risk is managed in accordance with good industry practice. A MEDIUM risk ranking (marine hazard) is ALARP if all practicable controls have been assessed and adopted if not grossly disproportionate to the benefit gained. The following ALARP analysis provides additional assurance that all treatment options have been considered.
Hierarchy of Controls	Eliminate: • Vessel will recover lost streamer wherever possible. Substitute: None Identified. Engineer: • A secondary retaining/attachment device is fitted to prevent loss. • Streamer contains buoyancy devices to assist in recovery. • Streamers fitted with marker buoys and radar reflectors for rapid location of lost equipment Isolate: None Identified. Administrative: • All streamers are routinely inspected and maintained for worn and damaged components. • Vessel operates under approved procedures for streamer retrieval and deployment. • Marine stakeholders are notified in the event of streamer loss and location.

Compliance with International Conventions, Legislative Codes and Standards	Compliant with the following legislation: • *Offshore Petroleum & Greenhouse Gas Storage Act 2006* (Com) (S280) – *Interference with Other Rights* • *Navigation Act 2012* (Section 185 & 186 – Incidents)
Good Industry Practice:	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the impacts from events such as loss of equipment to a level which is ALARP and acceptable including: • Demonstration of appropriate management practices being in place and implemented; • Contingency plans in place for the event. **IAGC:** The Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) requirements for deployed equipment and retrieval of lost equipment are satisfied (refer Section 8.8. Vessel Operations).
Professional Judgement:	Limited alternate controls have been identified as the industry has assessed the cost of the loss of streamer equipment and determined controls to prevent its loss to levels which are ALARP.
Engineering Risk Assessment:	Not Applicable – "Risk Decision Framework Context" is Category A
Cost Benefit Analysis	Not Applicable – "Risk Decision Framework Context" is Category A
Demonstration of Acceptability	
Policy compliance	The risk management strategy for deck spills reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards, and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrated PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raided about streamer loss incidents.
External Context: Environment	A portion of the survey area is coincident with the Western Eyre CMR. Survey area is deep water (100m+) and benthos consists of ascidians, porifera and bryozoans (common marine invertebrates).

Legislative criteria & standards	Compliant with the following legislation:
	• *Offshore Petroleum & Greenhouse Gas Storage Act 2006* (Com) (S280) – *Interference with Other Rights*
	• *Navigation Act 2012* (Chapter 3 – Vessel Safety) and subordinate legislation:
	  ○ Marine Order 3 (Seagoing Qualifications)
	  ○ Marine Order 27 (Safety of navigation and radio equipment)
	  ○ Marine Oder 30 (Prevention of Collisions)
	With control measures implemented the action will not impact of items of National Environmental Significance (NES), meets the requirements of the SW Marine Bioregional Plan and upholds IUCN Management Principles for Marine Reserves (Category VI) (EA, 2002) relevant to the West Eyre Marine Protected Area (MPA).

External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation Advices.	Western Eyre CMP: Impact, if it occurs within the CMP is contained locally. This risk does not conflict with the prescriptions detailed in the South-west Marine Parks Network Management Plan 2018 (DNP, 2018), does not conflict with conservation values and does not conflict with, and meets, the IUCN principles for, Category VI Reserve Areas (Multiple Use Zone and Special Purpose Zone). These reserves are managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*equipment loss does not compromise diversity/natural values*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*practices adopted ensure ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Recovery/Conservation Plans: Review and assessment of threatened species recovery plans and conservation advice (refer **Section 3.7**) did not identify threats associated with vessel artificial lighting impacts. No action objectives from recovery plans are applicable to this impact.
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
Nil	
Towed Equipment Deployment and Recovery Procedures Equipment Inspection Records (in-water equipment) Incident Records Vessel log (dropped object location) Vessel radio logs	

6.15 Risk: Vessel strike with marine mammals

6.15.1 Hazard

Movement of vessels through the survey area has the potential to strike air breathing marine mammals.

6.15.2 Known and potential environmental impacts

The known and potential environmental impacts associated with vessel strikes to marine mammals are injury or death.

6.15.3 Evaluation of environmental risk

Vessels associated with the Duntroon survey will operate on a 24/7 basis. The Duntroon OA is recognised as having habitats which seasonally support the presence of cetaceans and pinnipeds which forage and transit the area. Collision with marine fauna with survey vessels/equipment is considered credible, however, due to the slow speed of the survey vessel itself and the monitoring/observation of fauna to avoid impact, if contact made with species, the impact is expected to be slight.

The reaction of marine fauna to vessels is varied (Richardson et al, 1995):

- Sea lions in the water tolerate close and frequent approaches by vessels and sometimes congregate around fishing vessels. Sea lions hauled out on land are more responsive but rarely react unless a boat approaches within 100-200 m. Reaction to nearby boats are most common if motor noise varies in level;
- Dolphins often tolerate or even approach vessels but at time some members of the same species show avoidance. Reaction to boats appears related to the dolphin's activity: resting dolphins tend to avoid boats, foraging dolphins ignore boats and socialising dolphins may approach. Dolphins can reduce the energy of travelling by riding the bow and stern waves of vessels.
- In general:
  - Odontocete whales sometimes show no avoidance reaction to vessels or even approach them. However, avoidance behaviours have been observed especially if the vessel used chases or hunts the animals;
  - Baleen whales often ignore low-level sounds from distant or stationary vessels. When vessels approach whales slowly and non-aggressively, whales often exhibit slow and inconspicuous avoidance manoeuvres. In response to strong or rapidly changing vessel noise, baleen whales often interrupt their normal behaviour and swim rapidly away.

Literature identifies that most collisions between vessels and cetaceans occur on the continental shelf reflecting areas of high usage by both vessels and cetaceans. In general, the populations which are most frequently struck are those living on or near busy vessel routes (particularly shipping of ferry routes) or where there is an unusual concentration of vessels in a shallow, confined area (e.g. east coast of America or Canary Islands) (Dolman et al. 2006).

Laist et al. (2001) has identified that larger vessels (container vessel and fast ferries), moving more than 10 knots may cause fatal or severe injuries to cetaceans, with the most severe injuries caused by vessels travelling faster than 14 knots. As the survey vessel transits the survey area at low speeds (typically less than 5 knots) during data acquisition, the likelihood of vessel strike and associated injury or death of a whale or dolphin is considered very unlikely. PGS also considers that the survey vessel, as a slow moving and restricted manoeuvrability vessel with an operating array, does not pose a significant collision risk to pinnipeds. Operational acoustic sources which alert sound-sensitive mammals to the activity will illicit avoidance around the immediate vessel area.

Support/escort vessels generally travel at higher speeds to effectively patrol the requested clearance zone around the survey vessel and the towed array and it is considered that these vessels have a higher potential for collision and damage with marine mammals.

Should a vessel strike a marine mammal impacts at a population level are considered minor and temporary with no effects on critical habitat (MINOR consequence). With controls adopted vessel strikes leading to mortality is considered highly unlikely (LOW risk).

<u>Marine Notice 15/2016 (Minimising the risk of collisions with cetaceans):</u>

This marine notice issued by AMSA relates to reducing the risk of collision with cetaceans (whales, dolphins and porpoises) in accordance with IMO Circular MEPC.1/Circ.674. The notice urges seafarers to:

- Maintain a lookout for cetaceans particularly for the:
  - Blue whale between November and May between Scott Reef southwards across the GAB to Tasmania;
  - Southern right whale along the southern coastline between May and November;
  - Sei and fin whales (no location, no timeframe);
- Warn other vessels in the vicinity using all appropriate means of communication if whales have been sighted;
- Consider reducing speed in areas where cetaceans have been sighted; and
- Consider modest course alterations away from sightings.

It is noted that the operating acoustic array is expected to deter cetaceans close to the survey vessel. However, in addition to this, vessel watch by MFOs will be occurring on all vessels for cetaceans. Support vessels will observe EPBC Regulations (Part 8) vessel management and spatial buffers on sighting a cetacean (includes reducing speed and altering course in proximity to a cetacean). Survey vessels will warn other third-party vessels of the presence of whales.

Commonwealth Recovery Plans:

Review of management actions contained in the conservation/recovery plans of threatened species recorded as present in the survey area has identified vessel strike as a threat to the following threatened marine mammals:

- Recovery Plan for the Australia Sea Lion (SEWPC, 2013) (Objective 4.1) requires mitigation of the threat posed to the Australian sea lion by vessel strikes and an improved understanding of the data on confirmed vessel strikes;
- Conservation Management Plan for the southern right whale (SEWPC, 2012) (Objective A5.1) requires DoE to develop a national ship strike strategy which quantifies vessel movements within the distribution range of the southern right whale and outlines appropriate mitigation measures that reduce impacts from vessel collisions. *The National Strategy for reducing vessel strike on cetaceans and other Marine Megafauna (DoEE, 2017) has been developed*.
- Blue Whale Conservation Management Plan (DoE, 2015) (Objective A4.2 & A4.3) requires all vessel strikes to be reported in the National Ship Strike Database; and ensure that the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in area where blue whales occur and, if required, appropriate mitigation measures are implemented.
- The Conservation Advice for the humpback whale (TSSC, 2015c) requires all vessel strikes to be reported on the National Ship Strike Database and when assessing actions that increase vessel traffic in an area, appropriate mitigation measures should be adopted.
- The Conservation advice for the fin whale (TSSC, 2015d) and sei whale (TSSC, 2015e) require all vessel strikes to be reported on the National Ship Strike Database and the development of a national vessel strike strategy which identifies potential mitigation measures to be adopted (as above).

PGS has undertaken a risk assessment into the potential for marine mammal strikes associated with vessel activity during the Duntroon survey in accordance with the National Strategy (Objective 2, 3 & 4). Mitigation measures adopted include the use of MFOs (survey and support vessels) to identify marine mammals (whales, dolphins and pinnipeds), vessel operations observing buffer distances and vessel management strategies as legislated by the EPBC Regulations 2000 (Part 8) for these species. PGS will report any vessel strikes to both DoEE and NOPSEMA if collision incidents occur. PGS considers that all requirements outlined in the recovery/conservation plans are captured by these management actions.

Marine Reserves (Conservation Values and Management Principles):

An assessment of vessel strikes to megafauna has been undertaken against prescriptions contained in the South-west Marine Parks Network Management Plan 2018 (DNP, 2018), the Western Eyre CMP conservation values and IUCN management principles (Multiple Use Zone (IUCN VI)) (refer Table 6-89). Species at risk include the Australian sea lion, blue whale, southern right whale, fin and sei whales and sperm whale. The controls adopted during survey activities are expected to result in a low risk of vessel strike to these species, and while individual animals might be impacted, long-term impacts at a population level is not expected. Accordingly, impacts on long-term conservation values are slight, recoverable and consistent with the management plan prescriptions and principles for sustainable long-term use of the area (refer **Appendix M**). ALARP and acceptability is demonstrated in Table 6-89.

6.15.4 Risk assessment

Table 6-89 provides the risk assessment for potential vessel strike to marine mammals within the survey area as a result of survey activities.

Table 6-89: Vessel strike to marine mammals ERA

Aspect	Vessel strike to marine mammals (cetaceans and pinnipeds).				
Impact Summary	Fauna injury or death.				
Extent of Impact	Limited to individual pinnipeds or cetaceans in direct contact with vessel (no large-scale population impact).				
Duration of Impact	At a population level, impact is considered short-term.				
Level of certainty of impact	HIGH. Impacts from cetacean and pinniped strikes have been studied and the impacts are well documented.				
Species affected in the marine environment	Cetaceans (protected and listed) and Pinnipeds (protected and listed).				
Impact Decision Framework Context	A (nothing new or unusual, represents business as usual, well understood activity, good practice is well defined). Impact assessment is based on LCS, GIP and PJ.				
Impact with control failure (inherent)					
Consequence:	Minor	Likelihood:	Unlikely	Risk:	Medium (3)

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Survey Vessels (non-acquisition periods), Support Vessels (all times): Compliance with EPBC Regulation 2000 (Part 8) requirements for vessel proximity distance, approach and vessel management near whales and dolphins (vessels to adopt dolphin buffers for pinnipeds).	Administrative	YES	Represents good practice, is well defined and is a standard practice adopted for the offshore petroleum sector.
Survey Vessel (Data acquisition periods): Compliance with EPBC Regulation 2000 (Part 8) requirements for vessel proximity distance, approach and vessel management near whales and dolphins (vessels to adopt dolphin buffers for pinnipeds).	Administrative	NO	Operational array displaces sound-sensitive species. Survey vessel is slow moving without significant deviation in course and does not pose a significant threat to cetaceans and pinnipeds. Measure is not considered to add significant net environmental benefit to sound sensitive species.
Environmental induction for support vessel crews to ensure awareness of requirements.	Administrative	YES	Represents good practice, is well defined and is a standard practice adopted for the offshore petroleum sector.
Survey acquisition outside of pygmy blue whale foraging and feeding period (November to April).	Eliminate	Yes	The survey period (September to November) and controls adopted to prevent temporal overlap with the species, eliminates potential impacts. Undertaking seismic acquisition outside the pygmy blue whale season results in encounter with the southern right whales as it migrates away from the southern Australian coastline. Animat modelling has identified that the number of SR whales present are low within the survey area (refer Section 6.2). Timeframe adjustment is considered to have a net gain with respect to lower cetacean encounter.

Seismic acquisition only to occur in daylight hours	Eliminate	NO	Measure would double survey duration and PGS would not be able to meet seismic data delivery requirements to clients. If equipment was deployed and retrieved daily, survey objectives would not be realised as the time taken to deploy and retrieve is greater than the daylight hours.
Use of additional MFOs on support vessels	Administrative	Yes	Additional MFOs on support vessels ensure that trained personnel are available to sight cetaceans. MFOs on support vessels will be relieved periodically by crew trained in cetacean observation.
Notify other vessels if cetaceans are identified	Administration	Yes	Good Industry Practice – compliance with Marine Notice 15/2016.

Risk with controls (residual)					
Consequence:	Minor	Likelihood:	Highly unlikely	Risk:	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
EPO31: No collisions with marine megafauna by survey vessels in Duntroon OA. **MC:** Incident reports demonstrate zero incidents of collision with megafauna by survey vessels.	**EPS105:** Support vessel operations (all times) and survey vessel (non-acquisition periods) to conform to proximity distances, speeds and management measures contained in the EPBC Regulations 2000 (Chapter 8) for cetaceans when in the operational survey area. Vessel Masters observe 'dolphin' speed restrictions and proximity distances as required in the EPBC Regulations 2000 (Chapter 8) for pinniped species.	MFO Master Data Sheet verifies interaction between the MSS vessel and marine mammals comply with these requirements. Responsibility: MFO Support Vessel observation sheet verifies interactions between the vessel and marine mammals comply with these requirements. Responsibility: Vessel Master
	EPS106: All vessel crews have completed an environmental induction covering the requirements for **pinniped and** cetacean/vessel interaction consistent with EPBC Regulations 2000 (Chapter 8) and are familiar with the requirements.	Induction records verify that all crews have completed an environmental induction. Responsibility: Survey Chief
	EPS107: Vessel Masters will advise surrounding third-party vessels of cetacean presence on marine radio.	Vessel log verifies alert has been made based upon MFO records. Responsibility: Vessel master
	EPS108: Any vessel strike incident to whales, dolphins or pinnipeds shall be reported as soon as possible via the National Vessel Strike Database at https://data.marinemammals.gov.au/report/shipstrike by PGS.	Records verify incident has been reported. Responsibility: Vessel Master

Demonstration of ALARP	
Hazard Risk Criteria	A LOW risk ranking is considered broadly acceptable. If the risk control measures are consistent with applicable standards, then no action is required to reduce the risk further unless a reasonably practicable measure is available. The risk shall be managed and continuously improved in accordance with good industry practice.

Hierarchy of Controls	<u>Eliminate:</u> • The use of a vessel cannot be eliminated for the activity. • Survey area is not located in proximity to Southern Right Whale breeding areas (i.e. high aggregation areas). • Survey window has been selected to eliminate survey during seasonal presence of pygmy blue, fin ans sei whales within the survey area. SR whales present are predicted to be small in muber from animat modelling and Sperm whales are present all year-round. • Use of scout/support vessels to identify and avoid areas where cetaceans are present. <u>Substitute</u>: • None identified <u>Engineer</u>: • None identified <u>Isolate</u>: • Adoption of EPBC Regulation 2000 (Part 8) requirements for proximity distances and vessel management if cetaceans or pinnipeds are identified within certain buffer zones to the vessels <u>Administrative:</u> • Active watch on all vessels for the presence of cetaceans to minimise possible impacts. • All crews are inducted into these requirements • All vessel incidents with marine mammals will be reported to the DoEE and NOPSEMA within 2 hours of the incident.
Compliance with International Conventions, Legislative Codes and Standards	Compliant with the Commonwealth: • Environment Protection and Biodiversity Conservation Act 1999, associated Regulations (Part 8*)* • Marine Notice 15/2016
Good Industry Practice	**APPEA Code of Environmental Practice** (2008) objectives met for offshore seismic surveys with respect to reducing the impacts to other marine life to a level which is ALARP and acceptable including: • The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the vessels operate and assess potential impacts. **IACG:** Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) requirements met for Aquatic Life (Section 8.7) requirements.
Professional Judgement	Alternate controls identified and implemented where practicable. Controls adopted over multiple levels on the control hierarchy.
Engineering Risk Assessment	Not applicable – 'Risk Decision Framework Context is Category A
Cost Benefit Analysis	Not applicable – 'Risk Decision Framework Context is Category A
Demonstration of Acceptability	
Policy compliance	The risk management strategy for vessel strike to marine mammals reflects PGS's Environmental Policy goals of preventing harm to the environment by reducing risk, complying with applicable legal and industry standards and continually improving environmental performance.
PGS HSE Management System	**Section 7** demonstrates PGS's HSEQ Management System is capable of meeting environmental management requirements for this survey.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 9**). No stakeholder concerns have been raised with regard to vessel strikes.
External Context: Environment	Environment can contain seasonal presence of protected and listed whales, dolphins and pinniped species.

Legislative criteria & standards	Compliant with the Commonwealth: • *Environment Protection and Biodiversity Conservation Act 1999 and associated Regulations (Part 8)* • *Marine Notice 15/2016* *With control measures implemented, the risk associated with marine fauna impacts from vessel strikes in items of impacts at a population level to items of NES, SW Marine Bioregional Plan requirements and IUCN Management Principles for Marine Reserves (Category VI) (EA, 2002) is ALARP.*
External Context: Marine Reserves, Management Plans, Species Recovery Plans and Conservation advices	Western Eyre CMP: Impacts are expected within the Western Eyre CMR in areas of spatial overlap. Controls adopted are consistent with the management prescriptions detailed in the South-west Marine Parks Network Management Plan 2018 (DNP, 2018). While any impacts (low risk) may affect individual animals, the impact does not conflict with, and meets the IUCN principles for, Category VI Reserve Areas (Managed Resource Protected Area). The reserve area is managed for the sustainable use of natural ecosystems based upon the following principles: • The biological diversity and other natural values of the reserve should be protected and maintained in the long-term (*the vessel strike hazard does not represent a population level risk to the area*); • Management practices should be applied to ensure ecologically sustainable use of the reserve (*preventative measures adopted support the ecologically sustainable use of the CMP*); • Management of the reserve should contribute to regional and national development to the extent that it is consistent with these principles (*survey activities meet this requirement*). Species Recovery Plans: Measures adopted within this risk evaluation are consistent with the requirements for blue whale, southern right whale and Australian sea lion recovery/conservation plans.
Environmental risk demonstrated to be ALARP	The residual risk meets ALARP criteria.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity is maintained when undertaking this activity. The EIA presented throughout this EP demonstrates compliance with the principles of ESD (refer **Section 2.2**).
Environmental Monitoring	
MFO/crew observations from vessels during surveys	
MFO/crew sightings report MFO end-of-survey report Project Induction and attendance records Incident Reports (DoEE & NOPSEMA)	

7 Implementation Strategy

7.1 Environmental Management Framework

7.1.1 General

The design and execution of proposed surveys within the Duntroon multi-client surveys will be conducted under the framework of the PGS Environment Policy and HSE&Q Management System.

PGS will apply a tiered approach to optimising the environmental performance of the project and ensuring that PGS's environmental management standards and performance outcomes are achieved. The approach involves identification of local and regional environmental sensitivities, prioritisation of risks, determination of appropriate practices and procedures to reduce those risks, and clear designation of roles and responsibilities for implementation.

A series of work instructions, procedures and plans will be used for the Duntroon multi-client survey to ensure that appropriate management measures are applied as required to minimise the risk of environmental disturbance from operations. The work instructions, procedures and plans are documented within corporate systems/manuals developed by PGS as well as documents written specifically for the Duntroon multi-client survey. Many of the procedures apply to all vessels in the PGS fleet; however, the associated work instructions are generally vessel specific.

Specific documentation relevant to this survey includes:

- HSEQ Management System Manual;
- Crew HSEQ Plan;
- Emergency Response Procedures including Oil Spill Response Procedure and Extreme Weather Procedures;
- HSEQ Management Procedures;
- Hazard Management Procedures;
- Environmental Management Procedures;
- PGS Marine Operations Offshore Bunkering Operations; and
- This EP.

An individual survey specific Project HSE&Q Plan will complement this EP, and will include procedures for the following:

- Emergency response;
- Waste management;
- Hazardous materials and handling;
- Mitigation of sound impacts to marine fauna; and
- Fuel/oil spills.

The Implementation Strategy for this EP includes an outline of:

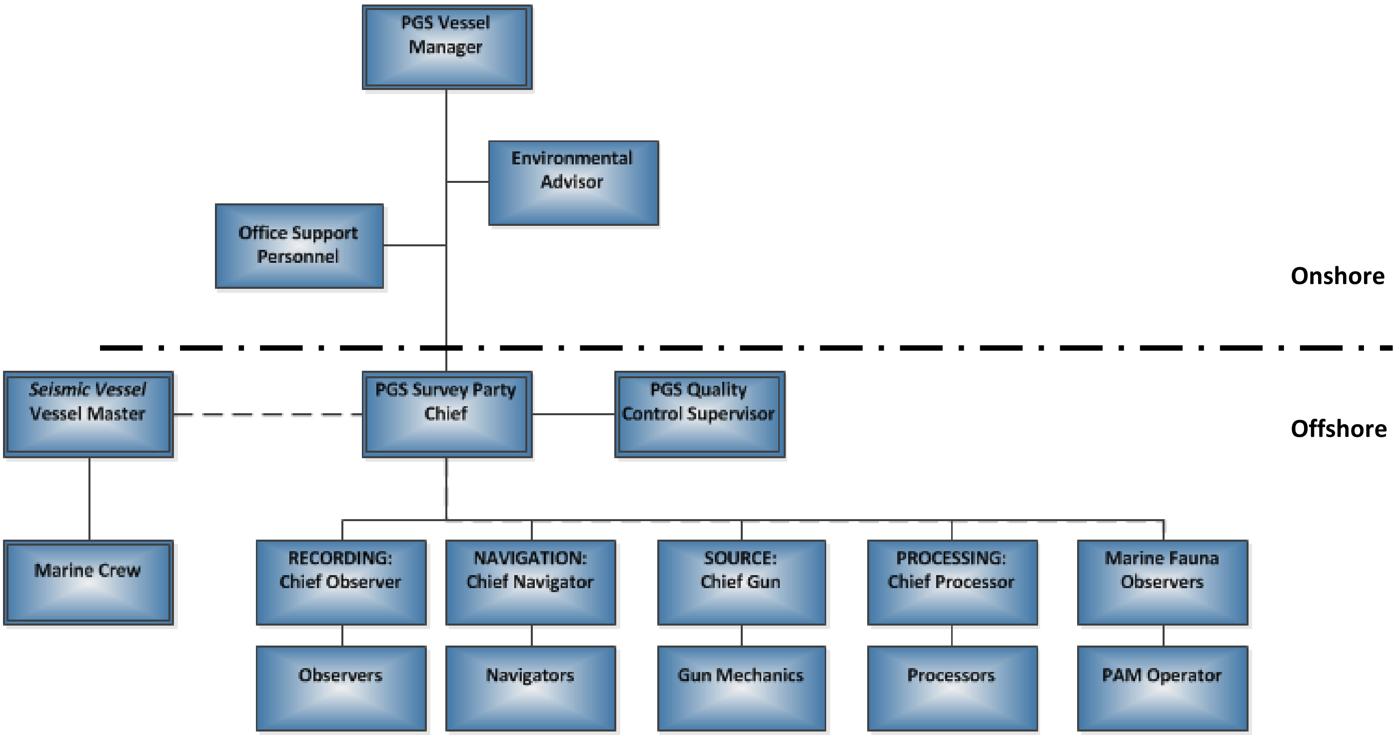
- Environmental management strategies;
- Roles and responsibilities;
- Training and competency;
- Monitoring;
- Auditing;
- Management of non-conformance;
- Record keeping;
- Emergency response and contingency planning;
- EP review; and
- Stakeholder consultation.

PGS is responsible for ensuring that the proposed activities undertaken within the Duntroon OA are managed in accordance with the Implementation Strategy and the PGS Environment Policy and HSE&Q Management System.

7.2 Roles and Responsibilities

Key roles and responsibilities for PGS and contractor personnel in relation to implementation, management and review of this EP are described in Table 7-1. The organisation structure is provided in Figure 7-1.

Figure 7-1: Organisation Structure



It is the responsibility of all PGS employees and contractors to ensure that the requirements of the corporate Environment Policy are applied in their areas of responsibility and that the personnel are suitably trained and competent in their respective roles.

Table 7-1: Position Roles and Environmental Responsibilities

Title	Location	Responsibilities
PGS Vessel Manager (VM)	Primary Onshore Contact	• Undertake risk assessment process as defined in **Section 7.8.2**. • Ensure the activity is undertaken as per the performance outcomes of the EP. • Provide sufficient resources to implement management measures to achieve EP performance outcomes. • Manage change requests for the activity notifying the PGS QGS and MFOs of any scope changes in a timely manner. • Liaise with regulatory authorities as required. • Review the EP as necessary and manage change requests. • Ensure environmental incident reporting meet regulatory requirements. • Monitor and close-out corrective actions raised from environmental inspections/audits or incident. • Manage company resourcing and compliance with the HSE&Q Commitment Statement and Environment Policy. • Communicate PGS operating policy and procedures. • Review results of compliance audit during the program and make recommendations where required. • Ensure that all reportable and recordable incidents are reported to NOPSEMA. • Ensure that a full briefing all project personnel is provided, including details of the environmental sensitivities of the survey area and environmental management procedures and EPOs detailed in this EP. • Ensure the annual Environmental Performance Report is prepared and submitted to NOPSEMA as per **Section 8.2** Emergency Response Role: • Responsible for supporting tactical response at the scene of scene of the accident (i.e. rescue, damage control notification, evacuation); • Commit necessary resources to facilitate an emergency response strategy in the event of an incident. • Manage PGS's emergency response strategy in the event of an incident.
Environmental Adviser	Onshore	• Prepare and revise the survey EP as necessary. • Assist the VM with the risk assessment process defined in **Section 7.8.2**. • Prepare environmental induction and vessel inspection information. • Provide a briefing to project personnel and survey vessel crew members of the environmental sensitivities of the survey area, environmental management strategies, EPO, and EPS detailed in the EP as part of the environmental induction process. • Assist with review, investigation and reporting of environmental incidents. • Ensure environmental inspections/audits are undertaken as per the requirements of the EP. • Ensure stakeholder consultation is undertaken as per the requirements of the EP. • Assist in preparation of external regulatory reports required for the survey, in line with environmental approval requirements and PGS incident reporting procedures. • Assist in the preparation of the Environment Performance Report (if required). • Prepare ECR (if required).

Title	Location	Responsibilities
Master Survey Vessel	Vessel-based	• Ensure the safe execution of all operations on the survey vessel. • Overall responsibility for HSE&Q management aboard the survey vessel. • Ensure that appropriate control and mitigation measures are implemented to minimise potential environmental effects resulting from vessel operations (e.g. waste management/disposal; fuel/oil spill response). • Immediately notify the PGS Quality Control Supervisor (QCS) of any incidents/activities arising from vessel operations that are likely to have a negative impact on the EPOs detailed in this EP. • Support the PGS Site Representative in ensuring that all relevant HSE&Q documents are understood and adhered to. • Ensure compliance with this EP, and any relevant statutory regulations (e.g. vessel discharges to sea). • Ensure that vessel procedures and systems comply with PGS standards as outlined in this EP. • Report hydrocarbon or other chemical spillage to the PGS survey Party Chief. • Establish and maintain radio contact with other vessels in the OA and adjacent waters.
Survey Vessel Chief Engineer	Vessel-based	• Overall responsibility for operation and maintenance of engines, generators and other machinery aboard the survey vessel. • Verify that the vessel's computerised PMS is used and updated and includes critical components and how to address them. • Select the correct survey modes for each machinery component with special regard to fuel economy and life time costs for the different components. • Verify that engine room log, oil record book and other logs are kept according to laws, regulations and vessel contractor's instructions. • Have the daily supervision of the running of all machinery, including engines, compressors, propulsion and power supplies. • Responsible for the maintenance in the engine department. • Responsible for waste management systems dealing with sewage, grey water, putrescible wastes and bilge water.

Survey Party Chief	Vessel-Based	• Ensure safe execution of all operations carried out by the seismic crew aboard the survey vessel.
		• Ensure that the following documents are aboard and in place:
		  ◦ HSE&Q Manual;
		  ◦ Emergency Response Procedures including Oil Spill Response Procedure and Extreme Weather Procedure;
		  ◦ HSE&Q Management Procedures;
		  ◦ Hazard Management Procedures;
		  ◦ Environmental Management Procedures; and
		  ◦ This EP.
		• Ensures the seismic operations are consistent with:
		  ◦ PGS HSE&Q Commitment Statement and Environment Policy;
		  ◦ Project HSE Plan;
		  ◦ This EP; and
		  ◦ Relevant environmental legislative requirements or regulatory conditions.
		• Provide a daily log of activities and environmental incidents to the PGS QCS.
		• Ensure that appropriate control and mitigation measures are implemented to minimise potential environmental impacts resulting from seismic acquisition (e.g. soft start procedures, whale watch and stop work procedures).
		• Ensure compliance with all aspects of HSE&Q reporting and for investigations of all incidents and near misses.
		• Immediately notify the PGS QCS of any incidents/activities arising from seismic operations that are likely to have a negative impact on the EPO detailed in this EP.
		• Liaise with PGS VM: If precaution zones have been increased and night-time operations ceased. When adaptive management procedures have been triggered and operations are to be relocated or ceased.

Title	Location	Responsibilities

PGS Quality Control Supervisor (PGS QCS)	Primary Offshore Contact	• Ensure that the following documents are understood and adhered to:
		  • HSE&Q Manual;
		  • Emergency Response Procedures including Oil Spill Response Procedure and Extreme Weather Procedure;
		  • HSE&Q Management Procedures;
		  • Hazard Management Procedures;
		  • Environmental Management Procedures; and
		  • This EP.
		• Facilitate clear communications between the Perth office, the PGS Operations Manager and the survey vessel personnel.
		• Investigate any hydrocarbon spills >1 L in size.
		• Ensure that, during the Duntroon multi-client survey all sub-contractors perform operations in a manner consistent with the EPO and EPS detailed in this EP.
		• Ensure that the survey Vessel Master and Party Chief are adhering to the requirements of this EP.
		• Monitor the implementation of all measures (Part A and Part B) identified in this EP and the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008a; DEWHA, 2008b).
		• Be fully aware of ongoing operations, particularly for environmentally critical activities.
		• Immediately alert the PGS Vessel Manager of any changes in operations that could have a negative impact on environmental performance.
		• Immediately report any reportable incidents to the PGS Vessel Manager.
		• Maintain records of daily logs, environmental incidents and waste inventory provided by the PGS Survey Party Chief.
		• Monitor and provide evidence of compliance to the environmental commitments as outlined in this EP and ensure the Environmental Compliance Register (ECR) is updated.
		• Record and collate all measurable performance outcomes of the EP within the ECR.
		• Assist in the preparation of the Environmental Compliance Register (ECR).
		• Maintain the ECR.
		• Ensure environmental inspections/audits are undertaken as per the requirements of the EP.
		• Conduct a compliance audit during the survey and forward results to the PGS Vessel Manager.
		• Assist the MFO team with visual observations for the presence of marine fauna and required EBPC Act - Policy Statement 2.1 reporting for cetacean interactions.
		• Assist with review, investigation and reporting of environmental incidents.
		• Assist in preparation of external regulatory reports required for the survey, in line with environmental approval requirements and the PGS HSE&Q incident reporting procedures.
		• Bring to the immediate attention of the PGS Party Chief and PGS Vessel Manager any actions that are not compliant with the EP. Any recordable incident will be logged within the ECR.
		• Prepare a report of the overall environmental performance upon completion of the survey, including the results of audits and any incidents, and forward to the PGS Vessel Manager.
		• Perform MFO duties when MFO is unable to.

Title	Location	Responsibilities
Marine Fauna Observers	Offshore	• Maintain watch for whales during the survey and advise the Master of the survey vessel, or Party Chief, of the presence of these marine fauna. • Ensure recording and reporting of cetacean, pinniped, dolphin and porpoise sightings. • Monitor the implementation of the EPBC-A (Standard) and EPBC-B (Management measures) identified in this EP. • Monitor and record any interactions with cetaceans and other marine fauna. • Provide a briefing to project personnel including details of environmental sensitivities of the Duntroon survey area and environmental management procedures and performance objectives detailed in this EP. • Monitor and provide evidence of compliance to the environmental commitments as outlined in this EP and ensure the environmental Commitments Register (ECR) is completed in conjunction with PGS QCS. • Assist in the preparation of the MFO Final Report. • Advise PGS QCS - when adaptive management procedures have been triggered and operations are to be relocated or ceased.
PAM Operators	Offshore	• Maintain surveillance for whales (24/7) during the survey and advise the MFO, of any whale detections. • Ensure recording of cetacean encounters. • Monitor and provide evidence of compliance to the environmental commitments as outlined in this EP. • Assist in the preparation of the MFO Final Report.
Seismic operators, technicians and vessel crew	Offshore	• Apply operating procedures in letter and in spirit. • Follow good housekeeping procedures and work practices. • Encourage improvement in environmental performance wherever possible. • Immediately report environmental incidents or spillage of >1 L of hydrocarbons or other chemicals to the survey vessel Master and survey Party Chief; • Vessel crews – monitor and record cetaceans, pinnipeds, dolphins and porpoises.

7.3 Training and Competency

7.3.1 Environmental Inductions

All personnel required to work on the survey and support vessels will be given an HSE&Q induction prior to the commencement of the Duntroon survey (this can be via a face-to-face presentation, website, or via email). The environmental component of the induction will include information on the following environmental issues.

- Description of the environmental sensitivities, heritage and conservation values of the individual survey area within the Duntroon multi-client survey area and surrounding waters;
- Overview of marine fauna likely to be in the area;
- Procedures for interaction with marine fauna;
- Importance of following procedures and using JHAs to identify environmental risks and mitigation measures;
- Procedures for reporting of any environmental incidents or hazards;
- Overview of emergency response and spill management procedures;
- Overview of the waste management requirements;
- Roles and environmental responsibilities of key personnel aboard the survey vessel;
- Chemical management requirements;
- Outline of environmental management measures, EPO, EPS and roles / responsibilities detailed in the EP. Identify EP Sections relevant to each department.

All personnel who undertake the induction will be required to sign an attendance sheet which is retained by the PGS VM. All vessel-based personnel will be required to conform to all applicable guidelines and requirements for management of HSE&Q issues. All crew on board the vessel/s will be made aware of and will be required to become familiar with the requirements of both relevant PGS' specific environmental management systems as well as the EP during the activity induction process. In addition, project specific EP requirements will be communicated to the vessel crew by the PGS QCS.

All personnel on the vessel are required to be competent to undertake their assigned positions. Specific responsibilities will be detailed in job descriptions and appropriate training provided to individuals with environmental responsibilities such as waste management measures; routine discharges; and deployment and recovery of streamer procedures. Training may be in the form of inductions, internal professional training, 'on the job' training or external courses.

PGS shall ensure the vessel operator provides marine crew who are trained and competent to undertake their respective activities on-board the vessel. All marine personnel will be qualified in accordance with the International Convention on Standards of Training Certification and Watch Keeping for Seafarers (STCW95) or Elements of Shipboard Safety as relevant. A training, induction and competency matrix will confirm that relevant crew have been trained as necessary for their position.

7.3.2 Vessel Master

The survey vessel Master shall possess appropriate skills, knowledge and qualifications to command the vessel.

7.3.3 Marine Fauna Observers

Only appropriately qualified and experienced MFOs (as determined by a review of their CVs in the project proposal from the provider) will be utilised for the survey. Two experienced MFO will be present on the survey vessel with a trained but possibly inexperienced additional MFO (Kangaroo Island representative). Otherwise MFOs will have a minimum of 6 months experience in marine fauna observations as demonstrated by training records and CVs.

As per the EPBC Policy Statement 2.1 requirements, MFOs will be "*trained and experienced in whale identification and behaviour, distance estimation, and be capable of making accurate identifications and observations of whales in Australian waters*."

7.3.4 PAM Operators

PAM operators will be competent to a standard equivalent to those in *2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations.*

7.4 Monitoring

7.4.1 Emission/Discharge Monitoring, Quantification and Reporting

Parameters provided in Table 7-2 provide the emission, discharge and interaction parameters which will be monitored and reported for the Duntroon survey.

Table 7-2: Duntroon MSS Emissions, Discharges & Interaction Monitoring Program

Discharge/Incident	Parameters	Record	Responsibility
Atmospheric Emissions			
Machinery exhaust	Quantity of diesel fuel used by the vessel(s) Bunkering receipts Fuel sulphur content	Daily Fuel Use Log	Vessel Master(s)
Incinerated waste	Volume of waste incinerated.	Garbage Record Book	Vessel Master(s)

Discharge/Incident	Parameters	Record	Responsibility
Discharges to Sea			
Oily water discharges	The volume of oily water discharge from vessel(s). Oil-in-water concentrations Discharge location	Engine Room Logs	Vessel Master(s)
Food-scraps	The volume of food-scraps discharged from vessel(s)	Garbage Record Book	Vessel Master(s)
Sewage/Grey water discharge	Discharge location Quantities discharged Discharge parameters (vessel speed; discharge rate)	Engine Room logs	Vessel Master(s)
Disposal of Wastes			
Hazardous wastes	Volume of hazardous wastes transferred onshore.	Garbage Record Book/Oil Record Book	Vessel Master(s)
Solid Non-biodegradable wastes	Volume of non-hazardous wastes transferred onshore	Garbage Record Book	Vessel Master(s)
Food-scraps	The volume of food-scraps discharged to shore based facilities	Garbage Record Book	Vessel Master(s)
Marine Fauna Interaction			
Marine Fauna sightings	Details required on the Whale and Dolphin Sighting Reports (DOE)	MFO Records	MFO
	Record of soft start commencements, shutdowns and visual checks undertaken before the commencement of arrays and actions taken if whale sightings within the observation and low-power zones during seismic acquisition. Daily log of seismic acquisition by Party Manager	MFO Records Daily Seismic Report	MFO
Marine User Interaction (Commercial Shipping and Commercial Fishing)			
Fishing Vessel Interaction/ Complaints: *Any incident involving negative interactions with commercial fishing vessels.*	Communications with other vessels. Location, duration and complaint issue. Any response actions taken	Incident Records	Vessel Master(s)
Commercial Shipping Incident: *Any collision or near-miss incident*	Communications with other vessels. Location, duration and complaint issue Any response actions taken	Incident Records	Vessel Master(s)
Spill/Release Incidents			
Spill/release incidents from Vessel(s)	Location, volume, duration and type of spill/waste Response actions taken	POLREP & SITREP Reports Incident Records	Vessel Master(s)
Vessel Collision	Location, equipment type and duration of incident Response actions taken	Incident Records	Vessel Master(s)
Equipment release incidents	Location, equipment type and duration of incident Response actions taken	Incident Records	Vessel Master(s)

Discharge/Incident	Parameters	Record	Responsibility
Whale Collision Incidents	Location, time, type of whale, expected injury Any response actions taken	Incident Records DOE Ship Strike database	MFOs/ Vessel Master(s)
Sound Verification			
Sound Source Verification	Parameters as detailed in **Appendix L**	Seismic Data Records	Party Chief
Noise Logging – SR Whale Calving BIA	Audio Files (0-288 kHz)	Sound data records	Vessel Manager

7.4.2 *Aerial Survey*

Pre-aerial Surveys:

Approximately three days prior to the commencement of the Duntroon survey, PGS will engage a spotter aircraft to undertake an aerial survey (weather permitting) to determine the presence of whale species within the survey area. The duration of the aerial survey is expected to be 4-5 hours (pers.com P. Gill, 2014).

Pre-aerial surveys proposed for the Duntroon multi-client survey will adopt the methodology outlined in Gill et al. (2011). This includes utilisation of a professionally piloted twin engine long-range aircraft surveying the area at speeds of approximately 240 km/hr and ~457 m (1500ft) altitude. All survey lines will follow parallel transects spaced approximately 6 nm apart and perpendicular to the shelf orientation providing a 3 nm area to be surveyed on either side of the aircraft. The survey area will be determined by the PGS Vessel Manager. Aerial surveys will be flown in a "closing mode" with the aircraft leaving the track-line and a GPS position obtained if a whale is sighted. The whale will be approached and circled with an exact position recorded, positive identification, behavioural status determined and relative associations to food and other wildlife aggregations.

Two trained and experienced observers located on each side of the aircraft will be engaged to sight and record sighting and effort data.

Sighting data to be recorded includes time, position, minimum estimate of the number present, direction of movement, broad behaviour category (e.g. feeding, travelling, diving), presence of visible surface or near-surface krill swarms, other species present, obvious environmental features (e.g. surface fronts) and vessels. Sea state and conditions of visibility including glare, cloud cover, haze and precipitation will be recorded at the start of each leg, and at any time when conditions change.

The trained aerial observers will assess for behavioural characteristics associated with the sperm whale, based upon the following, to determine if foraging is present withinthe survey area.

For sperm whales, Christal and Whitehead (2001) identified two general behavioural modes; foraging at depth and socialising/resting near the surface. Whilst foraging, which occupies about 75% of the species time, members of a group of females and immatures are usually spread out over 1-2 km of ocean, often forming a rank perpendicular to the direction of travel. Additionally, between dives of about 35 mins, members of the group breathe at the surface for about 8 min in groups usually containing 1-3 animals. These groupings are typically within 100 m of each other and show coordinated behaviour. Should sperm whales show this type of 'clumped'[129] distribution, "feeding" behaviours will be attributed.

This information will be documented and provided as a report to PGS by the trained observers.

If sperm whales are detected by aerial surveillance foraging within the sperm whale foraging BIA (i.e. over deep-water canyon systems), the survey vessel will position acquisition lines such that a distance of at least 13.05 km can be maintained between the operating array and the foraging animal location.

A scout vessel will be deployed to the foraging location to verify the continued presence of the sperm whales and their behaviours at this location.

[129] **Clumped Distribution:** Two or more distinct groupings of Sperm whales (1-3 individuals) or more than six individual Sperm whales, with each group located within 200 m of each other.

Aerial surveillance as a result of 'high whale numbers' will also be undertaken in accordance with this methodology.

Upwelling-related Trigger Aerial Surveillance Surveys:

Blue whale detection surveys, as a result of upwelling triggers, will also adopt the methodology outlined in Gill et al. (2011). This includes utilisation of a professionally piloted twin engine long-range aircraft surveying the area at speeds of approximately 240 km/hr and ~457 m (1500ft) altitude. The survey lines will follow parallel transects spaced approximately 6 nm apart and perpendicular to the shelf orientation providing a 3 nm area to be surveyed on either side of the aircraft. The survey area will be determined by the PGS Vessel Manager however will include an area 100km to the west and south of the MC3D survey where spatial overlap with the high-use foraging BIA occurs in Season 1. For surveys undertaken in Season 2 (if there is temporal overlap with the November timeframe), the aerial survey area will be determined by the PGS Project Manager based upon the remaining survey area to be completed and if there is a spatial overlap with the blue whale foraging BIA.

The methodology adopted for aerial surveys, observers and sighting data as detailed in the pre-survey aerial surveillance will apply to 'upwelling-related' aerial surveillance. The surveillance aircraft will maintain communication with the survey vessel to provide information on cetacean movement.

Given the number of transects (estimated 17 transects @ 140 km) and transect distance to be flown to cover this area (~2380 km) it is estimated that while one aircraft could perform this task in 10 hours, two aircraft will be required to perform this surveillance.

7.4.3 Passive Acoustic Monitoring

The Duntroon MSS will utilise PAM as a complementary control to mitigate impacts to sperm, beaked, killer and pilot whales that might be present in the survey area during operations.

Application:

The PAM system will be set up to detect the range of frequencies of cetacean vocalisations expected to be present in the survey area (1Hz-200 kHz) and will be used to establish a bearing a distance from the source array to the vocalising cetaceans. Note that while the system has the potential to detect low frequency (e.g. 10 Hz) vocalisations, it is likely that the flow noise generated by the movement of the hydrophone through the water during towing can drown out some low-frequency vocalisations. The system is more sensitive to medium to high-frequency vocalisations (sperm and beaked whales, dolphins) and will be used to target these species.

For clarity, the PAM system will be set up to detect available call signs for MF and HF odontocetes (excluding dolphins) listed in Table 6-45 which may be present in the Duntroon OA.

Mitigation measures (i.e. power-down and shutdown) will be implemented on the detection of a MF or HF odontocete within the low-power (2000 m) and shoutdown (500 m) zones. Usual visual surveillance, prior to start-up will be undertaken, however for water depths > 200m the surveillance period shall increase to 60 minutes.

For HF cetaceans which may be present in the survey area (i.e. pygmy and dwarf sperm whales) due to the limited detection range of PAM systems, any bioaccoustic detection will require an immediate shutdown of the active source or a delay in start-up of operations, regardless of the signal strenghth or distance or bearing from the acoustic source has been determined.

If a sperm whale is detected within 13 km of an operational array within the sperm whale foraging BIA (canyon systems) the whale will be assumed to be foraging and the source powered-down. A scout vessel will be deployed to verify the location and activity of the whales. The source will not be reactivated to full power unless the scout vessel confirms that the sperm whales are migrating; the PAM operator confirms that the animal has moved to a point which is greater than 13 km; or despite continuous observation 60 minutes have elapsed since the detection of a sperm whale within 13 km of the source.

The vessel may adopt "adaptive management procedures' in this instance to continue operations.

System Standard:

The efficacy and accuracy of PAM in the detection and localisation of marine mammals during seismic and other marine surveys is well established (Todd et al. 2015; Sousa-Lima et al. 2013). There are now broad international standards in hardware and software systems that are regularly used for the PAM of marine mammals although standards vary between countries. Australia has no formal State or Commonwealth technical specifications for a PAM system, and therefore PGS propose to implement the New Zealand Government document which provides mandatory technical specifications in the 2013 Code of Conduct for minimising acoustic disturbance to Marine Mammals for Seismic Survey Operations (Department of Conservation, 2013) the New Zealand Code is regarded as one of the most conservative and protective of marine mammals in the world.

Overall, the PAM team will work closely with the visual observation team (MFOs). During daylight hours, PAM detections will be validated against MFO observations and ranges in order to determine the error (if any) in PAM detection distances. If the PAM team detects a marine mammal, then they will notify the Team Leader who will assess the location of the individual relative to the mitigation zones. If they are found to be within the agreed zones, then the Team Leader will notify seismic operations, who will then initiate shutdown or power-down as appropriate. All observations and mitigation actions will be formally recorded and available to the Regulator for review.

Once this calibration has been established, then PAM will be used to trigger low power and shutdown procedures at night and during periods of low visibility when whales enter the appropriate precaution zones. If PAM records are shown inaccurate in estimating distances, the seismic vessel will power down in the event of a confirmed detection (comprising 3 or more detection records for an individual whale) and not power-up until 30 minutes have passed without detection.

The integration of PAM with visual observations provides effective control of operations ensuring the survey meets the requirements of the EP implementing appropriate mitigation actions when marine mammals are detected within the specified mitigation zones. These methods represent international best practice for seismic surveys and all personnel will be experienced in the application of these methods and the overall mitigation process.

Technical specifications for the PAM equipment to be used in the Duntroon multi-client survey are provided in **Appendix F**. The PAM system will be deployed directly off the seismic vessel and is run out parallel to the streamers. The PAM system proposed to be used will be a Seiche 250m towed hydrophone array with four separate hydrophone elements plus a depth sensor. The array sections consist of two pairs of two hydrophones:

- Two are set with a bandwidth of 10 Hz to 200 kHz and although the hydrophone starts to roll off at 10 Hz, it still remains sensitive down to 1 Hz where it will still register 4 dB; and
- The second pair of hydrophones is set to a bandwidth of 2 kHz to 200 kHz sensitivity. This will ensure that if the lower frequency pair of hydrophones is saturated by vessel noise, the system will still be capable of detecting vocalising marine mammals.

Overall, this means that this system is capable of monitoring marine mammals vocalising between 1 Hz and 200 kHz which covers all marine mammals likely to be present in the survey area.

The survey vessel will carry two completely independent and 100% complete PAM systems so that if one breaks down, the other can be immediately deployed. Skilled and experienced PAM operators are competent in reliably repairing PAM systems, however a senior PAM operator will also be on-board to guarantee the repair of the system.

Range Determination:

Range and direction to vocalising marine mammals will be determined using the industry standard and open software PAMGUARD[130] linked to the Seiche hydrophone systems. This has well tested and effective

[130] Software and information available at http://www.pamguard.org/

systems for the detection, classification and localisation of marine mammal vocalisations. A simplistic description is that the system using complicated algorithms to detect vocalisations and then use the differential time of arrival when a signal is received at the different hydrophones to estimate distance and bearing. Real time field trials have demonstrated the accuracy and reliability of PAMGUARD in detecting and locating marine mammals.

PAM Operator Competencies:

PAM operators will need to be able to demonstrate the following proficiencies as a minimum:

- Optimised assembling, deployment and configuration of PAM equipment to ensure effective detections of cetaceans for mitigation purposes;
- Detection and identification of vocalising species or cetacean groups;
- Measuring distances and bearings of vocalising cetaceans while accounting for vessel movement;
- Navigation (e.g. true vs magnetic north, course versus heading);
- Plotting positions of cetaceans in relation to vessel and acoustic source; and
- Understanding relevant aspects of seismic survey operations.

PAM operators working on the PGS Duntroon survey will meet at least one of the following competency standards and have suitable experience in PAM operations:

- Passed the NZ PAM Operators course and be approved to work in NZ by the NZ Government;
- Passed the US PAM Operators course and be approved to work in the US by the Bureau of Ocean Energy Management (BOEM) and/or the Bureau of Safety and Environmental Enforcement (BSEE);
- Passed the JNCC PAM Operators course and be approved to work in the UK by the Joint Nature Council of the UK; and
- Demonstrate suitable experience in the set-up, operation, troubleshooting and analysis of PAM systems and data on marine science surveys and/or seismic surveys.

PAM operators will have 3 years' professional experience and a minimum of 12 weeks relevant international sea-time.

PAM operators will also need to demonstrate regular refreshing of their detection skills with simulation-modelling software particularly with respect to sperm whale detection and training on the software to be utilised in the survey and the latest software/hardware advances.

7.4.4 *Source Verification via Streamer Data*

The Duntroon MSS will utilise sound data collected from seismic survey streamer data to reverify the sound source. The methodology for this activity is provided in **Appendix L** and will be undertaken once during the Duntroon survey.

This information is useful in providing verification of source sound levels in the receiving environment compared with modelled sound levels, but is limited by location, azimuth and maximum offset. On this basis, PGS will post process this data to verify source levels for input into any modelling that might be carried out for future surveys.

7.4.5 *SRW Calving BIA Sound Loggers*

PGS will install a sound logger at the SRW calving BIA boundary to continuously monitor sound levels from the survey operations during the period September 1 to November 30 (Season 1). Note, this is not a control measure but is used as a verification measure to validate received sound levels and sound propagation modelling. Given the expected sound levels within the calving BIA are significantly below biologically relevant behavioural disturbance thresholds, this information be post-processed at the completion of the survey.

7.5 Audits & Inspections

Environmental performance and the implementation strategy of the Duntroon multi-client survey will be reviewed in multiple ways. These reviews are undertaken to ensure that:

- All significant environmental aspects of the activity are covered in the EP;
- That environmental management measures (including PGS's environmental management framework) to achieve EPO and EPS are being implemented, reviewed and where necessary amended;
- Identification of potential non-conformances and opportunities for continuous improvement;
- That all EPO and EPS have been met before completing the activity; and
- All environmental commitments contained in the Environmental Commitments Register (ECR) have been fulfilled.

The following arrangements will be established to review environmental performance and the implementation strategy of the activity:

- A summary of the EPO, EPS and MC for the activity (ECR) will be distributed aboard the survey vessel(s). These will be monitored on a regular basis by the PGS QCS via mechanisms such as audits and inspections. For routine items (i.e. not related to a specific activity such as refuelling) regular is defined as weekly. For activity items (i.e. discrete activities such as refuelling) regular is defined as per occurrence;
- An inspection(s) of the vessels will be carried out before the activity to ensure that procedures and equipment for managing routine discharges and emissions are in place to ensure compliance with the EP;
- An inspection(s) of the vessels will be carried out prior to the survey to ensure that contractor HSE&Q management systems are in accordance with all relevant requirements of PGS's environmental management framework and HSE&Q management system;
- The PGS QGC is responsible for ensuring at least one compliance audit is undertaken during the Duntroon survey period;
- A test of the oil spill emergency response arrangements will be conducted during the mobilisation phase of the survey to ensure vessel SOPEP is current and applicable.

Any non-conformances shall be reported, tracked and closed-out in accordance with **Section 7.6**.

The collection of data from audits, inspections and response tests will form the basis of demonstration that the EPO and EPS for the Duntroon multi-client survey are being met, that specified mitigation measures are in place to manage environmental risks, and that they remain working, and contribute to continually reducing risks and impacts to ALARP.

PGS Management will review the environmental management framework, including the environmental performance and implementation strategy, upon completion of each phase of the activity.As part of each review, any new developments in the scientific understanding and knowledge of relevant impact and risks will be reviewed. The results of the review and any identified improvements or recommendations will be incorporated into processes and procedures for future surveys to help facilitate continuous improvement.

7.6 Management of Non-Conformance

Non-conformances from audits, inspections and response testing shall be tracked and monitored by the PGS QCS until closed.

PGS employees and contractors are required to report all environmental incidents and any non-conformances with EPOs or EPSs detailed in the EP in accordance with PGS's environmental management framework. Incidents are reported using the PGS Event Reporting Management Procedure, which includes recording of details of the event, immediate action taken to control the situation, and corrective actions to prevent reoccurrence.

Detailed investigations will be undertaken by PGS for all high potential environmental incidents, and these investigations will include the PGS QCS. The regulatory reporting requirements for this activity are outlined in **Section 8** of this EP.

An internal risk assessment will be carried out where non-conformances suggest that specified mitigation measures no longer adequately demonstrate that the activity is managed to ALARP or where new developments in the scientific understanding and knowledge of environmental sensitivities within the survey area/CMP and associated impacts and risks is present. Any inadequacies and opportunities for improvements will be amended in the EP via a Management of Change to ensure that environmental impact and risks of the activity are continually identified and reduced to a level that is ALARP and acceptable.

In the event of an environmental incident, crew members and relevant shore-based personnel will consult both the vessel specific environmental systems as well as the Duntroon EP to determine the appropriate action.

The risk assessment process is outlined in **Section 7.8.2**.

7.7 Emergency Response

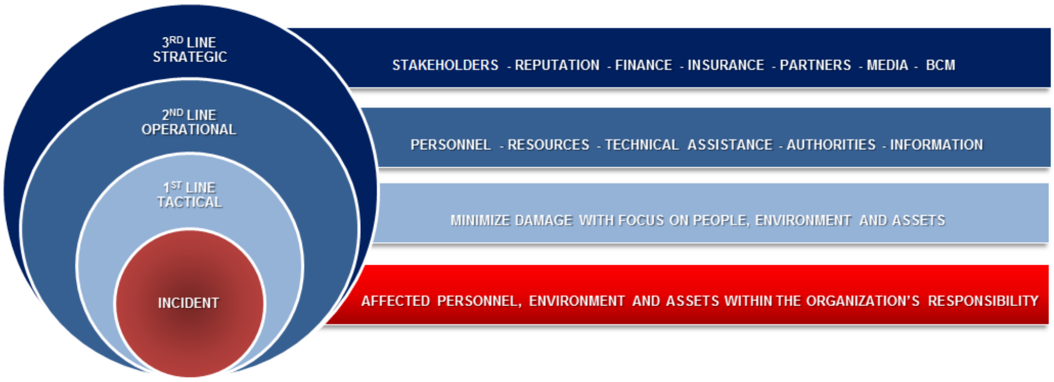
7.7.1 General

7.7.1.1 PGS Emergency Response Organisation

Figure 7-2 provides an overview of the emergency response organisation within PGS. The response organisation consists of three levels of emergency management:

- 1st line Tactical (vessel): Responsible at the scene of the accident for rescue, damage control, notification, combat, evacuation and normalisation. The responsibility of this team is to minimise damage at the worksite with a focus on people, assets and environment;
- 2nd line operational (Shore-based – VM): Responsible for supporting the 1st Line Tactical team with regard to personnel, resources, technical assistance, authorities and information (group communications). This group also conducts a proactive crisis management assessment to ensure effective handling of any incidents;
- 3rd line strategic (Shore-based – corporate): Responsible for supporting the PGS Group and 2nd Line operational with regards to reputation, finance, insurance, partners, media and business continuity. This group manages the strategic decisions related to emergency, liaising with national government ministries, departments, partners and stakeholders.

Figure 7-2: PGS Emergency Response Teams



In any incident, the PGS QCS will notify the onshore PGS VM (ERT Leader unless delegated). The ERT Leader will make an initial assessment and take actions in accordance with the PGS Emergency Response Plan (Operations). The ERT Leader will register the incident electronically (as appropriate) and notify the PGS organisation (as required). The ERT Leader will determine if an emergency exists, take appropriate action to control the situation and activate the ERT to provide emergency support (as above).

7.7.1.2 Emergency Response Preparation

Survey-specific emergency response procedures for the Duntroon survey are included in the Project HSE&Q Plan. The Project HSE&Q Plan contains instructions for vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification and contact information. In the event of an emergency of any type the survey vessel Master will assume overall onsite command and act as the Emergency Response Coordinator (ERC). All persons aboard the vessel/s will be required to act under the ERC's directions. The survey vessel will maintain communications with the PGS Vessel Manager and/or other emergency services in the event of an emergency. Emergency response support will be provided by VM if requested by the ERC.

The survey and support vessels will have equipment aboard for responding to emergencies, including but not limited to medical equipment, firefighting equipment and oil spill equipment.

7.7.1.3 Dangerous Weather Preparation

Severe weather events have the potential to cause damage to survey equipment, risk to the safety and health of survey personnel and potential to cause spills of hazardous materials into the environment from damaged vessels.

PGS has developed and implemented an Extreme Weather procedure (813VES00) for all seismic surveys utilising its vessels. This procedure will be adhered to during the survey. During the survey, the procedure will be implemented in the event of an approaching dangerous weather.

In addition to customised meteorological forecasts, the following regional charts on the Bureau of Meteorology (BoM) website provide useful information, and are sometimes more accurate than some of the customised local area modelling:

- 4-day MSLP (Mean Sea Level Pressure) prognosis;
- 10 m wind analysis (North Australia);
- Australian Region Total Significant Wave Height.

If a deep low-pressure system looks to be forming within, or approaching, the region the vessels' on-board management will make decisions in accordance with their authority and the PGS procedure. Depending on the situation, the survey vessel may also retrieve the seismic equipment and in a worst-case scenario proceed to the nearest port or to offshore waters away from the danger.

7.7.2 Oil Pollution Emergency Plan (OPEP)

The OPEP for the Duntroon multi-client survey, taking into account the nature and scale of the activity and the potential spill risks involved (refer **Section 6-10**), consists of the survey vessel(s) SOPEP (for vessels over 400 GRT involved in the survey or equivalent for lesser tonnage vessels) that manage the environmental impacts of a spill and vessel-based operational monitoring (refer SOPEP **Appendix D**); and statutory OPEPs which support the individual vessel-based SOPEPs.

Support/ chase vessels <400 GRT that are not obligated to have a SOPEP must have a spill response plan (to an equivalent standard) that is accepted by PGS and covers spill response arrangements and spill monitoring. As such, the following plans are in place as a contingency in the unlikely event of an oil spill, which collectively represent the OPEP for this activity.

- Survey or support vessel(s) > 400 GRT SOPEP - deals with spills which are either contained on the vessel or which can be dealt with from / by the vessel;
- Survey or support vessel(s) < 400 GRT spill management plan - deals with spills which are either contained on the vessel or which can be dealt with from / by the vessel;
- National Plan for Maritime Environmental Emergencies (NATPLAN): Australian Maritime Safety Authority (AMSA) – has jurisdiction and is the Control Agency (CA) for vessel spills which affect Commonwealth waters, i.e. outside 3 nm from the SA state boundary (AMSA, 2017);
- South Australian Marine Spill Contingency Action Plan (SAMSCAP): The South Australian Department of Planning, Transport and Infrastructure (DPTI) is the Control Agency for marine oil spills in SA state waters (as required).

7.7.2.1 Vessel SOPEPs

The seismic and support vessels (if > 400 GRT) SOPEPs, which have been prepared in accordance with the IMO guidelines for the development of shipboard oil pollution emergency plans (resolution MEPC.54 (32) as amended by resolution MEPC.86 (44)), include emergency response arrangements and provisions for testing the SOPEP (oil pollution emergency drills), as required under Regulations 14(8AA), 14(8A) and 14(8B) to 14(8E) of the Environment Regulations.

Support vessels <400 GRT, not having an approved SOPEP, will have a response plan that deals with spill response (including reporting), pollution monitoring and provisions for testing the plan.

Table 7-3 provides details on control measures which would be implemented to prevent and limit impacts in the event of a spill from vessels (ensuring safety of personnel on-board).

Table 7-3: Support Vessel Spill Prevention and Mitigation Controls

Scenario	Controls
Operational Spills (General)	Crew maintains a close watch for the escape of oil during bunker operations. Before bunker operations, crew mobilise oil spill equipment to area in case of a spill. Before bunkering commences, all scuppers and open drains will be plugged. Any free floating oil will be removed before draining. A drip-tray will be placed beneath any connections before bunkering commences. Any spilled fuel or used clean-up materials shall be retained on-board in proper containment until it can be disposed in shore-based facilities.
Leaking pipe	If leakage occurs from a pipe, valve or hose, operations through that connection will be stopped immediately and the defective pipe section isolated immediately. Initiate clean-up procedures. Inform all relevant parties of the leakage and the action taken to date. Any spilled fuel or used clean-up materials shall be retained on-board in proper containment until it can be disposed in shore-based facilities.
Hull leakage	If this occurs, tank which is leaking is identified. Reduce inventory in tank below the water line (sea level). If not possible to identify the leaking tank, reduce the level in all tanks in the vicinity with due consideration to hull stress and stability. If there is a spill due to a suspected hull leak, reduce the head of the bunker and transfer the bunker oil into an available empty or slack tank. Inform all relevant parties of the leakage and the action taken to date.
Spill caused by Machinery Spaces	If equipment failure occurs in the machinery space, further operation of equipment should be stopped immediately or measures taken to avoid a spill. The removed bunker oil or used clean-up materials shall be retained on-board in proper containment until it can be disposed in shore-based facilities.
Fire/Explosion	If fire/explosion occurs the general alarm will be sounded immediately. Priorities to be followed include: • Rescuing lives; • Limiting danger/damage to the vessel; • Preventing environmental pollution. Inform all relevant parties of the fire and the action taken to date.

Collision (fixed or moving object)	If collision occurs, mater will identify extent of damage to vessel and sound general alarm. If ships are separated, alter course to bring the own ship windward of any oil slick is possible. Shut down all non-essential air intakes. Isolated the samaged/penetrated tanks by sealing if possible. If possiblem and in consulttaion with appropriate shore authorities, consider moving vessels to a more suitable location to facilitate emergency repair or lightering operations. Inform all relevant parties of the incident and the action taken to date.

Support vessels shall be included in the survey OPEP drills contained in the Project HSEQ Plan.

In all cases, priority actions in the event of a fuel or oil spill, are to make the area safe and to stop the leak and ensure that further spillage is not possible. Deployment of small absorbent booms and other materials will be undertaken to maximise recovery of spilled material. All deck spills aboard the survey vessel will be cleaned-up immediately, using appropriate equipment from the on-board spill response kits (e.g. absorbent materials etc.) to minimise any likelihood of discharge of spilt hydrocarbons or chemicals to the sea.

7.7.2.2 *Drills and Training (Testing the OPEP/SOPEP)*

Drills of the OPEP, including the vessel SOPEP, will be conducted to assess the effectiveness of the arrangements, taking into account the nature and scale of the risk of a hydrocarbon spill (as detailed in Section 6.10 and Section 6.11). Specifically, the drills will ensure the following:

- Roles and responsibilities of those involved are clear and understood;
- Communication sequence from PGS offshore personnel to PGS onshore personnel and the Control Agency, including notification of the RCC and Flinders Ports (refer to Section 8.5), is adequate, current and includes all relevant responders;
- Ensures Type 1 operational monitoring such as spill surveillance and tracking is appropriate, understood and practiced; and
- Equipment and procedures intended for source control on board the vessel is adequate for use and effective as outlined in the vessel SOPEP.

All drill tests will be reported as per MARPOL Annex I (Regulation 15) requirements and reviewed after each drill as part of the ongoing monitoring and improvement of emergency response control measures. Should any inadequacies or improvements to the arrangements be found through testing, these corrective actions will be registered as a non-conformance (refer to **Section 7.6**) and the EP/OPEP will be amended for these items via a Management of Change process (refer **Section 7.8**). This is the responsibility of the PGS Vessel Manager.

The OPEP will be tested on the following occasions:

- Prior to survey commencing; and
- Following any significant amendment of the arrangements.

Additional, or more frequent, tests could be undertaken, on a monthly basis for example, however given the risk of the worst-case spill scenario occurring (refer **Section 6.10**); it is considered that the above arrangements for testing the OPEP are commensurate for the nature and scale of the worst-case spill scenario.

7.7.2.3 *Initial Actions*

As soon as an oil spill has been identified, the Vessel Master will immediately initiate the vessel SOPEP/ spill management plan and first strike actions as outlined within it. Due to the nature and scale of the activity, credible spill scenarios and characteristics of diesel, the initial response to any spill will be to monitor and evaluate (as assessed in Section 6-11). The preferred strategy for diesel spills will be to allow small spills to disperse and evaporate naturally, and to monitor the position and trajectory of any surface slicks. Physical break-up using prop wash from the support vessel and repeated transits through the slick may be considered for larger slicks (following consultation with the Combat Agency - AMSA).

Priority actions in the event of a fuel or oil spill are to make the area safe, to stop the leak and to ensure that further spillage is not possible. All deck spills on board vessel(s) will be cleaned-up immediately, using appropriate equipment from the on-board spill response kits (e.g. absorbent materials, etc.) and any likelihood of discharge of spilt hydrocarbons or chemicals to the sea will be minimised. Following clean-up, a planned maintenance system (PMS) will be implemented on the survey vessel(s), to ensure that all equipment used during operations is in full working order and does not represent a hydrocarbon spill risk.

As listed in the SOPEP (refer **Appendix D**), the vessels carry spill containment and recovery kits with absorbent booms and materials to contain small to medium scale deck spills. The Vessel Master is responsible for ensuring that these kits are stocked at all times throughout the proposed survey. Minor spills will be managed through housekeeping practices and the use of absorbent materials. Deck spills will not be discharged into the ocean.

Statutory Plans: Commonwealth Waters (Vessel Spills)

In the event of an oil spill in Commonwealth waters, initial actions will be undertaken immediately by the survey vessel (i.e. Vessel Master) and actions determined following immediate contact with relevant persons: AMSA contacted and activated as CA (under NATPLAN); PGS QCS; and PGS VM.

AMSA does not require titleholders to directly consult on OPEPs for seismic surveys or those addressing the operations of offshore supply vessels (AMSA, 2014). Such operations are already covered by existing NATPLAN arrangements. AMSA is the responsible CA for oil spills from vessels within the Commonwealth jurisdiction and will respond in accordance with its Marine Pollution Response Plan as approved by the AMSA Executive. Upon immediate notification of an incident (1800 641 792 or (02) 6230 6811), AMSA will assume control of the incident.

If the oil spill is a reportable incident as defined under OPGGSER Regulation 4 (i.e. determined by PGS to be a spill to the marine environment > 80 L), the PGS VM will notify NOPSEMA according to the requirements of the OPGGSER Regulation 26. Guidance on this notification and reporting of environmental incidents is contained in Section 8.3.

As per Section 8.3, the first NOPSEMA notification will occur within two hours of the incident or PGS becoming aware of the reportable incident (note: all verbal notifications will be followed by email confirmation as required by regulations). Within three days of the incident PGS will submit a written report of the reportable environmental incident to the Regulator (NOPSEMA). Within seven days a copy of the report will be given to NOPTA and the SA Department of Premier and Cabinet (DPC) (Energy Resources Division).

Also, within 24 hours of the oil spill event, the PGS VM will contact the DoEE regarding any impacts to protected marine fauna.

In summary, in the event of an oil spill in Commonwealth waters the PGS VM will be responsible for the following communications:

1. If determined a reportable incident, contact NOPSEMA within two hours and follow-up with a written confirmation;
2. If the oil pollution occurs in a marine park or will threaten a marine park the Director of National Parks must be contacted immediately on 0419 293 465 (24 hr Marine Compliance Duty Officer). Information which should be included within that notification includes:
    - Titleholder details;
    - Time and location of incident (including marine park likely to be affected);
    - Proposed response arrangements as per the OPEP; and
    - Contact details of the emergency coordinator.

3. Provide a copy of the written confirmation to NOPTA and SA DPC as soon as possible after written notification to NOPSEMA has occurred;
4. Contact DoEE within 24 hours;
5. Provide written incident report to NOPSEMA within three days;
6. Provide a copy of the written report to NOPTA and SA DPC within 7 days of the report submission to NOPSEMA.

South Australian State Waters

If surface slicks appear likely to enter SA State waters, then subsequent actions will be determined in consultation with the relevant personnel (i.e. AMSA, PGS QCS and PGS VM) and the state oil spill response arrangements (refer below).

Statutory Plans: South Australia (Vessel Spills):

The SA Department of Planning, Transport and Infrastructure (DPTI) is the Control Agency for marine oil pollution in SA waters and will appoint an Incident Controller for oil spills in SA waters except in Port Authority waters[131] under the SA Marine Spill Contingency Action Plan (SAMSCAP). SAMSCAP details roles, responsibilities strategies and actions to be carried out in the event of a spill.

Depending on the severity of the spill incident, activation of the SAMSCAP, and mobilisation of associated resources, will be initiated by the SA State Marine Pollution Controller (SMPC). If it is a small incident the SMPC may choose to form a response team within the DPTI.

Where SAMSCAP is activated, an Incident Management Team (IMT) may be assembled together with government agencies involved in the spill response at an operational level such as the SA Environmental Protection Agency (Environmental & Scientific Coordinator role) and DEWNR (oiled wildlife response). DTPI has access to AMSA's national Plan equipment to respond to spill incidents in State waters. This equipment is located at Port Adelaide, Walkley Heights, Port Lincoln, Port Pirie, Wallaroo and Thevenard (SA Government, 2017 – SAMSCAP).

In the event of a Level 2/3 spill the following response actions are summarised from the DPTI Consultation guidelines (DPTI, 2017) and consultation correspondence:

- In the event of a Level 2/3 spill the SA DPTI shall be contacted by the PGS VM via the Flinders Ports Signal Station ((08) 8248 3505) within 2 hours of the spill becoming known. Note as a courtesy PGS will notify DPTI of any Level 2 spill incident during the Duntroon survey;
- The initial verbal notification must be followed by an email containing a more detailed Pollution Incident Report from to DPTI.OilSpill@sa.gov.au;
- Depending on the nature and scale of the spill, DPTI will provide a liaison officer to PGS to assist with the state marine oil spill response coordination;
- For any Level 2/3 pollution emergency, it is an expectation of the DPTI that PGS will conduct initial response actions in State waters as necessary in accordance with their OPEP and continue to manage those operations until incident control can be established by DPTI. Upon establishment of incident control by DPTI, PGS is expected to continue to provide resources and capability support in accordance with their OPEP. This will include response assistance and contracts specified in their OPEP.

Where State waters are impacted by a Level 2/3 pollution emergency resulting from an offshore petroleum activity in Commonwealth waters, DPTI will assume the role of the CA for that portion of the response activity which occurs within State waters. The CA for a Level 1 spill pollution emergency in state waters resulting from an offshore petroleum activity is the petroleum titleholder (PGS) (DPTI, 2017).

[131] This is the responsibility of the Port Authorities for a Level 1 spill in port waters. For Level 2^{+} spills this then becomes the responsibility of SA DPTI.

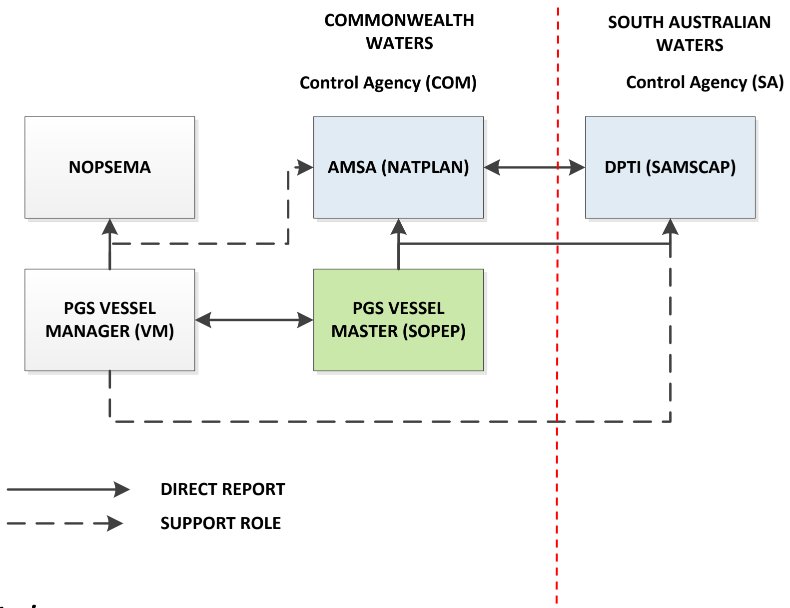
The DPTI will work with the CA (AMSA) to determine protection priorities and undertake an initial and ongoing Net Environmental Benefits Assessment (NEBA) to determine the most appropriate response to protection priorities in State waters.

AMSA may request the SA DPTI assume the Lead CA role, even though the spill occurred in Commonwealth waters in situations where oil is likely to impact on SA waters or the SA shoreline; where AMSA personnel are in transit to the site or a shipping issue requires the commitment of AMSA resources elsewhere (NATPLAN, 2011). Deployment of SA resources outside State Waters is usually coordinated and requested through AMSA (NATPLAN, 2017).

<u>Duntroon Survey IMT Structure (Commonwealth and State)</u>:

The PGS/Commonwealth/SA IMT structure and contingency plan arrangements for a spill in Commonwealth waters where spill residues may enter SA waters is shown in Figure 7-3.

Figure 7-3: IMT Structure and contingency arrangements for Vessel Spills in Commonwealth waters (entering state waters)



7.7.2.4 *Operational Monitoring*

In the event of a diesel spill to the waters surrounding the survey or support vessels, PGS would be responsible for undertaking Type I "Operational Monitoring" (unless AMSA as CA directs otherwise) with the primary objective of the monitoring being spill surveillance and tracking. This monitoring will be implemented to:

- Determine the extent and character of a spill;
- Track the movement and trajectory of surface diesel slicks;
- Identify areas/ resources / fauna potentially affected by surface slicks; and
- Determine sea conditions/ other constraints.

Operational monitoring will commence immediately from the survey and/or support vessel(s) simultaneously. With the exception of a vessel returning to port for fuel/supplies, and subject to mobilisation time of a second vessel if required (for example if an affected vessel is inoperable), two (2) support / guard vessel(s) will be on prospect throughout individual response process. If safe and practicable to do so, the PGS QCS and MFOs may be available to monitor and document the progress of the oil spill, including location, movement and extent and monitoring of wildlife, (wildlife present will be recorded using the DoEE Cetacean Sightings Application). Environmental monitoring of the spill will continue throughout the response phase and until response termination or until advised otherwise by the CA (i.e. AMSA or SA DPTI (as relevant)).

This oil spill monitoring will enable the Vessel Master to provide the necessary information to the relevant CA (AMSA or SA DPTI (as relevant)) via a POLREP form to determine and plan appropriate response actions under NATPLAN (if activated). Operational monitoring and observation in the event of a spill will inform spill response and scientific monitoring of relevant key sensitive receptors, including wildlife. Should monitoring and evaluation by crew and MFOs indicate wildlife is likely to be impacted the Vessel Master will notify AMSA or SA DPTI (as relevant) immediately. All oiled wildlife response strategies will be managed by AMSA or SA DPTI (as relevant) as the appropriate CA. The responsibility of assessing the appropriateness of any oiled wildlife response strategy, and its implementation, lies with AMSA or SA DPTI (as relevant) as the CA.

In addition, provisions for real-time oil spill monitoring and/or modelling may be undertaken by a third party. Specific monitoring / data requirements are:

- Estimation of sea state;
- Estimation of wind direction and speed;
- Locating and characterising any surface diesel slicks;
- GPS tracking;
- Manual or computer predictions (e.g. using ADIOS2 or real-time oil spill monitoring) of movement of surface slicks;
- GIS mapping.

This Type I monitoring will be restricted to daylight hours only, when surface slicks would be visible from the vessel. The information gathered from this monitoring will be passed on to AMSA or SA DPTI (as relevant), via the POLREP form, but also via ongoing SITREP reports following the initial spill notification. If it is determined that modelling is required to predict oil spill movements, this will be initiated within 3 hours, particularly if the spill is likely to reach protected areas within the estimated worst-case scenario of 6.6 hours (i.e. Rocky (south) Island – refer Section 6.10). Accordingly, modelling will be triggered in a Level 2/3 spill event to predict oil spill movement. Note this 'level' definition captures spill volumes with potential for exposure to groups of fauna or threatened fauna. Guidelines for incident classification adopted during the survey, consistent with NATPLAN are provided in Table 7-4.

Table 7-4: Spill Level Classification (AMSA, 2014)

Characteristic	Level 1	Level 2	Level 3
MANAGEMENT			
Jurisdiction	Single jurisdiction	Multiple jurisdictions	Multiple jurisdictions, including international
Delegation	Incident Controller responsible for all functions	Some functions delegated or Sections created	All functions delegated and/or divisions created
Number of agencies	First-response agency	Routine multi-agency response	Agencies from across government and industry
Incident Action Plan	Simple/Outline	Outline	Detailed
Resources	Resourced from within one area	Requires intra-state resources	Requires national or international resources
TYPE OF INCIDENT			
Type of response	First-strike	Escalated	Campaign
Duration	Single shift	Multiple shifts Days to weeks	Extended response Weeks to months
Hazards	Single hazard	Single hazard	Multiple hazards
RESOURCES AT RISK			
Human	Potential for serious injuries	Potential for loss of life	Potential for multiple loss of life
Environment	Isolated impacts or with natural recovery expected within weeks	Significant impacts and recovery may take months. Remediation required	Significant area and recovery may take months. Remediation required
Wildlife	Individual fauna	Groups of fauna or threatened fauna	Large numbers of fauna
Economy	Business level disruption	Business failure	Disruption to a sector
Social	Reduced services	Ongoing reduced services	Reduced quality of life
Infrastructure	Short term failure	Medium term failure	Severe impairment
Public Affairs	Local and regional media coverage	National media coverage	International media coverage

In the event of an oil spill, EPOs and EPSs as well as good industry practice will be adhered to (see Section 6-11 (spill response)). PGS will implement, assist with, or contribute to (including funding if required) any other operational monitoring as directed by the CA.

7.7.2.5 *Scientific Monitoring*

Type II 'Scientific Monitoring' will be implemented by PGS in the event of a Level 2/3 spill incident from the Duntroon survey. Scientific monitoring arrangements will be in-place at least one month prior to the start date of the Duntroon survey. In accordance with the NATPLAN incident classification guidance contained in Table 7-4, a Level 2 spill incident is defined as a spill where:

- Significant impacts and recovery may take months with remediation required;
- The spill threatens groups of fauna or threatened fauna; or
- Requires AMSA resources to participate in the response activities.

For spill scenarios identified for the Duntroon OA, Level 2 spills would include a vessel collision/hull failure; or a smaller spill (e.g. refuelling spill) which may impact on groups of fauna or threatened fauna. Table 7-5 provides an assessment of the receptors which might be affected by an MDO spill from a Level 2 oil spill from the Duntroon survey vessel. Table 7-5 identifies those receptors which might be affected by ecological thresholds and areas which may be socio-economic values (e.g. tourism) through surface sheens. Also nominated within Table 7-5 is the linkage between environmental sensitivities, their locations and the scientific monitoring modules to be adopted to establish receptor impacts, recoveries and possible remedial measures. Note that the exposure of these receptors to this worst-case scenario is while the survey vessel is operating along the northern OA boundary. Exposure risk is present for a short duration during the whole survey period.

<u>Requirements for Type II (Scientific Monitoring)</u>:

The Scientific Monitoring Plan consists of SMP modules which detail monitoring performance outcomes, standards, monitoring methodology, sampling and analysis plan (including laboratory QA/QC where applicable), available baseline information (sites, sampling frequency, baseline data-sets, baseline custodian), impacts assessment approach (BACI or beyond BACI), competencies, responsibilities and reporting requirements.

In the open waters of the Duntroon OA, it is foreseeable rapid implementation of operational/scientific monitoring may be required for receptors such as seabirds and marine megafauna (cetaceans, pinnipeds, white shark) in close proximity to the spill area commencing as soon as possible (but within 3 hours) after the spill is reported. Given the nature of diesel, it is expected to evaporate, disperse rapidly and remain in the upper levels of the water column for approximately 3 to 5 days. As OA waters are deep no impact to benthic habitats are expected.

Given the nature of MDO spills and the oceanic nature of the Duntroon OA, scientific monitoring will initially be undertaken by MFOs on-board the survey vessels to be supplemented by third party resources as practicable (i.e. spill residue still present, daylight hours, suitable flying conditions). Pending the nature and scale of the spill, additional resources will be deployed to support scientific monitoring, particularly if residues enter state waters. Using surveillance and modelling information collected from operational monitoring, PGS and suitable environmental specialists will implement scientific monitoring to establish the impact to, and recovery of, any impacted receptors. In the event of shoreline or SA coastal water contact, scientific monitoring may be implemented for the shoreline receptors identified in Table 7-5 such as sand beaches (inter-tidal zones), inter-tidal/subtidal seagrass communities, fish (including commercial and recreational fishery target species) and/or tourism.

Table 7-5: Sensitivities which may be monitored as part of the SMP for a Level 2+ spill event during the Duntroon Survey.

Environmental Sensitivity	Applicable SMPs	Western Eyre CMP	Western Kangaroo Island CMP	Southern Kangaroo Island CMP	Great Australian Bight CMP	Murray CMP	Neptune Island MP	West Kangaroo Island MP	Thorny Passage MP						Investigator MP	Sir Joseph Banks Group MP	Gambier Island Group MP	South Spencer Gulf MP	South Kangaroo Island MP
SECONDARY LOCATION							(includes Neptune Islands)	(includes shoreline)	Coffin Bay	Rocky (south) Island	Greenly Island	Four Hummocks Island	Whidbey Island	Liguanea Island					
HABITATS																			
Water Quality	SM01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Marine Sediment Quality	SM02																		
Reef Systems (includes fish)	SM03						X	X	X	X	X	X			X	X	X	X	X
Seagrass/Macroalage	SM03						X	X	X	X	X	X			X	X	X		
Saltmarsh/Mangrove	SM04								X							X			
Sand Beach	SM02							X	X						X	X	X	X	X
SPECIES																			
Seabirds/Shorebirds (foraging)	SM06	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pinnipeds (foraging)	SM05	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cetaceans	SM05	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Turtles	SM05																		
Elasmobrachs	SM07	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Pinniped (Colonies/haul-out)	SM05						X	X		X	X	X	X	X	X	X		X	X
Seabirds and Shorebirds (Colonies)	SM06						X	X	X					X	X	X	X	X	X
SOCIO-ECONOMIC																			
Commercial Fishing (incl. taint)	SM08	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
Aquaculture	SM08								X							X		X	
Tourism (incl. Rec Fishing)	SM09						X	X	X						X	X	X	X	X

(orange)	Environmental receptors predicted to exceed ecological thresholds of 10µm or encounter levels of entrained phase hydrocarbons
(yellow)	Locations potentially contacted by visible sheens or encounter levels of entrained phase hydrocarbons
X	Indicates the receptor occurs at the location and will be monitored if contacted by hydrocarbon

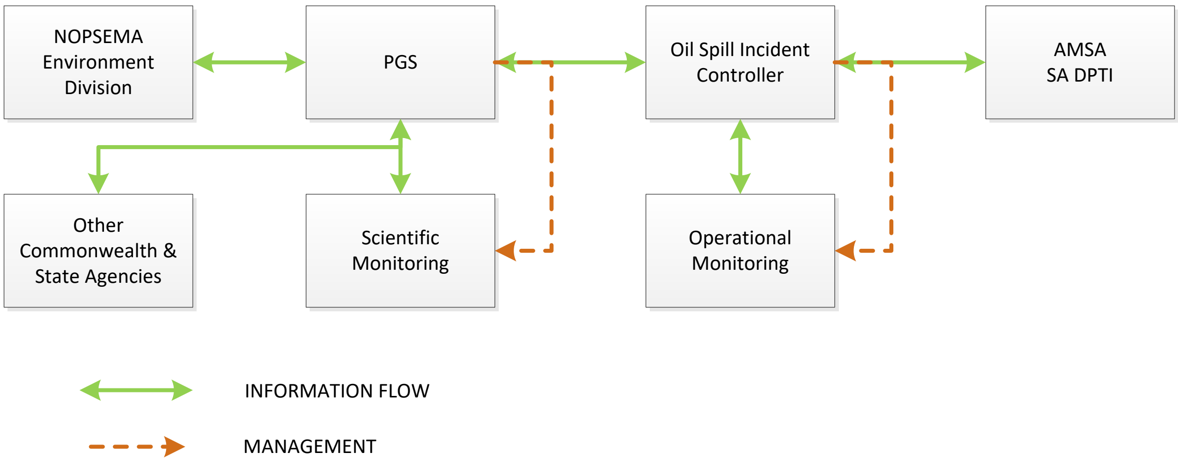
Individual SMP modules as identified in Table 7-5 are summarised in Appendix E. It is to be noted that monitoring parameters and methodologies selected will observe the requirements of conservation management plans with respect to individual species (where monitoring parameters are available). Also, where available, management plans provide details of relevant 'umbrella species' which are monitored over time (e.g. long-term indicators for RAMSAR sites) which measure the area's long-term health and meet objectives of management plans (e.g. water quality indicators, inter-tidal reef indicators). Relevant management plans for protected species, conservation parks, etc. will be consulted in the preparation of modules to identify these indicators (e.g. for bird species such as the hooded plover parameters such as population size and breeding success).

Information Flow:

Operational (Type 1) monitoring information will be used by PGS to advise AMSA and DPTI to inform operational response activities. AMSA as CA for vessel spills is responsible for operational monitoring in Commonwealth waters to inform response activities, however PGS will assist. All Type I monitoring information will be directed to AMSA and the SA DPTI to assist in these activities.

Information resulting from scientific (Type II) monitoring will be directed to the relevant Commonwealth and SA environmental authorities as it becomes available. These monitoring and information flow management pathways are illustrated in Figure 7-4 below.

Figure 7-4: Monitoring and Information Flow Management Framework



Type II (Scientific) Monitoring Consultation:

PGS will consult with relevant Commonwealth and SA state authorities prior to the implementation of any Type II monitoring studies to ensure that scientific monitoring is undertaken to the satisfaction of the Commonwealth and South Australia. These authorities include:

- For Commonwealth waters:
    - Marine Research and monitoring organisations such as Blue Whale Study; SARDI; and/or CSIRO;
    - Director of Marine Parks;
    - AMSA;
    - Department of Energy and Environment (DoEE);
    - Australian Fisheries Management Authority (AFMA);
    - Other relevant parties identified which have an interest in the affected area.

- For spill residues reaching SA waters:
    - SA DPTI;
    - SA EPA (who will coordinate SA Government advice - 0428 825 141);
    - SA DEWNR; and
    - PIRSA.

PGS will notify these authorities on a Level 2 spill incident and provide available operational data. PGS will consult with these authorities on the content of Type II studies (e.g. baseline, location of reference and control sites and confirmation of monitoring parameters) and obtain this spill-specific feedback which will be incorporated into the Type II study design to ensure monitoring is to the satisfaction of the Commonwealth and State authorities. Based upon this feedback, the Type II modules may be modified.

Note that SA/Commonwealth has over-riding decision making authority on the requirements of scientific monitoring. If there is a conflict between the current modules and State/Commonwealth feedback, regulator recommendations will be adopted. This liaison approach will be adopted throughout the spill event to ensure that changing impacts and risks are captured within the process.

Note also that scientific monitoring will also monitor for the impacts of spill response (e.g. marine fauna strikes due to monitoring activities). These incidents will be reported back to the CA.

PGS has consulted with potential scientific monitoring service providers to ensure they have the appropriate capability to undertake scientific monitoring. Prior to survey commencement, PGS will review terms and conditions with these providers to ensure their capability is adequate. Given the nature and scale of the spill, standby of monitoring service providers is not proposed as the cost (> $10K per 7-day period) outweighs the risk associated with the survey.

7.7.2.6 Summary of AMSA Arrangements

Following initial activation via the vessel SOPEP, AMSA will assume responsibility for leading any response to a significant diesel spill associated with the activity. There are well established plans in place that appear fit for purpose for the nature and scale of the survey and any potential spill arising from it.

7.7.2.7 Keeping arrangements Up to Date

PGS will monitor AMSA's and DPTI's published plans and should the plans change, PGS will assess the implications of any changes on the OPEP arrangements as described in this EP. Any change to the activity itself, or the potential and risks associated with it, will result in a review of the EP (including the OPEP) to ensure the measures in place remain suitable and there is not a significant increase in impact or risk (refer **Section 7.8**).

7.8 Environment Plan Review, Revision and Resubmission

7.8.1 Management of Change

For the Duntroon survey, the following activities will trigger a Management of Change (MoC) process which may lead to a revision of the accepted Duntroon EP:

- A new scope (e.g. timing, location or changes to operational details such as vessel type, equipment, processes or procedures) which has the potential to impact on the environment and has not assessed for environmental impact previously or authorised in existing management plans and procedures. This is managed by, and is the responsibility of, the PGS Vessel Manager;
- Changes to the *existing* activity, scope, equipment, process or procedures which have the potential to impact on the environment or interface with an environmental receptor. This is managed by, and is the responsibility of, the PGS Vessel Manager;
- Changes in the external environment managed and monitored by the PGS Environmental Advisor:

  - Provision of new information that differs to that included in this EP (such as potential changes in science surrounding impacts and risks from seismic activities or new environmental sensitivities within or adjacent to the survey area);
  - Issue of new regulatory requirements (e.g. revised CMR Management Plan arrangements, new species Conservation Management Plans);
  - Identification of KEFs, threatened or migratory species or critical habitats/BIAs not identified in the EP;
  - Identification of issues and concerns through stakeholder consultation (refer **Section 9**).
- Non-conformances (audits, inspections, etc.) which identify that mitigation measures no longer demonstrate that the environmental impact/risk of the activity is managed to ALARP or acceptable criteria. Non-conformances are monitored by the PGS QCS;
- Incidents which identify new or increased impacts and risks arising from activities not previously identified in the accepted EP. Incidents are monitored by the PGS QCS.

A risk assessment will accompany any MoC with identified environmental impacts/risks in accordance with the PGS Risk Management process (refer **Section 7.8.2**).

For changes (e.g. additional controls, etc.) identified in the risk assessment process, if stakeholder interests are affected by the change, stakeholder feedback on the proposed change is required (refer **Section 9**). All environmental risk assessments must include an ALARP and acceptability assessment against PGS criteria which includes obtaining and responding to stakeholder concerns associated with the change.

Additional controls identified as part of the MoC shall be effective in reducing the environmental impact and risk to a level which is ALARP and acceptable; and meet the nominated EPOs and EPSs set out in the accepted EP for the activity. *Note: EPOs and EPSs cannot be altered from those set out in the accepted EP. If EPOs/EPSs cannot be met, a recordable or reportable incident must be registered for the activity*.

In accordance with NOPSEMA's EP Assessment policy (PL1347, Rev 5, April 2016), minor revisions to the Duntroon EP that do not require resubmission to NOPSEMA will be made when:

- Minor administrative changes are identified that do not impact on the environment (e.g. document references, contact details, etc.);
- A review of the activity/change and the environmental impacts and risks of the activity/change do not trigger a requirement for revision under the OPGGSER (Regulation 17 and Regulation 18).

Where amendments are made to the accepted EP via the PGS MoC process, revisions made will be justified, tracked and a comprehensive record of the revision made for each change. This includes all risk assessments associated with the MoC.

<u>EP Revision Resubmission Criteria</u>:

If any change is a significant modification that is not provided for in the accepted EP in force for the activity, a revision of the EP will be conducted in accordance with OPGGSER Regulation 17 or Regulation 18 if the change is requested by NOPSEMA. The revised EP will be submitted to NOPSEMA in accordance with the requirements of OPGGSER Regulation 17(2), and the proposed change to the activity will not commence until the revised EP has been accepted by NOPSEMA.

As required under OPGGSER Regulation 17, PGS will submit a revision of the Duntroon EP to NOPSEMA if any of the following criteria are met:

- Regulation 17(1) (*new activity*): Prior to the commencement of a new activity;
- Regulation 17(5) (*significant modification or new stage of activity*): Before the commencement of any significant modification or new stage of the activity not provided for in the accepted EP;
- Regulation 17(6) (*new or increased environmental impact or risk*): Before or as soon as practicable after:
  - The occurrence of any significant new environmental impact or risk, or significant increase in an existing environmental impact or risk, not provided for in the accepted EP; or

- The occurrence of a series of new environmental impacts or risks, or a series of increases in existing environmental impacts or risks, which, together, amount to the occurrence of:
  - A significant new environmental impact or risk; or
  - A significant increase in an existing environmental impact or risk;

Not provided for in the accepted EP.

While the EP revision is being assessed by NOPSEMA, any activities under the existing accepted EP are authorised to continue. The proposed change to the activity will not commence until the revised EP has been accepted by NOPSEMA.

The OPEP will be regularly reviewed to ensure it is appropriate to the nature and scale of the activities within its scope and to ensure maintenance of the response capability and the operator's preparedness. In compliance with OPGSSER Regulation 14(8AA) the OPEP will be continuously reviewed and kept up-to-date to ensure new information or improved technology can be incorporated as specified in the SOPEP.

7.8.2 Risk Assessment

The PGS Vessel Manager and Environmental Advisor (as per **Section 7.2**) will ensure an internal risk assessment is conducted in the following situations:

- Non-conformances suggest the specified mitigation measures no longer adequately demonstrate that the environmental impact/risk of the activity is managed to ALARP;
- New developments in the scientific understanding of impacts and risks suggest the risks and impacts are no longer acceptable;
- New information regarding the receiving environment relevant to Duntroon activities identifies a potential new or increase in potential impact or risk;
- Any stakeholder claims, or concerns received during consultation associated with the survey activity (refer **Section 9**);
- EP changes as identified in **Section 7.8.1**.

Participants in the risk assessment workshop will be determined by the PGS Vessel Manager and Environmental Advisor based upon the scope of the review. The risk assessment methodology outlined in **Section 5** of this EP will be adopted for risk assessment activities. This methodology includes the steps to identify, analyse and evaluate the risks and impacts of the activities being undertaken within the Duntroon OA. The decision-making framework is designed to ensure that activities do not pose an unacceptable environmental risk and are ALARP and acceptable in accordance with AS/ANZ ISO 31000 Risk Management (Principles and Guidelines) and Oil and Gas UK Guidance on Risk Related Decision Making (2014).

Should:

- New information suggests that risks and impacts are no longer reduced to acceptable levels; or
- Controls are no longer effective in reducing the risks and impacts to ALARP and acceptable levels;

Then the process for identifying additional controls will follow the risk assessment methodology outlined in **Section 5**. Any opportunities for improvement identified in the internal risk assessment (i.e. new controls adopted) will be amended via Management of Change (refer **Section 7.8.1**).

All environmental impacts and risk assessments must include an ALARP and acceptability assessment against PGS criteria.

Risk assessments will be documented and approved by the Vessel Manager.

7.8.3 Maintaining Environmental and Legislative Currency

General (monthly): Changes to the external environment will be identified by the Environmental Adviser by subscribing to environmental websites such as the DoEE to obtain regular updates of Commonwealth environmental information (e.g. species listings, threat abatement/management plan issue and policy updates via RSS news feeds[133]) and monitoring other key research websites on a monthly basis such as the Fisheries Research and Development Corporation (FRDC) (fishery research), South Australian Research and Development Institute (SARDI) (fishery, oceanographic research) and Marine Innovations South Australian (MISA) (GAB Research) to establish research which may provide additional information on the Duntroon OA environment, or new science on species present which might affect this EP assessment.

Prior to Survey Season: At least eight weeks prior to each survey season (as appropriate), PGS (i.e. PGS Vessel Manager and Environmental Adviser) shall undertake pre-survey planning that will review and consider the following at a minimum:

- Stakeholder consultation requirements as per Section 9;
- New issues or concerns raised by stakeholders;
- Changes to all relevant legislation or regulatory guidelines;
- Existing information in relation to any component of the receiving environment described in Chapter 3 (including BIAs, CMPs);
- Information from previous surveys, including but not limited to:
    - Marine fauna migration routes and frequency of sightings;
    - Avoidance of multiple surveys undertaken in same area if less than one year apart;
    - Potential for cumulative impacts from past or proposed surveys, if known;
- Search the NOPSEMA website and consult with geophysical companies and/or titleholders to determine the presence of other seismic operations overlapping the proposed OA;
- Changes to commercial fishery license areas, fishery status, current fishing effort and licence holders overlapping the OA based on:
    - Status reports and available data sources such as SARDI, of the fisheries and aquatic resources;
    - Information provided directly by fishers, PIRSA-Fisheries and AFMA through the stakeholder consultation process;
    - Fishing locations;
    - Spawning areas;
- Potential military/defence activities;
- Newly-available scientific literature;
- New acoustic source technology and justification for or against its implementation;

If new information regarding the receiving environment relevant to the Duntroon OA is present, then an internal risk assessment will be conducted as described in Section 7.8.2. If sighting data is available from previous PGS surveys, or if new information regarding whale migration periods is available, the information will be used to inform the timing of individual surveys within the Duntroon OA. Should new technologies emerge during the life of the Duntroon EP that would improve mitigations, and assessment of their use be ALARP, and should such technologies be broadly accepted and adopted by industry, then PGS will review and adopt such technologies accordingly.

7.9 Records management

The following list summarises the record retention requirements for the proposed Duntroon multi-client survey as reflected in the impact and risk assessment tables provided in Section 6:

Duntroon Project Specific HSE Plan;

[133] DoEE provides an RSS feed which lets people know when a certain website or part of a website is updated with new content.

Regulator Reports;

Lighting:

- Inspection records;
- Environmental Induction Records;

Acoustic:

- Survey Vessel logs;
- Environmental condition report (November – SARDI Upwelling Report);
- Aerial survey report;
- CVs – aerial observers;
- CVs – MFOs;
- Crew Induction (EPBC Policy Statement 2.1);
- MFO report;
- MFO sighting record datasheets;
- Vessel logs – soft starts, etc.;.
- PAM system specifications and assessment;
- CV – PAM operators;
- PAM master observation sheet;
- Support vessel observation records;
- SIMOP Communication records (as required);
- SIMOPs procedure (as required);
- Duntroon acoustic modelling report;
- Aircraft operational procedures (reflect in EPBC Regulations Part 8);

Oily water:

- IOPP (or equivalent);
- Oil Record Book Excerpt for survey period;
- PMS Records Oil Treatment System;
- ODME Calibration records;

Sewage:

- ISPP (or equivalent);
- Vessel waste log;
- PMS records sewage treatment plant;
- POB Listing;

Food-scraps:

- Vessel Garbage Management Plan;
- Macerator Specification;
- Garbage Record Book Excerpt;
- PMS Records – macerator;
- Environmental Induction Records;

Air:

- IAPP (or equivalent);
- Bunker receipts;
- Garbage Record Book;
- Incinerator manufacturers specification and operating procedures;
- Vessel daily report;
- SEEMP records;

IMS:

- ePAR;
- BWMS Form;
- Ballast Water Management Plan;
- IMS Risk Assessment/Corrective Action Implementation closeout;

- IAFS;
- In-field equipment cleaning;

Commercial Vessels:

- AMSA RCC Notification;
- Notice to mariners;
- Vessel Class Survey Certificate (navigational Safety Equipment);
- Vessel Log;
- Crew Training and Competency Records;
- Bridge Log;

Commercial Fishing:

- Consultation and Notification Records;
- Vessel Log;
- MFO Master Sheet;

Diesel Spill:

- Bunker record;
- Vessel selection assessment against EP requirements;
- SOPEP (or equivalent);
- Inspection records (spill kit replenishment);
- Crew Training records (spill response);
- Induction records;
- Emergency Drill Reports;
- SOPEP Drill Record (prior to survey);
- Approval records (at sea refuelling);
- Completed Bunkering Offshore Checklist;
- Vessel log;
- JHA Records;
- Equipment certificates;
- Incident Records;

Oil spill response:

- SOPEP;
- Training Records (crew);
- Consultation records;
- Incident Report;
- Telephone Records (emergency response communications);
- Vessel Records ;
- OSMP implementation records;
- Insurance documentation;

Deck Spill:

- Inspection records;
- SDS;
- Pre-mobilisation audit records (spill kits);
- SOPEP (or equivalent);
- Environmental Induction Records;
- SOPEP Drills;
- Incident records ;

Release overboard (solid/non-biodegradable/hazardous):

- Vessel Garbage Management Plan;
- Vessel Inspection records;
- Incident Reports;
- IAPP Certificate;
- Manufacturers specification and operating procedures (incinerator);

- Environmental induction records;

Streamer Loss:

- Streamer deployments and retrieval procedures;
- Inspection Record (in-water equipment);
- Vessel log (dropped objects);
- Incident records;
- Vessel radio logs;

Vessel strike with marine mammals:

- MFO master Sheets;
- Support vessel observation sheet;
- Environmental Induction;
- Incident Records;
- Regulator Reports; and
- End of Survey Closeout Report.

PGS will store and maintain these records, on their server, for a period of 5 years. These records shall be made available to regulatory authorities on request.

8 Reporting Arrangements

8.1 Marine Fauna Reporting

A record of marine fauna interaction procedures employed during operations will be maintained. The MFO Final Report on the conduct of the survey, and any marine fauna sightings/interactions (including any whale-instigated shut-downs of the acoustic source) will be provided to DoEE within two months of the completion of the survey. The report will contain:

- The location, date and start-up time of the survey;
- Name, qualifications and experience of any MFOs involved in the survey;
- The location, times and reasons when observations were hampered by poor visibility or high winds;
- The location and time any start-up delays, power downs or stop work procedures instigated as a result of whale sightings;
- The location, time and distance of any cetacean, tuna and turtle sightings; and
- The date and time of completion of the survey.

The following procedures will be implemented during the survey to ensure all marine fauna sightings are properly recorded and reported:

- Detailed reports of all cetacean sightings will be recorded using the DoEE Cetacean Sightings Application (CSA - Version 3 - BETA) (http://data.marinemammals.gov.au/portal/csa/).
- At the completion of the survey, a copy of the report generated by the CSA will be provided to DoEE as part of the MFO Final Report.

8.2 Post-survey Environmental Performance Report

OPGGSER Regulation 14(2) requires the titleholder to nominate when environmental performance reports for the activity will be submitted to the Regulator. As such, a post-survey environmental report will be submitted to NOPSEMA within 3 months of the completion of a survey.

The report will consist of a review of EPO and EPS achievement for the survey and will include:

- A review of the following routine activities and incident records (see Section 6);
  - Start-up delays, power downs or stop work procedures instigated due to marine fauna sightings;
  - Cetacean, pinniped and other marine fauna sighting records;
  - Vessel/towed equipment and marine fauna interaction records;
  - Accidental discharge of hazardous materials;
  - Fuel and oil spills;
  - Vessel collisions;
  - Negative interactions with other mariners, including commercial, recreational fisheries, diving vessels, shipping and/or defence vessels
- An assessment of EPO and EPS compliance with the requirements of the EP (refer Section 6);
- A review of compliance with the PGS HSE&Q Management System and Environment Policy;
- A review of all environmental incidents (recordable and reportable) and any other issues;
- Emission/discharge quantification (Refer Table 7-2);
- Audit & review outcomes and corrective action status (Refer Section 7.5 and Section 7.6);

- Performance in fulfilling all commitments listed on the Environmental Commitments Register.

8.3 Reportable Environmental Incidents

8.3.1 Definition

A reportable environmental incident as defined under OPGGSER Regulation 4 as '*an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage'* as categorised by the risk assessment process undertaken as part of the preparation of the EP. For the Duntroon survey, moderate to significant environmental damage is equivalent to a PGS Qualitative risk matrix consequence level of MODERATE or above.

8.3.2 Duntroon Survey Reportable Environmental Incidents

A review of the environmental impact and risk assessment summary (refer Section 6) for the Duntroon survey identified the following environmental hazards as having the potential to result in significant environmental damage (i.e. consequence level of MODERATE or above):

- Fuel spills.
- Acoustic sound impacts to cetaceans within the shutdown zone if the array is not immediately shut-down.

Hence, for the Duntroon survey a "reportable" environmental incident as per the OPGGSER includes:

- Any incident causing fuel and/or oil leaks to the marine environment (defined as a spill or leak to the environment over 80 litres); or
- Any other incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage (MODERATE to CATASTROPHIC on the PGS risk matrix).

Additionally, environmental incidents required to be reported to the Regulator (NOPSEMA and DOEE) regardless of the classification as having the potential to cause 'moderate to significant environmental damage' includes:

- Injury or death of an individual of a species of conservation value or damage to habitat of importance to those species (e.g. injury or death of an individual of a species listed as threatened or migratory under the EPBC Act).

8.3.3 Notification

NOPSEMA will be notified of all reportable environmental incidents, according to the requirements of OPGGSER Regulation 26 and 26A and with NOPSEMA guidance on notification and reporting of environmental incidents. PGS will:

- Notify all reportable environmental incidents to NOPSEMA (verbal and written) as soon as practicable, but within two hours of the incident or of its detection by PGS;
- Submit the written notification to NOPTA and SA DPC as soon as practicable after written notification has been provided to NOPSEMA;
- Submit a written report of the reportable environmental incident to NOPSEMA as soon as practicable, but within three days of the first occurrence of the reportable incident with a copy of the report to NOPTA and SA DPC within 7 days after its submission to NOPSEMA.

Reportable environmental incidents must be reported within two hours of the incident occurring or becoming aware of the incident to NOPSEMA via the notification phone line (08 6461 7090) or incident reporting forms emailed to submissions@nopsema.gov.au.

The written report for a reportable environmental incident will contain:

- All material facts and circumstances concerning the reportable environmental incident that PGS knows or is able, by reasonable search or enquiry, to find out;
- Any action taken to avoid or mitigate any adverse environment impacts of the reportable environmental incident; and
- The corrective action that has been taken, or is proposed to be taken, to prevent a similar reportable environmental incident.

The SA DPC, as the relevant state authority for petroleum, will also be notified (within two hours) in the case of any reportable incident associated with the survey program. This will be via written notification submitted as soon as practicable to DPC.Engineering@sa.gov.au.

All reports should be submitted to NOPTA on reporting@nopta.gov.au

8.4 Recordable Environmental Incidents

8.4.1 Definition

A recordable environmental incident as defined in the OPGGSER Regulation 4 as an incident arising from the activity that is '*a breach of an environmental performance outcome or environmental performance standard, in the environment plan that applies to the activity, that is not a reportable incident*'.

8.4.2 Survey Recordable Incidents

Section 6 of this EP details the EPOs, EPSs and measurement criteria for the survey. Any breach of these EPOs/EPSs will be raised as a recordable environmental incident and managed as per the notification and reporting requirements outlined below.

8.4.3 Notification

NOPSEMA will be notified of all recordable environmental incidents, according to the requirements of OPGGSER Regulation 26B, as soon as practicable but not later than 15 days after the end of each the calendar month.

The written report must contain:

- A record of all recordable environmental incidents that occurred during the calendar month;
- All material facts and circumstances concerning the recordable environmental incidents that PGS knows or is able, by reasonable search or enquiry, to find out;
- Any action taken to avoid or mitigate any adverse environment impacts of the recordable environmental incidents; and
- The corrective action that has been taken, or is proposed to be taken, to prevent similar recordable environmental incidents.

If no recordable environmental incidents have occurred a nil Incident report must be submitted to NOPSEMA, via email to: submissions@nopsema.gov.au.

8.5 Other Notifications

8.5.1 Other Incident reports

In addition to the reporting and advising of environmental incidents in accordance with OPGGSER and PGS internal procedures, the following reporting requirements also apply:

- Loss of a streamer and associated equipment (birds, paravanes, tail buoys) will be reported to the Regulator as a recordable environmental incident;
- Any oil pollution incidents in port will be reported immediately to the relevant port authority;
- Any oil pollution incidents in Commonwealth waters will be reported to AMSA as per Article 8 and Protocol I of MARPOL. A pollution report (POLREP) should accompany this as soon as practicable; and
- Any ship sourced spills in Commonwealth waters must be reported to AMSA within one hour, via the national 24-hour emergency notification contacts.

If the vessel is at sea, reports are to be made to:

Rescue Co-ordination Centre Australia (RCC Australia):
Phone: +61 2 6230 6811 or 1800 641 792
Facsimile: 1800 622 153
Telex: 62349
AFTN: YSARYCYX

If the vessel is within a port or harbour, reports are to be made to the relevant port authority.

Additionally, the following pollution activity should be reported to AMSA via the RCC Australia:

- Any quantity of oil. If oil can be seen, then it is likely to be an illegal discharge. Oil includes waste oil, fuel oil, sludge, lube oil and additives etc.;
- Any discharge from a ship involving washings of chemical or dry cargoes;
- Any plastic material; and
- Garbage disposed of in the sea within 12 nm of land (garbage includes food, paper, bottles etc.).

8.5.2 Other Notifications

As required by OPGGSER Regulation 29 and through consultation feedback, additional notifications required to regulators and statutory authorities are provided in Table 8-1.

Table 8-1: Notifications to Regulatory and Statutory Authorities

Authority	Requirement	Minimum Timeframe
AHS	Notification of the proposed survey to raise a Notice to Mariners	Four weeks prior to survey commencement
NOPSEMA SA Department of Energy & Mining)	Notification of Survey Commencement [OPGGSER Regulation 29(1)]	At least 10 days prior to survey commencement
NOPSEMA SA Department of Energy & Mining	Notification of Survey Completion [OPGGSER Regulation 29(2)]	Within 10 days of activity completion
NOPSEMA	End of Environment Plan [OPGGSER Regulation 25A]	When all commitments within the EP have been fulfilled.

9 Stakeholder Consultation

The stakeholder consultation process which PGS has adopted for the Duntroon survey is provided in Table 9-1.

9.1 Preliminary Consultation

PGS has consulted with a number of stakeholders who, based upon previous surveys in the area have provided feedback on petroleum activities. Relevant stakeholders were identified through the following mechanisms:

- Review of relevant legislation applicable to Commonwealth water petroleum and marine activities;
- Adjacent south Australian authorities who may have interests in the survey area;
- Identification of marine user groups in the area (possible recreational/commercial fisheries, fishing industry groups, merchant shipping, eco-tourism providers);
- Identification of marine 'interest' groups (i.e. technical and scientific entities); and
- Industry/company support groups (e.g. APPEA, etc.).

Communication with these differing groups, undertaken by various methods, has identified 'relevant' persons that might be reasonably impacted by the activity; or additional persons to be contacted to determine possible impacts.

Communications/briefings with these parties and information obtained during this process has allowed for the collation of an Offshore Stakeholder listing; identifying their relevance to the Duntroon multi-client survey; and the activity triggers as relevant to the seismic activity which may initiate consultation/ communication events or require on-going updates.

Table 9-2 provides details of the stakeholders engaged on the Duntroon survey. Selected stakeholders were identified as highly relevant, that is those which were considered to have the greatest potential interest in, or interests affected by, the survey activity. This included, for example, fishing bodies with potential activities in the Duntroon OA. It was considered that these stakeholders would likely merit a greater level of interaction and consultation than just the provision of information (i.e. a letter) on which they could comment.

<u>Initial Consultation</u>:

All stakeholders were initially issued with the stakeholder consultation letter provided in Appendix I in mid to late November 2016. This letter provided details of a 2-year survey program with an operational area covering 29,500m^2 which would be undertaken over two seasons March 1 - May 31, 2016 and January 1 - May 31, 2018.

After this initial letter, a number of meetings were held with Kangaroo Island Council, Kangaroo Island Dolphin Watch, Kangaroo Island Commissioner, Regional Development Australia Whyalla and Eyre Peninsula, City of Port Lincoln, State Member for Flinders and Goyder, SA Department of State Development, South Australian Sardine Industry Association (SASIA), Australian Southern Bluefin Tuna Industry Association (ASBTIA), South Australian Rock Lobster Advisory Council (SARLAC) and Great Australian Bight Industry Association (GABIA). PGS responded in writing to all stakeholders who attended face-to-face meetings with a summary of items discussed, concerns raised, outcomes and agreed actions.

For other letter recipients, except when deemed that the party was not a 'relevant person', where no response to the original consultation was received after four weeks, the consultation was followed up with a secondary email.

By 23rd December 2016, PGS had received responses from 33 stakeholders. These are summarised in Appendix I. Feedback was reviewed in detail and the merits evaluated and taken into consideration in the preparation of this EP. Specific issues raised and an assessment of their merit is provided in the Stakeholder log contained in **Appendix I**. Responses to stakeholder issues and concerns have been provided to those specific issues as indicated in that Appendix and have been addressed in **Section 6**.

Table 9-3 provides a summary table of the notification trigger points for stakeholders received to date (i.e. those who have provided feedback during consultation or those required by legislation).

Updated Consultation (October 2017):

Further definition of the Duntroon MC3D and MC2D survey activities occurred during 2Q 2017 together with refinement of acoustic modelling. During August/September 2017 updated information was provided to stakeholders who identified functions, interests or activities in the Duntroon survey area, to provide greater clarity around the survey scope; the temporal windows for individual surveys within the Duntroon survey scope; where relevant to the stakeholder, details on recently issued scientific studies; and for stakeholders with specific issues and concerns, additional relevant information to assist in resolution.

Feedback provided by some stakeholders (e.g. SA Department of Premier and Cabinet) recommended additional stakeholders and information has been provided to those parties.

Concerns raised by stakeholder groups during this EP preparation phase were assessed for merit, where merit existed controls were identified and agreed with stakeholders and responses provided to the stakeholders. Concerns raised by three stakeholder groups, ASBTIA, AMSA and CSIRO, were assessed for merit and controls identified to limit impacts or exposures. Unfortunately, due to the constraints of the survey and the time required to undertake the Duntroon scope of works all requested controls could not be adopted. For these cases, PGS has made representations (meetings, information, etc.) to the groups exploring available options to resolve or mitigate the degree to which the group are affected through control measures. Those persons have been informed on how PGS has addressed their objections and claims and are also aware of PGS's position which will be presented to NOPSEMA. PGS believes that the control adopted to address their concerns and limit impacts to these stakeholders are ALARP.

Responses received to date from this updated consultation have predominantly related to ASBTIA (**Stakeholder Record 6**) with regards to the proposed commencement of survey activities prior to April 1 as they do not want fishing conflicts with seismic activities. PGS has reduced their survey period to accommodate environmental sensitivities in the period January-February and propose spatial controls to known upwelling areas in March to prevent possible conflicts. TWS (**Stakeholder Record 42**) also provided comment on the Duntroon EP (Rev 0) issued to them in March. Provision of the updated Duntroon EP post NOPSEMA submission will identify that most issues have been addressed.

SARLAC (**Stakeholder Record 4**) identified, in preliminary consultation, that as evidenced by studies undertaken by Day et al (2016), there was apparent evidence of significant detrimental impacts from seismic testing to the southern rock lobster. This included significant damage to lobster health and well-being; permanent damage to statocysts leading to potential for reproduction impacts. Further, SARLAC identified that 'any impact no matter the significance was unacceptable to the industry'. Significant detrimental impact did not hold merit against the findings of Day et al (2016). In addition, as there is no spatial overlap between the southern rock lobster fishery and Duntroon survey area, impacts to catch and the sustainability of the fishery for th survey are not expected. The spatial overlap information has been presented to SARLAC and they have not provided comment from the recent updated consultation material.

WML (**Stakeholder Record 35**) has reviewed the acoustic modelling report and pinniped assessment section and found them to be satisfactory. PGS has also consulted with both the SA DPTI (state marine oil spill responder) (**Stakeholder Record 16**) and DNP (**Stakeholder Record 63**) for information relating to operations within the Western Eyre CMR.

Contact with additional new stakeholders Flinders Ports (**Stakeholder Record 70**), Eyre Peninsula Local Government Authority (EPLGA) (**Stakeholder Record 69**), SA Oyster Growers Association (SAOGA) (**Stakeholder Record 68**), GAB Right Whale Study (**Stakeholder Record 67**), Flinders University CEBEL Group (**Stakeholder Record 66**) and EPA (**Stakeholder Record 62**) have all been made at the recommendation of the SA DPC (**Stakeholder Record 17**).

No other concerns have been raised by stakeholders. Therefore, in the context of the nature and scale of the proposed activity, the environmental sensitivities and values of the operational area, and the outcomes of the impact and risk assessment conducted in this EP, PGS is satisfied that further attempts to contact the stakeholders who haven't responded so far will not alter significantly the manner in which the activity will be conducted.

Updated Consultation (February 2018):

After submission of the revised EP in October 2017, additional concerns were raised by the SAOGA (**Stakeholder Record 68**), GABIA (**Stakeholder Record 3**), The Blue Whale Study (**Stakeholder Record 29**), ASBTIA (**Stakeholder Record 6**) and TWS (**Stakeholder Record 42**). A common concern raised by this group was undertaking the Duntroon survey in the upwelling area during the peak productivity season and its potential impact to sound-sensitive species drawn to the high productivity waters or to the GABIA FIS survey.

- Concerns raised by the OGASA (**Stakeholder Record 68**) related to the lack of available scientific information on seismic survey impacts on oysters and undertaking the Duntoon survey in upwelling areas during the most productive time of the year and requested the survey to start at earliest mid-April 2018.

- Concerns raise by BWS (**Stakeholder Record 29**) included comment on the timing of the period of peak productivity in the GAB and raised concerns about the survey's impacts on upwelling-related sensitivities between January-April as quoted in scientific literature. SARDI (**Stakeholder Record 18**) was contacted to clarify the upwelling timeframe (mid-December to mid-March). Upwelling in November is unlikely a compared with the peak upwelling timeframe.

- Concerns raised by GABIA (**Stakeholder Record 3**) included committing to timeframes which do not impact on the activities of the GABTF (i.e. ensuring that location and abundance of fish species is not affected), the unacceptability of the seismic survey being undertaken while the biennial FIS is undertaken and opposition to any MSS work commencing before April 1, 2018 in the GAB.

- Concerns raised by TWS (**Stakeholder Record 42**) include the survey timeframes coinciding with the Kangaroo Island upwelling and foraging-related BIAs at biologically important times, the survey should not be undertaken in the May timeframe to avoid overlap with the migrating southern right whale and requested further information on the controls adopted to protect species during the survey.

Concerns raised by stakeholder groups during this EP preparation phase were assessed for merit, where merit existed controls were identified and agreed with stakeholders and responses provided to the stakeholders. Controls identified limited impacts or exposures. Based on this feedback, further refinement was made to the survey scope during 4Q/1Q 2017/18. This included deferring the survey until the 2019 year, commencing operations no earlier than March 15 in that year and restricting survey activity to the MC2D area in deeper waters which exclude and apply a spatial buffer to upwelling-related BIAs during March 15-31. Updates were sent to all stakeholders advising of this change in early-mid January.

No concerns have been raised by stakeholders to this revised survey arrangement except for ASBTIA (**Stakeholder Record 6**) who cannot accept seismic acquisition in the eastern GAB before April 1 in any year.

Unfortunately, due to the constraints of the survey and the time required to undertake the Duntroon scope of works and fulfil workplan obligations for titleholders, all requested controls cannot be adopted (i.e. no acquisition prior to April 1). For these cases, PGS has made representations to the groups on mitigations which can be adopted to limit the degree of impact (if any). Those persons have been informed on how PGS has addressed their objections and claims and are also aware of PGS's position which will be presented to NOPSEMA. PGS believes that the controls adopted to address their concerns and limit impacts to these stakeholders are ALARP.

Updated Consultation (July 2018):

PGS after feedback from the Australian Antarctic Division on issued associated with blue whale detection and SRW behavioural disturbance during gestation, migration into calving habitats, calving and juvenile (neonatal) calf-rearing, elected to review all survey design parameters including temporal window. This evaluation established that an alternate temporal window of between September 1 and November 30 minimised the potential for overlap with upwelling conditions and associated foraging-related activities within shelf areas of the eastern GAB. An additional benefit included the elimination of temporal overlap with the presence of juvenile SBT in the eastern GAB and associated fishery surveys to assess for stock numbers.

Consultation with AFMA (**Stakeholder Record 2**) on the controls adopted to prevent behavioural disturbance from acoustic operations to the gulper shark was initiated in June 2018, to confirm the acceptability of measures adopted. Multiple approaches and reminders were sent to AMFA to provide feedback however feedback provided on 6th November 2018 identified that while the information and analysis was well considered and thorough, AFMA were unable to comment on the likely effectiveness or otherwise of the proposed control measures to minimise impacts on gulper sharks. Further referral to CSIRO and Department of Environment was encouraged.

During the period June-September 2018, PGS provided an update to all stakeholders advising then of the revised Duntroon survey timeframe and, if the surveys could not be completed in one season (September 1 to November 30, 2019), a second season with vessel remobilisation may be required (September 1 to September 30, 2020). Many of the stakeholders who provided feedback when the survey was in the timeframe March to May did not provide a response. PGS anticipates that as the revised period falls in the 'low season' for activity (e.g. crab/lobster fishing closure period, predominantly downwelling conditions), the sensitivity of the survey is not considered as significant. The following stakeholders provided feedback on the altered survey timeframe:

- Consultation with AFMA (**Stakeholder Record 2**) on the controls adopted to prevent behavioural disturbance from acoustic operations to the gulper shark was initiated in June 2018, to confirm the acceptability of measures adopted. Multiple approaches and reminders were sent to AMFA to provide feedback however feedback provided on 6th November 2018 identified that while the information and analysis was well considered and thorough, AFMA were unable to comment on the likely effectiveness or otherwise of the proposed control measures to minimise impacts on gulper sharks. Further referral to CSIRO and Department of Environment was encouraged.

- AIASA (**Stakeholder Record 54**) expressed concern with survey activity being undertaken close to the coast and outer reef systems and during sensitive abalone spawning months. PGS has provided information and the assessment undertaken for abalone impacts to the stakeholder. Given the distance of the survey from coastal features, the minimum water depth within the survey area (100 m) and the recorded substrate (ascidians, bryozoans) survey activity is not considered to be '*close to the coast or outer reef systems*'. Additional information was provided on the potential for impacting abalone eggs and vegliers during the survey. Given the distance from commercial abalone areas and the localised nature of veglier colonisation, Duntroon survey activities are not expected to impact on any spawning events. PGS has not received a reply from PGS correspondence dated 10th October 2018 to AIASA detailing this information.

- ASBTIA (**Stakeholder Record 6**) provided feedback that the organisation cannot support the Duntroon survey due to the "dead zone" that has been created from the pervious seismic survey undertakne in the period 2012-2015 in the central GAB. ASBTIA considers that the SBT stock foraging has moved eastwards due to this "dead zone". Literature reviewed by PGS identifies that the location of the SBT fishing grounds have varied across the GAB in past years and PGS considers that the current fishing grounds are in the 'normal range' of locations. PGS altered the timeframe of the Duntroon survey to prevent temporal overlap with upwellings and SBT presence in the GAB. ASBTIA also shown concern for the:

    - Changes in timeframe made to the survey and the level of 'wasted consultation' which has occurred over the course of the survey; and

  - Increased levels of sound within the GAB as a result of survey activities, proposing alternate sound monitoring thresholds related to incremental sound levels above ambient levels as determining whether survey activities should be halted.

  PGS has considered the merit of the suggestions proposed by ASBTIA and provided written feedback. PGS has not received a reply to PGS correspondence dated 3rd October 2018 to ASBTIA detailing this information

- All other fishing groups were advised of the change in timeframe and no issues or concerns were raised.

- The **BWS (Stakeholder Record 29)** provided feedback that their concern has been addressed by shifting the survey to the September-November period. This timeframe is less likely to have an impact on foraging pygmy blue whales although their appearance cannot be ruled out in October or November (sightings have been made off Portland in these months in the recent past (non - published literature)). The monitoring/detection approach for onset of upwelling favourable conditions using wind stress and SST is appreciated. BWS provided feedback that kill can be in the system before upwelling is established at the commencement of a season and have noted whales feeding before the upwelling season itself has commenced. PGS has requested further information from BWS with respect to this anecdotal information on blue whale foraging activity and locations in October and November (currently unpublished).

Continued Consultation:

If comments or feedback are raised by stakeholders prior to or during the survey that were not previously identified in the preparation of the EP, the impacts and risks will be assessed in accordance with the impact and risk assessment process defined in **Section 7.8.2**.

If a significant new or increased impact or risk is identified, the EP will be reviewed and if considered necessary based upon OPGGSER Regulation 17 revision criteria, the EP will be revised and resubmitted to NOPSEMA for acceptance. If the feedback results in a change in operations or procedures but is not considered to result in significant new or increase impact or risk, the EP will be amended in accordance with the MoC requirements and process outlined in **Section 7.8.1.** The PGS MoC and risk assessment process, as per OPGGSER Regulation 14(3), ensures that any impacts of the survey on stakeholder's activities or interests are addressed and impacts and risks are continually reduced to ALARP and acceptable levels in line with the PGS HSE Management System (refer **Section 7**).

PGS considers that all stakeholder issues, objections and claims have been assessed for merit and incorporated into the Duntroon EP as required by OPGGSER Regulation 11A – Consultation with relevant authorities, persons and organisations, etc..

Table 9-1: Consultation Process and Consultation Phases

Step	Task	Timing	Details	Implementation Strategy
Preparatory Consultation	Initial Consultation	During preparation of the EP	Provide overview of survey plans including indicative survey area, start date and timing.	Letters sent to all stakeholders identified outlining proposed activity (Letters reissued with timing updates)
Assessment of Feedback	Incorporate feedback into survey plans	During preparation of EP and in preparation for survey	Assessment of feedback from email, telephone and face to face meetings regarding proposed activity.	Where feedback is received, the merits of feedback are assessed and evaluated. Where appropriate and practicable, commitments have been identified accordingly as outlined in Section 6.
Ongoing Consultation and Survey Notifications (Season 1)	Ongoing notifications	At time of 'change event' confirmation	Should a change in the survey occur, prior to commencement or during the survey, which would affect stakeholder interests, PGS will consider impacts and risks to stakeholders and seek their feedback on the proposed changes if their interests are affected. An environmental risk assessment will be undertaken together with an ALARP and acceptability assessment.	Stakeholder feedback will be considered in the risk assessment and actions implemented. All assessments will assess for, and meet, PGS ALARP and acceptability criteria. Controls will be incorporated into ECR for closeout.
	Confirmation of survey activities to all Identified stakeholders	At least 1 month prior to survey commencement date. At least 5 days prior to equipment deployment. At commencment of survey acquisition. At survey completion (within 10 days of survey completion)	Provide detailed relevant information (appropriate to the milestone) regarding: • Survey and support vessel names; • Expected equipment deployment and acquisition start date; • Refined survey area; • Details of survey specific website to access 48 hr lookahead	Once survey plans have been finalised a notification will be sent out to stakeholders identified.

	Website	Equipment deployment to survey completion.	Provides overview of the survey plans including the confirmed:
			• Survey and support vessels
			• Survey area and sail lines (including coordinates)
			  ○ Anticipated start date and location
			  ○ Current location of survey vessel
			  ○ Proposed sail lines to be acquired (including direction) in next 48 hours.
				The website will be live prior to the survey start date.
				Initially information provided will be the same as that contained in the notification letter.
				Should information change as start date approaches (e.g. start date delayed due to weather) website will be updated as soon as practicable.
				Once survey has commenced the website will be updated daily with vessel location and proposed sail lines to be acquired.

Step	Task	Timing	Details	Implementation Strategy
	Advice on Season 2 Activities	Season 2 (Notification 1): At the survey completion (within 10 days) Season 2 (Notification 2): As soon as details are finalised.	Season 2 (Notification 1): Provide information to stakeholder as soon as possible after the completion of the CY2019 acquisition period, (Season1). PGS will confirm whether the survey has either (i) definitely been completed in full, or (ii) has any chance of continuing into a 2nd (CY2020) acquisition season (with an estimated final decision-date being provided). Season 2 (Notification 2): Provide information to all stakeholders as soon as possible once a final decision has been made, even if that decision is that a 2nd acquisition season is not required.	Notification to all stakeholders
Season 2 Consultation (if relevant to activity)	Confirmation of survey activities to all identified stakeholders	At least 2 month prior to survey commencement date. At least 5 days prior to equipment deployment. At commencment of survey acquisition. At survey completion (within 10 days of survey completion)	Provide detailed relevant information (appropriate to the milestone) regarding: • Survey and support vessel names; • Expected equipment deployment and acquisition start date; • Refined survey area; • Details of survey specific website to access 48 hr lookahead	Once survey plans have been finalised a notification will be sent out to stakeholders identified.

	Website	Equipment deployment to survey completion.	Provides overview of the survey plans including the confirmed:
			• Survey and support vessels
			• Survey area and sail lines (including coordinates)
			    ○ Anticipated start date and location
			    ○ Current location of survey vessel
			    ○ Proposed sail lines to be acquired (including direction) in next 48 hours.
				The website will be live prior to the survey start date.
				
				Initially information provided will be the same as that contained in the notification letter.
				
				Should information change as start date approaches (e.g. start date delayed due to weather) website will be updated as soon as practicable.
				
				Once survey has commenced the website will be updated daily with vessel location and proposed sail lines to be acquired.

Table 9-2: Stakeholders Preliminary Consultation

Interest Area	Organisations
Commonwealth Fisheries	Australian Fisheries Management Authority (AFMA) Great Australian Bight Industry Association (GABIA) Australian Southern Bluefin Tuna Industry Association (ASBTIA) Commonwealth Fisheries Association (CFA) Sustainable Shark Fishing Inc (SSF) Southern Shark Industry Alliance (SSIA). Small Pelagic Fishery Industry Association (SPFIA) Southern Shark Industry Alliance (SSIA) Small Pelagic Fishery Industry Association (SPFIA)
South Australian Fisheries	Marine Fishers Association of South Australia (MFASA) South Australian Rock Lobster Advisory Council (SARLAC) South Australian Sardine Industry Association (SASIA) South Australian Recreational Fishing Advisory Council (SARFAC) Wildcatch SA Andrew Ferguson Central Zone Abalone Fishery Abalone Industry Association of SA (AIASA) Recreational Charter Boat Fishery Calypso Star Charter RecFISH SA SA Oyster Growers Association Game Fishing Association of South Australia (GFASA) Crab Fishermen (refer Stakeholder Log) Shark Hook fishermen (refer Stakeholder log)
Government Authorities (Commonwealth)	Department of Defence Australian Maritime Safety Authority Geoscience Australia Director of National Parks Department of Environment and Energy
Government Authorities (South Australia)	Primary Industries and Regions South Australia (PIRSA) Department of Environment, Water and Natural Resources (DEWNR) now DEW Department of Planning Transport and Infrastructure (DTPI) Department of State Development (DSD) now administered by the Department of Premier and Cabinet (DPC) now Department of Energy and Mining (DEM) Kangaroo Island Council District Council of Lower Eyre Peninsula City of Port Lincoln Regional Development Australia Whyalla and Eyre Peninsula Environment Protection Authority Flinders Ports Eyre Peninsula Local Government Authority
Research Organisations	Commonwealth Scientific and industrial Research Organisation (CSIRO) Department of Defence, Science and Technology (DSTO) South Australian Research and Development Institute (SARDI) Blue Whale Study
Federal Representatives	Federal Member for Grey Federal Member for Mayo
State Representatives	State Member for Finness State Member for Flinders State Member for Goyder

Interest Area	Organisations
	SA State Minister – Resources and Energy
Shipping Organisations	Shipping Australia
Conservation Organisations	Australian Marine Conservation Society Conservation Council of South Australia (CCSA) International Fund for Animal Welfare (IFAW) Kangaroo Island Dolphin Watch Kangaroo Island Ecoaction Kangaroo Island Marine Action Group Greenpeace Wild Migration Limited PEW Environmental Group Whale and Dolphin Society The Wilderness Society Kangaroo Island Futures Authority Kangaroo Island Commissioner GAB Right Whale Study Group Flinders University – CEBEL Group
Eco-tourism/Tourism	Natural Resources Kangaroo Island Exceptional Kangaroo Island Kangaroo Island Fishing Adventures
Aboriginal Organisations	Aboriginal Lands Trust Aboriginal Affairs and Reconciliation
Titleholders	Geo-Venture Solutions (Asia Pacific)

Table 9-3: Summary of Individual Notification/Consultation Triggers for Duntroon Survey

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
Note as contained in Table 9-1, the following notifications regarding Season 2 will be undertaken for all stakeholders: • Season 2 (Notification 1): Provide information to stakeholder as soon as possible after the completion of the CY2019 acquisition period, (Season1). PGS will confirm whether the survey has either (i) definitely been completed in full, or (ii) has any chance of continuing into a 2nd (CY2020) acquisition season (with an estimated final decision-date being provided). • Season 2 (Notification 2): Provide information to all stakeholders as soon as possible once a final decision has been made, even if that decision is that a 2nd acquisition season is not required Season 2 (if undertaken) will have a notification schedule which is the same as Season 1, but with an additional notification of at least 2 months prior to survey commencement when survey vessels are known.				
Aboriginal Lands Trust	Survey Notifications	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Aboriginal Affairs and Reconcilitaion Division	Survey Notifications	[EMAIL]	On acceptance of Duntroon EP At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of survey acquisition Within 10 days of survey completion	PGS Vessel Manager

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
AMSA	Copy of EP	[EMAIL]	On acceptance of EP	PGS Vessel Manager
	Survey Vessel to Notify RCC of pending operations commencement	[EMAIL]	24-48 hrs prior to survey commencement	PGS Vessel Master
	Survey commencement and completion	[EMAIL]	At commencement and completion of survey	PGS Vessel Master
AMSA	Oil Spill	[PHONE] [WEBSITE]	As soon as possible after the event	PGS Vessel Master
AHS	Issue of Notice to Mariners	[EMAIL]	4 working weeks prior to survey commencement	PGS Vessel Manager
Blue Whale Study	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
CEBEL GABWS	Survey Notifications	[EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
City of Port Lincoln	Progress of EP and Approvals	[EMAIL]	On EP submission At Acceptance	PGS Vessel Manager
	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Department of Defence (Com)	Weekly summary of planned activities	[EMAIL]	Weekly	PGS Vessel Manager
Department of Environment (Com)	Survey Compliance and Sighting Report	[EMAIL]	Within 2 months of activity completion	PGS Vessel Manager
	Vessel strike to cetacean/marine mammal	[WEBSITE]	As soon as possible after the event but within 2 hrs	PGS Party Chief

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
Department of Environment, Water & Natural Resources (DEWNR) (SA) (now DEW)	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
District Council of Lower Eyre Peninsula (DCLEP)	Survey Noifications	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Kangaroo Island Commissioner	Survey Notification		(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Kangaroo Island Council	Copy of EP	[EMAIL]	On submission to NOPSEMA	PGS Vessel Manager
	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Kangaroo Island Dolphin Watch	MFO & PAM Reports Water Temperature and Salinity Data Bathymetric Data for 3D survey	[EMAIL]	On receipt of information	PGS Vessel Manager
	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
Kangaroo Island Ecoaction	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Kangaroo Island Natural Resources Management	Survey Notification	[EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
NOPSEMA	Reportable Incident	Telephone: (08) 6461 7090 Email: submissions@nopsema.gov.au	Within 2hrs (oral notification) Written notification (ASAP after verbal) Within 3 days (written report)	PGS Vessel Manager
	Notification of Activity Commencement & Completion	Email: submissions@nopsema.gov.au	At least 10 Days prior to commencement and within 10 Days after completion	PGS Vessel Manager
	Altered Risk, Activity or Change in Titleholder	Email: submissions@nopsema.gov.au	ASAP on Change Trigger	PGS Vessel Manager
	Recordable Environmental Incident Monthly Report (Written Report)	Email: submissions@nopsema.gov.au	No Later than 15th Day of following Month	PGS Vessel Manager
	EP Performance Report	Email: submissions@nopsema.gov.au	Within 3 months of Survey completion	PGS Vessel Manager
	End of EP Operation	Email: submissions@nopsema.gov.au	After completion of all activity and all obligations completed	PGS Vessel Manager
NOPTA	Reportable Incident	Email: Reporting@nopta.gov.au Address: Titles Manager – NOPTA Level 8 Alluvion House 58 Mounts Bay Rd, PERTH WA 6000 GPO Box 7871, PERTH, WA 6850	Written notification ASAP after NOPSEMA notification (i.e. 2hrs) Written Report (within 7days of giving NOPSEMA written report	PGS Vessel Manager
Regional Development	Acceptance of EP	[EMAIL]	On acceptance of the EP	PGS Vessel Manager

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
Australia Whyalla and Eyre Peninsula	Survey Notifications	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	
Eyre Peninsula Local Government Association	Acceptance of EP	[EMAIL]	On acceptance of the EP	PGS Vessel Manager
	Survey Notifications		(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	
South Australia Department of Premier and Cabinet (DPC) now Department of Energy and Mining	Reportable Incident	[EMAIL] [EMAIL]	Written notification ASAP after NOPSEMA notification (i.e. 2hrs) Written Report (within 7days of giving NOPSEMA written report	PGS Vessel Manager
	Survey Notification	[EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Flinders Ports Signal Station	Notification of spill incident (courtesy) (Level 2)	[PHONE]	As soon as possible	PGS Vessel Manager
DPTI	EP/OPEP (electronic copy provision)	[EMAIL]	Prior to offshore activity commencing	PGS Vessel Manager
	Planning Advice		(At least) One month prior to survey commencement	
	Notification (pending start)		(At least) 5 days prior to survey equipment deployment	
	Notification (Start)		At commencement of acquisition	
	Notification (Completion)		At survey completion (within 10 day of end of survey)	
	Spill	[EMAIL]	Within 2 hrs	
DPTI	New or increased environmental risk or changes to response arrangements in approved documents	[EMAIL]	On MoC Event	PGS Vessel Manager

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
EPA	OSMP Activation	[PHONE]	ASAP (but within 2 hrs)	PGS Vessel Manager
	Survey Notifications	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
CSIRO	Survey Notifications	[EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel manager
DNP	Acceptance of EP	[EMAIL]	On acceptance	PGS Vessel Manager
	Planning Advice		(At least) One month prior to survey commencement	
	Pending Commencement		(At least) 5 days prior to survey equipment deployment	
	Commencement		At commencement of acquisition	
	Completion		At survey completion (within 10 day of end of survey)	
	Oil Pollution Incident	[PHONE]	As soon as possible	PGS Vessel Manager
PIRSA	Survey Notifications	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel manager

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
Fisheries: GABIA ASBTIA SARLAC [CONTACT] AFMA Recreational Charter Boat Fishery (CBF) Marine Scalefish Fishery SASIA [CONTACT] [CONTACT] [CONTACT] [CONTACT]	Notification of survey activity	[EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion Websit updated for survey activity in next 48 hrs (during survey)	PGS Vessel Manager
SA Oyster Growers Association Central Zone Abalone Fishery Abalone Industry Association of SA RecFish SA Wildcatch SA	Survey Notifications	[EMAIL] [EMAIL] [EMAIL] [EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
SPFIA CFA SSIA SSF	Survey Notifications	[EMAIL] [EMAIL] [EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion	PGS Vessel Manager
State Parliament Members: Finniss Flinders Goyder	Survey Notification	[EMAIL] [EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Federal Parliament Members Mayo Grey	Survey Notification	[EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager

Stakeholder	Relevant/Interaction Trigger	Engagement Methodology	Timing	Responsibility
Whale & Dolphin Conservation Society (WDCS)	Survey Notification	[EMAIL] [EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Wildlife Migration Limited (WML)	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
Wilderness Society	Survey Notification	[EMAIL]	(At least) One month prior to survey commencement (At least) 5 days prior to survey equipment deployment At commencement of acquisition At survey completion (within 10 day of end of survey)	PGS Vessel Manager
	Monitoring Data: Whale Sightings Monitoring Data: Aerial Survey Sightings MFO Report	[EMAIL]	Weekly during survey period End of Survey (Season-basis)	PGS Vessel Manager

9.2 Ongoing Consultation

Table 9-3 identifies key milestones which trigger further consultation. These include:

- EP submission, acceptance and availability of EP summary on the NOPSEMA website;
- Commencement of survey (1 month prior, 5 days prior to equipment deployment, at commencement);
- Any significant incidents;
- Survey completion; and
- Receipt of environmental reports (data etc.).

All notifications will include the relevant details on the activity for the notification type (e.g. for commencement of survey – location, timeframe, vessel details, website details for 48 hr lookahead) and contact details or where any claims, objections, queries or concerns may be directed. Contact details will include the EP liaison person, telephone number and email address.

PGS recognises the need for ongoing effective stakeholder consultation throughout the duration of the Duntroon survey activity. As extensive consultation has been undertaken already, trigger events detailed in Table 9-3 (above) provided to stakeholders are not expected to raise any new or additional concerns.

In the event of a change to the program scope or other changes occur as detailed in Section 7.8.2 (e*.g. there are developments in the scientific understanding of impacts and risks; or new information regarding the receiving environment relevant to Duntroon activities identifies a potential new or increase in potential impact or risk*) which may affect stakeholder's interests or activities, PGS will inform relevant stakeholders of the change and seek their feedback. As required by OPGGSER Regulation 16(b), PGS shall assess the merits of any new claims or objections made by a relevant stakeholder whereby they believe the activity will have an adverse impact on their interests or activities. If the claim has merit, where appropriate, PGS will modify the management of the activity. The assessment will be done using the methodology detailed in the internal risk assessment methodology the impacts and risks will be assessed detailed in **Section 7.8.2.**

PGS shall endeavour to finalise the merit of any claim or objection received during the survey within one week of receipt and undertake any resulting MoC actions as soon as practicable, but preferably within that timeframe. The assessment of merit and any resulting MoC actions will be shared with the concerned stakeholder. For objections and claims that do not hold merit, PGS will respond to stakeholders providing reasoning and supporting information (as relevant) to support PGS's conclusions. This may include the provision of reasonably available options/controls explored to mitigate the degree to which the stakeholder may be affected and/or demonstration that the risk or impact in question has been reduced to ALARP and acceptable levels.

If the assessment of merit of a claim or objection received during the survey suggests that new or increased impact and risk is significant then this will trigger a revision to the EP as per **Section 7.8.1** (MoC) given it is an offence under OPGGSER Regulation 8(1) for a titleholder to continue if a significant new impact or risk, or a significant increase in the impact or risk is not provided for in the accepted EP.

If a significant new or increased impact or risk is identified as a result of internal risk assessments described in **Section 7.8.2** and it is not already appropriately covered under this EP, then as required by OPGSSER Regulation 17, PGS shall submit a proposed revision to the EP. PGS will determine at the time of the internal risk assessment, whether an impact or risk is considered 'significant' (i.e. results in an increased residual impact or risk ranking) based upon information available at the time (e.g. reviewed scientific information, stakeholder claims or concerns). Notification to existing and new stakeholders of significant new or increased risks will be issued prior to the submission of the revised EP as part of the consultation activity for the EP revision.

This EP contains a record of all PGS' relevant commitments to ensure the impact on the environment and stakeholders is reduced to ALARP and acceptable levels. An ECR developed from this EP will focus these commitments, and ensure documented outcomes are recorded.

In conjunction with this, the ongoing Stakeholder Consultation Log will represent the records dialogue with all relevant stakeholders, along with notes about additional commitments made during such dialogue. Any additional commitments will be recorded in the ECR to ensure action is both taken and documented.

<u>Ongoing Consultation Plan Steps:</u>

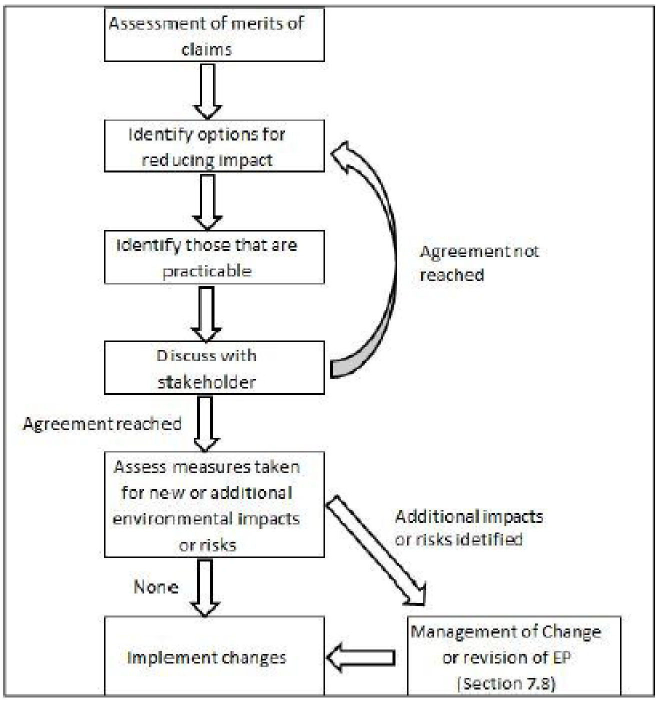
1. The existing consultation commitments, including the planned implementation of control measures, will be noted in the ECR with all other environmental commitments. The Responsible person as nominated on the ECR will ensure these items are actioned and logged. The PGS Vessel Manager and Environmental Advisor will regularly update and monitor these commitments to ensure closeout.

2. The PGS Vessel Manager will be responsible for ensuring that important/sensitive stakeholders are contacted, and meetings held as often as deemed appropriate based on a combination of importance and sensitivities, and key discussions logged. Any new commitments made will be added into the ECR for action.

3. Any new issues or concerns arising from stakeholder consultation will be assessed as bet OPGGSER Regulation 16(b) and acted on according to the process outlined above and defined in Figure 9-1.

4. Any matters arising from stakeholder consultation that identify issues or increased impacts, or risks will be assessed. After assessment (as required) PGS will amend the EP via a MOC and submit a revision to NOPSEMA as required.

Figure 9-1: Process for Assessing, Evaluating and Implementing Ongoing Stakeholder Feedback throughout the Life of this EP.



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Appendix A: EPBC Protected Matters Database Search

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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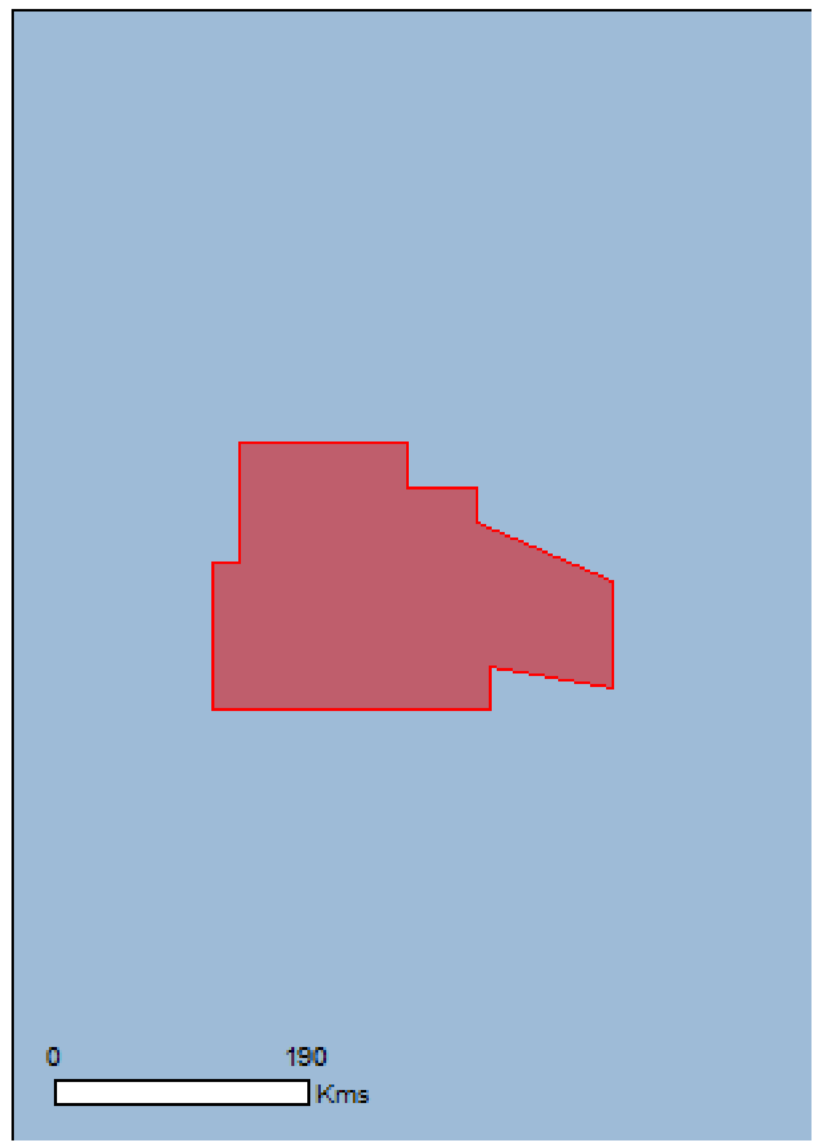

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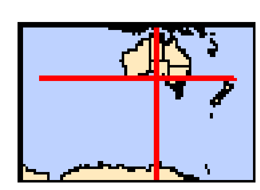

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	89
Listed Migratory Species:	65

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	9
Commonwealth Heritage Places:	1
Listed Marine Species:	107
Whales and Other Cetaceans:	35
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	12

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	319
Regional Forest Agreements:	None
Invasive Species:	58
Nationally Important Wetlands:	18
Key Ecological Features (Marine)	2

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east
South-west

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Eyre Peninsula Blue Gum (Eucalyptus petiolaris) Woodland	Endangered	Community likely to occur within area
Kangaroo Island Narrow-leaved Mallee (Eucalyptus cneorifolia) Woodland	Critically Endangered	Community likely to occur within area
Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris		
Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus lathami halmaturinus		
Glossy Black-Cockatoo (Kangaroo Island), Glossy Black-Cockatoo (South Australian) [64436]	Endangered	Breeding known to occur within area

Name	Status	Type of Presence
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat known to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Extinct within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Psophodes nigrogularis leucogaster Western Whipbird (eastern), Mallee Western Whipbird [64448]	Vulnerable	Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Status	Type of Presence
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding likely to occur within area
Stipiturus malachurus parimeda Southern Emu-wren (Eyre Peninsula) [26006]	Vulnerable	Species or species habitat known to occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable	Species or species habitat known to occur within area
Zoothera lunulata halmaturina Bassian Thrush (South Australian) [67121]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Leporillus conditor Wopilkara, Greater Stick-nest Rat [137]	Vulnerable	Translocated population known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur

Name	Status	Type of Presence
		within area
Sminthopsis aitkeni Kangaroo Island Dunnart [300]	Endangered	Species or species habitat known to occur within area
Sminthopsis psammophila Sandhill Dunnart [291]	Endangered	Species or species habitat known to occur within area
Tachyglossus aculeatus multiaculeatus Kangaroo Island Echidna [87597]	Endangered	Species or species habitat likely to occur within area
Plants		
Acacia enterocarpa Jumping-jack Wattle [17615]	Endangered	Species or species habitat known to occur within area
Acacia pinguifolia Fat-leaved Wattle [5319]	Endangered	Species or species habitat known to occur within area
Acacia rhetinocarpa Neat Wattle, Resin Wattle (SA) [11282]	Vulnerable	Species or species habitat known to occur within area
Acacia whibleyana Whibley Wattle [64497]	Endangered	Species or species habitat known to occur within area
Asterolasia phebalioides Downy Star-bush [3599]	Vulnerable	Species or species habitat known to occur within area
Beyeria subtecta Kangaroo Island Turpentine Bush [2076]	Vulnerable	Species or species habitat known to occur within area
Bossiaea peninsularis Sword Bossiaea [86647]	Endangered	Species or species habitat known to occur within area
Caladenia brumalis Winter Spider-orchid [54993]	Vulnerable	Species or species habitat known to occur within area
Caladenia conferta Coast Spider-orchid [55000]	Endangered	Species or species habitat may occur within area
Caladenia intuta Ghost Spider-orchid [82821]	Critically Endangered	Species or species habitat likely to occur within area
Caladenia macroclavia Large-club Spider-orchid [55012]	Endangered	Species or species habitat known to occur within area
Caladenia ovata Kangaroo Island Spider-orchid [3957]	Vulnerable	Species or species habitat likely to occur within area
Caladenia tensa Greencomb Spider-orchid, Rigid Spider-orchid [24390]	Endangered	Species or species habitat known to occur within area
Cheiranthera volubilis Twining Finger Flower [3125]	Vulnerable	Species or species habitat likely to occur within area
Correa calycina Hindmarsh Correa [7226]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Eucalyptus paludicola Mount Compass Swamp Gum, Fleurieu Swamp Gum, Marsh Gum [64276]	Endangered	Species or species habitat may occur within area
Euphrasia collina subsp. osbornii Osborn's Eyebright [3684]	Endangered	Species or species habitat known to occur within area
Haloragis eyreana Prickly Raspwort [8737]	Endangered	Species or species habitat likely to occur within area
Logania insularis [13105]	Vulnerable	Species or species habitat likely to occur within area
Olearia microdisca Small-flowered Daisy-bush [21465]	Endangered	Species or species habitat likely to occur within area
Olearia pannosa subsp. pannosa Silver Daisy-bush, Silver-leaved Daisy, Velvet Daisy-bush [12348]	Vulnerable	Species or species habitat known to occur within area
Pleuropappus phyllocalymmeus Silver Candles [21123]	Vulnerable	Species or species habitat likely to occur within area
Pomaderris halmaturina subsp. halmaturina Kangaroo Island Pomaderris [21964]	Vulnerable	Species or species habitat known to occur within area
Prasophyllum goldsackii Goldsack's Leek-orchid [2380]	Endangered	Species or species habitat likely to occur within area
Prasophyllum laxum Lax Leek Orchid [86264]	Critically Endangered	Species or species habitat likely to occur within area
Prostanthera calycina West Coast Mintbush, Limestone Mintbush, Red Mintbush [9470]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis mirabilis Nodding Rufoushood [86228]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis sp. Hale (R.Bates 21725) Hale Dwarf Greenhood [64539]	Endangered	Species or species habitat known to occur within area
Ptilotus beckerianus Ironstone Mulla Mulla [3787]	Vulnerable	Species or species habitat known to occur within area
Pultenaea trichophylla Tufted Bush-pea [12715]	Endangered	Species or species habitat known to occur within area
Pultenaea villifera var. glabrescens Yellow Bush-pea, Splendid Bush-pea [10271]	Vulnerable	Species or species habitat known to occur within area
Senecio macrocarpus Large-fruit Fireweed, Large-fruit Groundsel [16333]	Vulnerable	Species or species habitat likely to occur within area
Spyridium eriocephalum var. glabrisepalum MacGillivray Spyridium [13771]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Stackhousia annua Annual Stackhousia, Annual Candles [17773]	Vulnerable	Species or species habitat likely to occur within area
Swainsona pyrophila Yellow Swainson-pea [56344]	Vulnerable	Species or species habitat likely to occur within area
Tecticornia flabelliformis Bead Glasswort [82664]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat likely to occur within area
Veronica derwentiana subsp. homalodonta Mount Lofty Speedwell [82836]	Critically Endangered	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Maritime Safety Authority
Commonwealth Land - Australian National Railways Commission
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Minister of Transport
Commonwealth Land - Telstra Corporation Limited
Defence - COOMUNGA RANGE
Defence - LAUNCHER SITES - ROXBY DOWNS
Defence - PORT LINCOLN TRAINING DEPOT

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Cape Du Couedic Lighthouse	SA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres		
Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Roosting known to occur within area

Name	Threatened	Type of Presence
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur within area
Himantopus himantopus Black-winged Stilt [870]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat may occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur

Name	Threatened	Type of Presence
		within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Puffinus tenuirostris Short-tailed Shearwater [1029]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tryoni Tryon's Pipefish [66193]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus horridus Shaggy Pipefish, Prickly Pipefish [66244]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Vanacampus vercoi Verco's Pipefish [66286]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Breeding known to occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata		
Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis		
Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii		
Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata		
Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis		
Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area
Feresa attenuata		
Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus		
Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas		
Long-finned Pilot Whale [59282]		Species or species habitat may occur within area

Name	Status	Type of Presence
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Tasmacetus shepherdi Shepherd's Beaked Whale, Tasman Beaked Whale [55]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Great Australian Bight	Multiple Use Zone (IUCN VI)
Murray	Marine National Park Zone (IUCN II)
Murray	Multiple Use Zone (IUCN VI)
Murray	Special Purpose Zone (IUCN VI)
Southern Kangaroo Island	Special Purpose Zone (Mining
Western Eyre	Multiple Use Zone (IUCN VI)
Western Eyre	National Park Zone (IUCN II)
Western Eyre	Special Purpose Zone (IUCN VI)
Western Eyre	Special Purpose Zone (Trawl) (IUCN VI)
Western Kangaroo Island	National Park Zone (IUCN II)
Western Kangaroo Island	Special Purpose Zone (IUCN VI)
Western Kangaroo Island	Special Purpose Zone (Mining

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Althorpe Islands	SA
Avoid Bay Islands	SA
Baird Bay Islands	SA
Barwell	SA
Bascombe Well	SA
Calpatanna Waterhole	SA
Cap Island	SA
Cape Blanche	SA
Cape Bouguer	SA
Cape Gantheaume	SA
Cape Gantheaume	SA
Cape Torrens	SA
Carribie	SA
Cocata	SA
Coffin Bay	SA
Dakalanta	SA
Flinders Chase	SA
Gambier Islands	SA
Greenly Island	SA
Hambidge	SA
Hincks	SA
Hincks	SA
Innes	SA
Investigator Group	SA
Kathai	SA
Kellidie Bay	SA
Kelly Hill	SA
Kulliparu	SA

Name	State
Lake Newland	SA
Lathami	SA
Leven Beach	SA
Lincoln	SA
Lincoln	SA
Memory Cove	SA
Moody Tank	SA
Mount Dutton Bay	SA
Mount Taylor	SA
Murrunatta	SA
Parndana	SA
Peachna	SA
Point Davenport	SA
Point Labatt	SA
Ravine des Casoars	SA
Rudall	SA
Sceale Bay	SA
Sceale Bay Coastlink	SA
Seal Bay	SA
Searcy Bay	SA
Seddon	SA
Shannon	SA
Sleaford Mere	SA
Tucknott Scrub	SA
Tumby Island	SA
Unnamed (No.HA1001)	SA
Unnamed (No.HA1003)	SA
Unnamed (No.HA1016)	SA
Unnamed (No.HA1019)	SA
Unnamed (No.HA1026)	SA
Unnamed (No.HA1035)	SA
Unnamed (No.HA1037)	SA
Unnamed (No.HA1040)	SA
Unnamed (No.HA1048)	SA
Unnamed (No.HA1052)	SA
Unnamed (No.HA106)	SA
Unnamed (No.HA1064)	SA
Unnamed (No.HA1072)	SA
Unnamed (No.HA1088)	SA
Unnamed (No.HA1091)	SA
Unnamed (No.HA1101)	SA
Unnamed (No.HA1103)	SA
Unnamed (No.HA1117)	SA
Unnamed (No.HA1127)	SA
Unnamed (No.HA1133)	SA
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Unnamed (No.HA1169)	SA
Unnamed (No.HA117)	SA
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Unnamed (No.HA1263)	SA
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Unnamed (No.HA1291)	SA
Unnamed (No.HA1296)	SA
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Unnamed (No.HA1309)	SA
Unnamed (No.HA132)	SA
Unnamed (No.HA1327)	SA
Unnamed (No.HA1346)	SA
Unnamed (No.HA1355)	SA
Unnamed (No.HA1358)	SA
Unnamed (No.HA1360)	SA
Unnamed (No.HA1367)	SA
Unnamed (No.HA1373)	SA
Unnamed (No.HA1374)	SA

Name	State
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Unnamed (No.HA1383)	SA
Unnamed (No.HA1388)	SA
Unnamed (No.HA1399)	SA
Unnamed (No.HA1409)	SA
Unnamed (No.HA1424)	SA
Unnamed (No.HA1425)	SA
Unnamed (No.HA1449)	SA
Unnamed (No.HA145)	SA
Unnamed (No.HA1451)	SA
Unnamed (No.HA146)	SA
Unnamed (No.HA1461)	SA
Unnamed (No.HA1469)	SA
Unnamed (No.HA1472)	SA
Unnamed (No.HA1477)	SA
Unnamed (No.HA148)	SA
Unnamed (No.HA1480)	SA
Unnamed (No.HA1486)	SA
Unnamed (No.HA1493)	SA
Unnamed (No.HA150)	SA
Unnamed (No.HA1504)	SA
Unnamed (No.HA1505)	SA
Unnamed (No.HA1506)	SA
Unnamed (No.HA1508)	SA
Unnamed (No.HA1509)	SA
Unnamed (No.HA151)	SA
Unnamed (No.HA1514)	SA
Unnamed (No.HA1515)	SA
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Unnamed (No.HA318)	SA
Unnamed (No.HA324)	SA
Unnamed (No.HA328)	SA
Unnamed (No.HA330)	SA
Unnamed (No.HA335)	SA

Name	State
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Unnamed (No.HA341)	SA
Unnamed (No.HA342)	SA
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Unnamed (No.HA392)	SA
Unnamed (No.HA395)	SA
Unnamed (No.HA405)	SA
Unnamed (No.HA413)	SA
Unnamed (No.HA422)	SA
Unnamed (No.HA424)	SA
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Unnamed (No.HA578)	SA
Unnamed (No.HA583)	SA
Unnamed (No.HA592)	SA
Unnamed (No.HA596)	SA
Unnamed (No.HA598)	SA
Unnamed (No.HA600)	SA
Unnamed (No.HA603)	SA
Unnamed (No.HA605)	SA
Unnamed (No.HA608)	SA

Name	State
Unnamed (No.HA61)	SA
Unnamed (No.HA614)	SA
Unnamed (No.HA617)	SA
Unnamed (No.HA629)	SA
Unnamed (No.HA63)	SA
Unnamed (No.HA631)	SA
Unnamed (No.HA634)	SA
Unnamed (No.HA635)	SA
Unnamed (No.HA636)	SA
Unnamed (No.HA641)	SA
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Unnamed (No.HA870)	SA
Unnamed (No.HA873)	SA
Unnamed (No.HA879)	SA
Unnamed (No.HA885)	SA
Unnamed (No.HA887)	SA
Unnamed (No.HA891)	SA
Unnamed (No.HA897)	SA
Unnamed (No.HA906)	SA
Unnamed (No.HA907)	SA
Unnamed (No.HA91)	SA

Name	State
Unnamed (No.HA914)	SA
Unnamed (No.HA920)	SA
Unnamed (No.HA934)	SA
Unnamed (No.HA935)	SA
Unnamed (No.HA936)	SA
Unnamed (No.HA937)	SA
Unnamed (No.HA941)	SA
Unnamed (No.HA942)	SA
Unnamed (No.HA947)	SA
Unnamed (No.HA969)	SA
Unnamed (No.HA974)	SA
Unnamed (No.HA975)	SA
Unnamed (No.HA978)	SA
Unnamed (No.HA982)	SA
Unnamed (No.HA988)	SA
Unnamed (No.HA993)	SA
Unnamed (No.HA994)	SA
Venus Bay	SA
Verran Tanks	SA
Vivonne Bay	SA
Waldegrave Islands	SA
Wanilla	SA
Wanilla Land Settlement	SA
Warrenben	SA
Western River	SA
Wharminda	SA
Whidbey Isles	SA

Invasive Species

[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Meleagris gallopavo Wild Turkey [64380]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Annona glabra Pond Apple, Pond-apple Tree, Alligator Apple, Bullock's Heart, Cherimoya, Monkey Apple, Bobwood, Corkwood [6311]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf		Species or species habitat likely to occur

Name	Status	Type of Presence
Madeiravine, Potato Vine [2643]		within area
Asparagus asparagoides		
Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus declinatus		
Bridal Veil, Bridal Veil Creeper, Pale Berry Asparagus Fern, Asparagus Fern, South African Creeper [66908]		Species or species habitat likely to occur within area
Asparagus plumosus		
Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Cabomba caroliniana		
Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Carrichtera annua		
Ward's Weed [9511]		Species or species habitat may occur within area
Chrysanthemoides monilifera		
Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera		
Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata		
Bitou Bush [16332]		Species or species habitat likely to occur within area
Cryptostegia grandiflora		
Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Cylindropuntia spp.		
Prickly Pears [85131]		Species or species habitat likely to occur within area
Cytisus scoparius		
Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Eichhornia crassipes		
Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia		
Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana		
Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis		
Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Mimosa pigra		
Mimosa, Giant Mimosa, Giant Sensitive Plant, ThornySensitive Plant, Black Mimosa, Catclaw		Species or species habitat likely to occur

Name	Status	Type of Presence
Mimosa, Bashful Plant [11223]		within area
Nassella neesiana		
Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Olea europaea		
Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp.		
Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Pinus radiata		
Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla		
Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii		
Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Solanum elaeagnifolium		
Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Ulex europaeus		
Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
Baird Bay	SA
Big Swamp	SA
Coffin Bay Coastal Wetland System	SA
Flinders Chase River Systems	SA
Grassdale Lagoons	SA
Innes Salt Lakes	SA
Lake Ada	SA
Lake Hamilton	SA
Lake Newland	SA
Murray Lagoon	SA

Name	State
Pillie Lake	SA
Point Davenport	SA
Point Labatt	SA
Six Mile Lagoon	SA
Sleaford Mere	SA
Streaky Bay	SA
Tod River Wetland System	SA
Tumby Bay	SA

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 90-120m depth	South-west
Kangaroo Island Pool, canyons and adjacent shelf	South-west

Caveat
The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-34.63889 133.06472,-34.63889 134.18889,-34.88694 134.19111,-34.88694 134.66194,-35.07389 134.66194,-35.39556 135.57111,-35.97361 135.57361,-35.86306 134.755,-36.09306 134.755,-36.0925 132.88722,-35.30333 132.88722,-35.30333 133.06472,-34.63889 133.06472

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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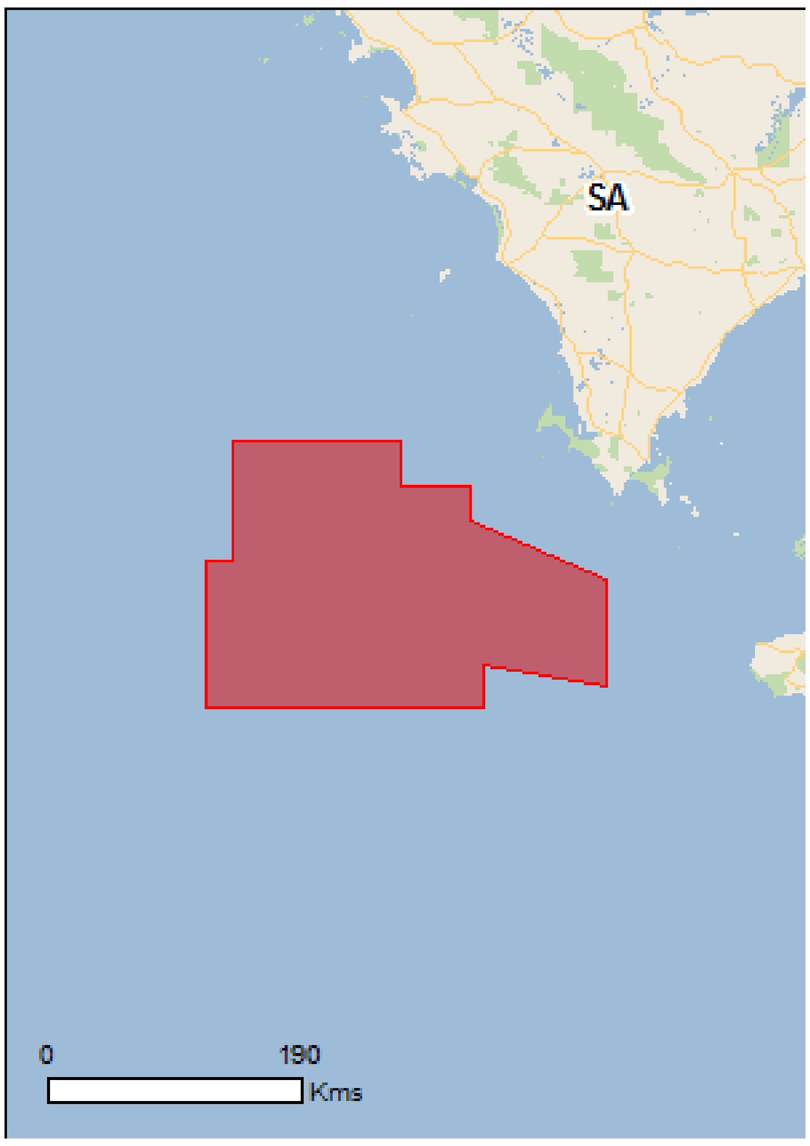

Coordinates
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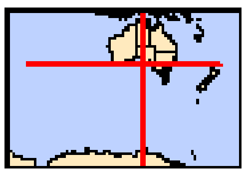

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	28
Listed Migratory Species:	33

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	59
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	2

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	2

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Sharks		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia		
Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli		
Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca		
Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Balaena glacialis australis		
Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera bonaerensis		
Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Sterna caspia Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus horridus Shaggy Pipefish, Prickly Pipefish [66244]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stigmatopora olivacea a pipefish [74966]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Vanacampus vercoi Verco's Pipefish [66286]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area

Name	Status	Type of Presence
Pseudorca crassidens False Killer Whale [48]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Commonwealth Reserves Marine [Resource Information]

Name	Label
Western Eyre	Multiple Use Zone (IUCN VI)
Western Eyre	Special Purpose Zone (IUCN VI)

Extra Information

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 90-120m depth	South-west
Kangaroo Island Pool, canyons and adjacent shelf	South-west

Caveat
The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-34.63889 133.06472,-34.63889 134.18889,-34.88694 134.19111,-34.88694 134.66194,-35.07389 134.66194,-35.39556 135.57111,-35.97361 135.57361,-35.86306 134.755,-36.09306 134.755,-36.0925 132.88722,-35.30333 132.88722,-35.30333 133.06472,-34.63889 133.06472

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix B: Duntroon Marine Seismic Survey Acoustic Modelling

Duntroon Marine Seismic Survey

Acoustic Modelling for Assessing Marine Fauna Sound Exposures for a 3260 in³ array

Submitted to:

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19 September 2018

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Version	Date	Name	Change
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Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

Executive Summary

Sound models were used to assess underwater noise levels during the proposed Duntroon Multi-Client Marine Seismic Survey (MSS) by PGS Australia. The modelling results are required for assessing the noise that marine fauna, are exposed to near survey operations. Previous modelling for this project assessed a 3090 in^3 seismic airgun array (McPherson et al. 2017); however, a 3260 in^3 is anticipated to be used in the survey and therefore is evaluated in this report. There is potential for the survey to be conducted any time during March – May or September – November; therefore, a review of sound speed profiles from these months versus May, which was used in the original modelling, was done to investigate the most conservative scenario, which was still found to be May. The modelling approach accounted for the acoustic emission characteristics of a 3260 in^3 seismic airgun array that is likely to be operated during the survey and considered source directivity and the area's range-dependent environmental properties relevant for the sound propagation.

The modelling study for the Duntroon MSS assessed twelve single pulse sites, nine of which were used to inform a representative accumulated sound exposure level (SEL, L_E) scenario over 24 hours. Four sites additional sites relevant to seafloor peak pressure (PK, L_{pk}) and peak-to-peak pressure level (PK-PK, $L_{pk\text{-}pk}$) metrics were considered. Water depth for all sites varied from 127 to 1496 m.

The analysis considered the maximum distances away from the seismic source or survey lines at which several effects criteria were reached, with consideration of sound levels within Biological Areas of Importance for Australian sea lions and Southern Right Whales (SRW) north of the proposed survey area. Additionally, modelling considered the sound levels received by mysticetes (low-frequency cetaceans), and other fauna, such as turtles, which only utilise depths less than or equal to 600 m. A number of different criteria have been employed to assess the ranges for potential noise-induced effects to occur in each of the taxonomic groups, the results are summarised below for the representative single-impulse sites and accumulated SEL scenarios.

Marine Mammals

- NMFS (2018) marine mammal injury criteria: The results considered both metrics within the criteria for Permanent Threshold Shift (PTS) (PK and SEL_{24h}). The farthest distance associated with either metric is required to be applied according to the criteria. Table 1 summarises the maximum distances and their associated metric. Because the array is not a point source (8.8 × 16.8 m), the actual ranges from the outer edge of the airgun array are small for mid-frequency cetaceans, and phocid and otariid pinnipeds.
- Based on the marine mammal injury criteria (NMFS 2018), temporary threshold shifts (TTS; non-injurious) are not predicted to occur in either in otariid pinnipeds, such as the Australian sea lion, or mid-frequency cetaceans, however they are predicted to occur in low and high-frequency cetaceans, along with phocid pinnipeds.
- United States National Marine Fisheries Service (NMFS; 2013) acoustic threshold for behavioural effects in marine mammals: Airgun sounds exceeded the sound pressure level (SPL) threshold of 160 dB re 1 µPa for behavioural effects on marine mammals within 7.6–13.05 km of the 3260 in^3 seismic airgun array (R_{max} distances) considering the entire water column or 6.59–13.05 km (R_{max} distances) considering depths less than or equal to 600 m.
- Received sound levels at the boundary of the SRW calving and calving buffer BIAs were examined from the closest modelled site, and expressed in terms of unweighted and NMFS (2018) low-frequency (LF) weighted SPL. The LF weighted SPL is reported for comparison to the Wood et al. (2012) probabilistic disturbance threshold for migrating mysticetes, which have been demonstrated to respond to seismic airgun noise at lower received sound levels when compared to mysticetes in other behavioural states. The thresholds for migrating mysticetes are a 10% response likelihood at a weighted SPL of 120 dB re 1 µPa, 50% at a weighted SPL of 140 dB re 1 µPa, and a 90% response likelihood at a weighted SPL of 160 dB re 1 µPa.
    - Unweighted sound levels at the boundaries of the calving buffer BIA and calving BIA are predicted to be 137 dB and 125 re 1 µPa (SPL), respectively.
    - LF-weighted sound levels at the boundaries of the calving buffer BIA and calving BIA are predicted to be 132.8 dB and 121.8 re 1 µPa (SPL), respectively.

Table 1. Summary of marine mammal Permanent Threshold Shift (PTS) (injurious) onset distances, maximum of PK (L_{pk}) and SEL24h (L_E) presented. The per-pulse modelling resolution was 20 m.

Relevant hearing group	Metric associated with PTS onset	Distance R_{max} (m)
Low-frequency cetaceans†	Weighted SEL24h ($L_{E, 24h}$)	760
Mid-frequency cetaceans	PK (L_{pk})	<20
High-frequency cetaceans	PK (L_{pk})	450
Phocid pinnipeds in water	PK (L_{pk})	40
Otariid pinnipeds in water	PK (L_{pk})	<20

†The model does not account for shutdowns.

Turtle Behaviour

- United States NMFS criterion for behavioural effects in turtles: Airgun sounds exceeded the 166 dB re 1 µPa (SPL) threshold for behavioural effects within 1.9 to 4.32 km based on $R_{95\%}$ distances, or 2.25 to 5.38 km based on R_{max} distances at depths ≤600 m.

Fish, Turtle Injury, Fish Eggs, and Fish Larvae

- Based on PK metrics, acoustic injury (including both lethal and recoverable injuries) could be sustained at the seafloor within a maximum horizontal distance of 28 m of the seismic array for fish without a swim bladder (Site F, 160 m deep) and within a maximum horizontal distance of 150 m for fish with a swim bladder, turtles, fish eggs, and fish larvae (Site F, 160 m deep). The ranges associated with both possible mortality and potential mortal injury, and recoverable injury on fish, turtles, fish eggs and larvae suggested by Popper et al. (2014) using the SEL24h metric were not reached. Therefore, following the criteria, the PK metric should be used to assess these impacts to fish, turtles, fish eggs, and fish larvae.

Crustaceans, Bivalves, Plankton, Corals and Sponges

- To assist with the assessment of potential effects on crustaceans and bivalves, seafloor PK-PK was assessed at four locations, considering isopleths equivalent to those reported in Day et al. (2016b), along with the distance to a PK-PK of 202 dB re 1 µPa from Payne et al. (2007). The maximum distance to this sound level (202 dB re 1 µPa) is 718 m.
- To assist with the assessment of potential effects on plankton through comparison to relevant literature, the distance to the sound level of 178 dB re 1 µPa PK-PK from McCauley et al. (2017) was determined at five modelling sites through full-waveform modelling using FWRAM, and ranged from 8.1 to 19.8 km based on R_{max} distances and maximum-over-depth.

1. Introduction

JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the Duntroon Multi-Client (MC) Marine Seismic Survey (MSS) proposed by Petroleum Geo-services (PGS) Australia in the Great Australian Bight (GAB). Previous modelling for this project assessed a 3090 in^3 seismic airgun array (McPherson et al. 2017); however, a 3260 in^3 is anticipated to be used in the survey and therefore is evaluated in this report. The modelling study specifically focused on one of the proposed three-dimensional (3-D) components of the survey, due to the acquisition line spacing and proximity to the coast and Kangaroo Island. The acoustic modelling evaluated the propagation of sounds produced by the seismic survey on marine fauna including cetaceans, pinnipeds, turtles, fish and invertebrates. The modelling considers a 3260 in^3 airgun array towed at 7 m depth. Sound levels due to pressure are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate.

Per-pulse sound fields were modelled at:

- Ten sites along two possible survey lines in in 3-D Survey Area 1 (Figure 1, Table 2)
- Two sites in in 3-D Survey Area 2 (Figure 1, Table 3)
- Four sites relevant to seafloor PK and PK-PK metrics (Figure 2, Table 7)

The modelling used seismic lines that were based on an acquisition pattern being considered for the proposed 3-D survey component that PGS provided to JASCO. This pattern was based on the original Bight Lightning MSS design, and was in a similar location to 3-D Survey Area 1. The model considers 24 hours of operation within this survey design. The acquired seismic lines are orientated with respect to prevailing weather conditions in the Great Australian Bight and are within an area that might best represent a 3-D acquisition area. These survey lines were selected because they best represent the range of bathymetry within the operational area closest to the Australian sea lion Biologically Important Areas (BIAs), and include the closest line to the Southern Right Whale (SRW) calving BIAs. The single impulse points within the Scenario are all those listed in Table 2.

To provided context for the received levels within the male and female sea lion foraging BIA which is not traversed by the vessel during the survey design, JASCO selected five locations to sample the modelled 24 h sound field. They represent the closest approach of the array to the BIA in broadside and endfire directions, or simply the closest in absolute terms, and the closest approach to the 100 m contour in either broadside direction or absolute terms. Tables 2–5 list the geographic coordinates of the modelled sites, survey lines, and sound field sampling locations.

Additionally, PGS requested that two per-pulse sites be modelled within a possible second 3-D survey area (3-D Survey Area 2) within the Duntroon MC MSS Operational area (Figure 1, Table 3). The footprints at these sites are compared to similar per-pulse sites within 3-D Survey Area 1. Additionally to assess the closest operational point to the Southern Right Whale (SRW) BIAs for calving and the calving buffer two locations were defined (Table 6), the sound levels from the closest operational point within 3-D Survey Area 1 (Line 2, Site 5) were predicted. PK and PK-PK at the seafloor were predicted at two sites within each 3-D survey area (Figure 2, Table 7).

Blue whales are known to primarily migrate and feed in the first few hundred metres of the water column (Croll et al. 2001, Goldbogen et al. 2011), with the deepest dive being reported from a pygmy blue whale being 506 m (Owen et al. 2016). Therefore, the sound levels received by mysticetes (low-frequency cetaceans), and other fauna which only utilise depths less than or equal to 600 m, such as turtles, have also been examined.

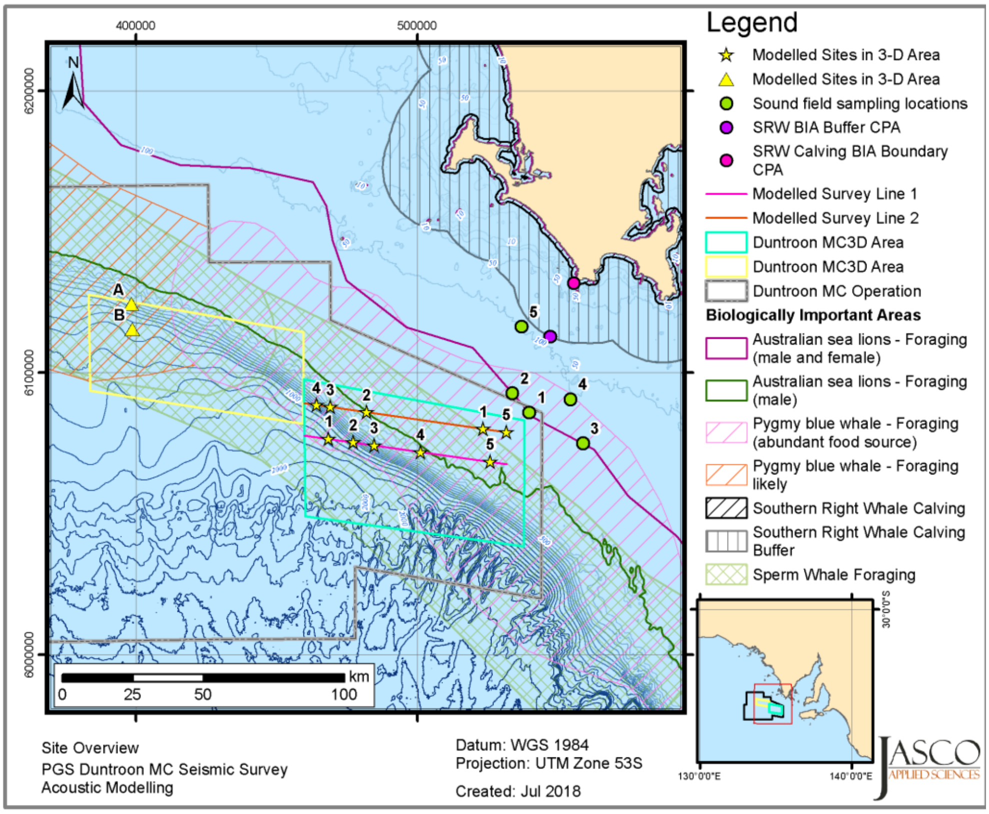

Figure 1. Site locations and relevant features for the Duntroon MSS 3-D Survey Area 1.

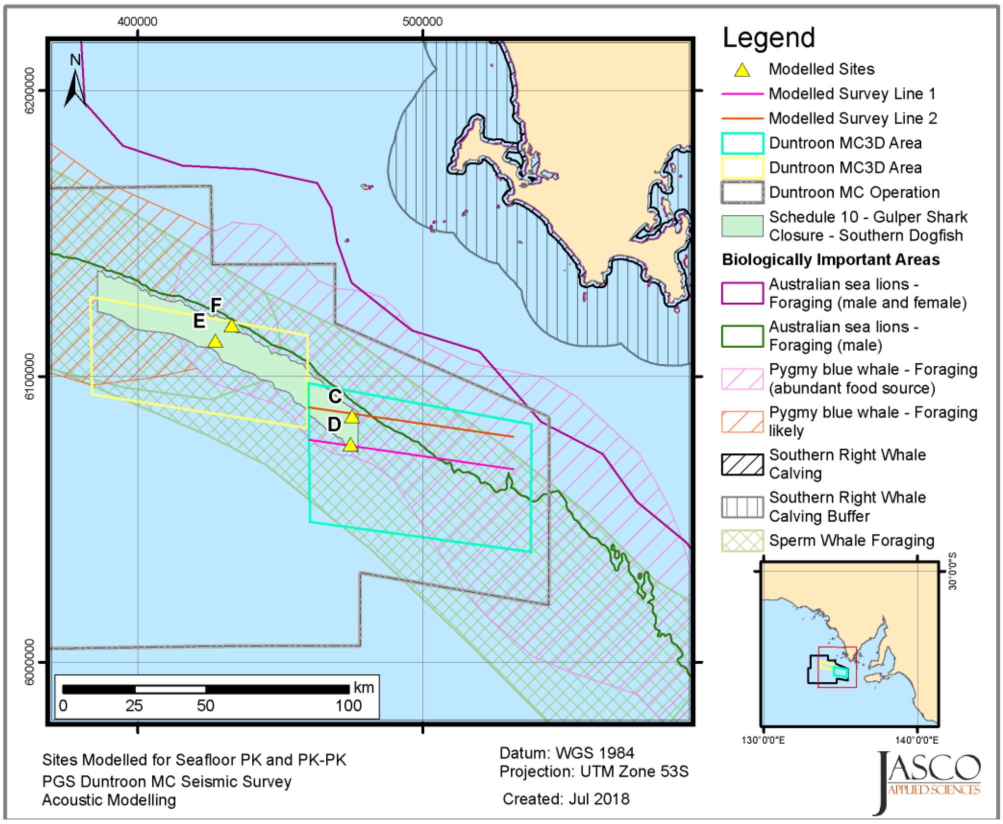

Figure 2. Seafloor relevant modelling locations and relevant features for the Duntroon MSS 3-D Survey Areas 1 and 2.

Table 2. Location of modelled sites on potential 3-D acquisition lines in 3-D Survey Area 1 of the Duntroon 3-D MSS (UTM zone 53S).

Line #	Site #	Latitude	Longitude	Easting	Northing	Water depth (m)	Tow heading (°)
1	1	−35.4538	134.6535	468557	6076572	1496	098
	2	−35.4655	134.7511	477418	6075302	1001	098
	3	−35.4753	134.8331	484860	6074235	501	098
	4	−35.4966	135.0135	501229	6071887	164	098
	5	−35.5282	135.2866	525981	6068338	135	098
2	1	−35.4225	135.2578	523405	6080073	127	278
	2	−35.3693	134.8035	482152	6085988	141	278
	3	−35.3521	134.6603	469133	6087855	348	278
	4	−35.3456	134.6064	464232	6088557	747	278
	5	−35.4329	134.3488	531656	6078890	128	278

Table 3. Location details for modelled sites in 3-D Survey Area 2 of the Duntroon 3-D MSS (UTM zone 53S).

Site	Latitude	Longitude	Easting	Northing	Water depth (m)	Tow heading (°)
A	−35.0171	133.8879	398537	6124501	496	278
B	−35.0980	133.8903	398858	6115531	950	278

Table 4. Location details for the survey lines modelled in 3-D Survey Area 1 to assess the defined 24 h SEL scenario for the Duntroon 3-D MSS (UTM zone 53S).

Line #	Position	Latitude	Longitude	Easting	Northing	Tow heading (°)
1	Start	−35.4424	134.5590	459976	6077803	098
	End	−35.5353	135.3488	531618	6067530	
2	Start	−35.4329	135.3488	531656	6078890	278
	End	−35.3399	134.5592	459940	6089173	

Table 5. Location details for the 24 h sound field sampling locations for the Duntroon MSS operating in 3-D Survey Area 1 (UTM zone 53S).

Location		Latitude	Longitude	Easting	Northing	Distance from closest survey line (km)
1	Closest point between the array and the foraging (male and female) sea lion BIA	−35.3692	135.4365	539649	6085927	10.65
2	Closest point between the broadside of the array and the foraging (male and female) sea lion BIA	−35.3075	135.3703	533662	6092788	14.05
3	Closest point between the endfire of the array and the foraging (male and female) sea lion BIA	−35.4668	135.6470	558700	6074991	27.33
4	Closest point between the array and the 100 m isobath	−35.3262	135.5985	554397	6090622	25.60
5	Closest point between the broadside of the array and the 100 m isobath	−35.0958	135.4054	536948	6116257	37.75

Table 6. Location details for the SRW BIA relevant sound field sampling locations for the closest operation point from the Duntroon MSS operating in 3-D Survey Area 1 (UTM zone 53S).

Location	Latitude	Longitude	Easting	Northing
Boundary of SRW Calving Buffer BIA	−35.1263	135.5173	547130.8	6112826
Boundary of SRW Calving BIA	−34.955	135.6082	555533.2	6131782

Table 7. Location details for the Duntroon MSS modelled sites for seafloor PK and PK-PK metrics (UTM zone 53S).

Site	Site label	Latitude	Longitude	Easting	Northing	Water depth (m)	Tow heading (°)
3-D Survey Area 1, Site 1	C	−35.3675	134.7265	475159	6086162	200	098
3-D Survey Area 1, Site 2	D	−35.4565	134.7216	474738	6076294	1099	098
3-D Survey Area 2, Site 1	E	−35.1267	134.2016	427252	6112615	649	098
3-D Survey Area 2, Site 2	F	−35.0786	134.2650	432994	6117992	160	098

2. Noise Effect Criteria

The perceived loudness of sound, especially impulsive noise such as from seismic airguns, is not generally proportional to the instantaneous acoustic pressure. Rather, perceived loudness depends on the time over which the pulse rises, how long this occurs for, and its frequency content. Thus, several sound level metrics are commonly used to evaluate noise and its effects on marine life (Appendix A). The period of accumulation associated with SEL is defined, with this report referencing either a “per pulse” assessment or over 24 h. Appropriate subscripts indicate any applied frequency weighting; unweighted SEL is defined as required. The acoustic metrics in this report reflect the updated ANSI and ISO standards for acoustic terminology, ANSI-ASA S1.1 (R2013) and ISO/DIS 18405.2:2017 (2016).

The noise criteria were chosen for this study include standard thresholds and thresholds suggested by the best available science (Sections 2.1–2.2 and Appendix A), additionally specific sound levels have been included for comparison to those reported in specific recent literature. All criteria and specific sound levels considered are as follows:

1. Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from the U.S. National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals.
    a. TTS for low-frequency cetaceans is presented also considering the maximum-over-depth value for depths ≤600 m.
2. Marine mammal behavioural threshold based on the current interim U.S. National Marine Fisheries Service (NMFS) criterion (NMFS 2013) for marine mammals of 160 dB re 1 µPa SPL (L_p) for impulsive sound sources. Reported as both:
    a. Maximum-over-depth value for entire water column
    b. Maximum-over-depth value for depths ≤600 m.
3. Low-frequency (LF) weighted SPL for comparison to the Wood et al. (2012) probabilistic disturbance thresholds for migrating mysticetes (relevant for calving mysticetes), assessed using the NMFS (2018) frequency weighting function. The relevant thresholds are LF-weighted SPLs of 120, 140 and 160 dB re 1 µPa, relating to response likelihoods of 10, 50 and 90%, respectively. These thresholds are considered only at the closest modelling site to the SRW calving and calving buffer BIAs.
4. Sound exposure guidelines for fish, fish eggs and larvae, and turtles (Popper et al. 2014).
5. Threshold for turtle behavioural response of 166 dB re 1 µPa SPL (L_p) (NSF 2011), as applied by the US NMFS.
    a. Maximum-over-depth value for entire water column
    b. Maximum-over-depth value for depths ≤600 m.
6. PK-PK ($L_{pk\text{-}pk}$) at the seafloor is reported for comparison to results in Payne et al. (2008), and Day et al. (2016a).
7. 178 dB re 1 µPa PK-PK in the water column, reported for comparison to McCauley et al. (2017) for plankton.

Additionally, to assess the size of the low-power zone required under the Australian Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 2.1, Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008), the distance to an unweighted per-pulse SEL of 160 dB re 1 µPa^2·s is reported as both:

a. Maximum-over-depth value for entire water column
b. Maximum-over-depth value for depths ≤600 m.

2.1. Marine Mammals

The criteria applied in this study to assess possible effects of airgun noise on marine mammals are summarised in Table 8 and detailed in Sections 2.1.2 and 2.1.3, with frequency weighting explained in Section 2.1.1 and Appendix A.2.

Table 8. The SPL (unweighted, L_p, and LF-weighted, $L_{p,\,LF}$) SEL_{24h} ($L_{E,24h}$) and PK (L_{pk}) thresholds for acoustic effects on marine mammals. Injury is defined as permanent threshold shift (PTS).

Hearing group	Behaviour	NMFS (2018)			
		PTS onset thresholds* (received level)		TTS onset thresholds* (received level)	
	SPL (dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,\,24}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,\,24}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	160 (L_p) (NMFS 2013)	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
High-frequency cetaceans		155	202	140	196
Phocid pinnipeds in water		185	218	170	226
Otariid pinnipeds in water		203	232	188	212
Migrating and calving SRW	Modified Wood et al. (2012) – See Table 9	Refer to Low-frequency cetaceans			

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
L_{pk}, flat–peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa
L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa²s
Subscripts indicate the designated marine mammal auditory weighting.

2.1.1. Marine mammal weighting functions

The potential for anthropogenic sounds to impact marine mammals is largely dependent on whether the sound occurs at frequencies that an animal can hear well, unless the sound pressure level is so high that it can cause physical tissue damage regardless of frequency. Auditory (frequency) weighting functions reflect an animal's ability to hear a sound (Nedwell and Turnpenny 1998, Nedwell et al. 2007). Auditory weighting functions have been proposed for marine mammals, specifically associated with PTS thresholds expressed in metrics that consider what is known about marine mammal hearing (e.g., SEL (L_E)) (Southall et al. 2007, Erbe et al. 2016, Finneran 2016). Marine mammal auditory weighting functions published by Finneran (2016) are included in the NMFS 2018 Technical Guidance for use in conjunction with corresponding PTS (injury) onset acoustic criteria.

The application of marine mammal auditory weighting functions emphasises the importance of making measurements and characterising sound sources in terms of their overlap with biologically-important frequencies (e.g., frequencies used for environmental awareness, communication or the detection of predators or prey), and not only the frequencies of interest or concern for the completion of the sound-producing activity (i.e., context of sound source; NMFS 2018).

2.1.2. Behavioural response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016). Because of the complexity and variability of marine mammal behavioural responses to acoustic exposure, NMFS has not yet released technical guidance on behaviour thresholds for use in calculating animal exposures (NMFS 2018). The NMFS currently uses a step function to assess behavioural impact. A 50% probability of inducing behavioural responses at a SPL of 160 dB re 1 µPa was derived from the HESS (1999) report which, in turn, was based on the responses of migrating mysticete whales to airgun sounds (Malme et al. 1983, Malme et al. 1984). The HESS team recognized that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above a SPL of 140 dB re 1 µPa. An extensive review of behavioural responses to sound was undertaken by Southall et al. (2007, their Appendix B). Southall et al. (2007) found varying responses for most marine mammals between a SPL of 140 and 180 dB re 1 µPa, consistent with the HESS (1999) report, but lack of convergence in the data prevented them from suggesting explicit step functions. Absence of controls, precise measurements, appropriate metrics, and context dependency of responses (including the activity state of the animal) all contribute to variability. Therefore, unless otherwise specified, the relatively simple sound level criterion for potentially disturbing a marine mammal applied by NMFS has been used. For impulsive sounds, this threshold is 160 dB re 1 µPa SPL for cetaceans (NMFS 2013).

Wood et al. (2012) proposed a graded probability of response for impulsive sounds using a frequency weighted SPL metric. They defined behavioural response categories for sensitive species (including harbor porpoise and beaked whales) and for migrating mysticetes. The migrating mysticete category has been applied in this analysis to Southern Right Whales, in particular within the calving and calving buffer BIAs, but also during migration, to assess behavioural response to impulsive sounds (Table 9). The Wood et al. (2012) approach has been updated to consider the frequency weighting from NMFS (2018).

Table 9. Behavioural exposure criteria used in this analysis for calving and migrating SRW Probability of behavioural response frequency-weighted sound pressure level (SPL dB re 1 µPa). Probabilities are not additive. Adapted from Wood et al. (2012).

Probability of response to frequency-weighted SPL (dB re 1 µPa)		
120	140	160
10%	50%	90%

2.1.3. Injury and hearing sensitivity changes

There are two categories of auditory threshold shifts or hearing loss: permanent threshold shift (PTS), a physical injury to an animal's hearing organs and Temporary Threshold Shift (TTS), a temporary reduction in an animal's hearing sensitivity as the result of receptor hair cells in the cochlea becoming fatigued.

To assist in assessing the potential for injuries to marine mammals this report applies the criteria recommended by NMFS (2018), considering both PTS and TTS, to help assess the potential for injuries to marine mammals. Appendix A provides more information about the NMFS (2018) criteria.

2.2. Fish, Turtles, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and turtles, work begun by a NOAA panel two years earlier. The resulting guidelines included specific thresholds for different levels of effects and for different groups of species (Popper et al. 2014). These guidelines defined quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- TTS

Masking and behavioural effects were assessed by Popper et al (2014) only qualitatively, by assessing relative risk rather than by specific sound level thresholds. These effects are not assessed in this report. Because the presence or absence of a swim bladder and ancilliary structures has a role in hearing in fish, their susceptibility to hearing related injury from noise exposure varies depending on the species and anatomy. Accordingly, , Popper et al (2014) suggested different thresholds for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae were considered separately.

Table 10 lists relevant effect thresholds suggested by Popper et al. (2014). In general, any adverse effects of seismic sound on fish behaviour depends on the species, the state of the individuals exposed, and other factors. Despite mortality being a possible outcome for fish exposed to airgun sounds, Popper et al. (2014) do not reference this effect occurring, but since that time, newer studies have further examined that question. Popper et al. (2016) added further information to the possible levels of impulsive seismic airgun sound to which adult fish can be exposed without immediate mortality. They found that the two fish species in their study, with individual body masses in the range 200–400 g, exposed to a maximum received level of either 231 dB re 1 µPa (PK) or 205 dB re 1 µPa^2·s (per-pulse SEL), remained alive for 7 days after exposure and that the probability of mortal injury did not differ between exposed and control fish.

The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, a period of time must be defined. For marine mammals, following the Southall et al. (2007) criteria, the period is 24 h or the duration of the activity, whichever is shorter. Popper et al. (2014) recommended a standard period of time should be applied, where this is either defined as a justified fixed period or the duration of the activity, however they also included caveats about the length of time to which fish could be exposed because fish and sources can move or remain stationary. When Popper et al. (2014) discuss their criteria, they refer to complications determining a relevant period for mobile seismic surveys and mobile or site-attached fish, because the received levels at the fish change between impulses due to the mobile source, and that in reality a revised guideline based on the closest PK or the per-pulse SEL might be more useful than one based on accumulated SEL. This is because exposures at the closest point of approach are the primary contributors to a receiver's accumulated level (Gedamke et al. 2011). Additionally, several important factors determine the likelihood and duration a receiver is expected to be very close to a sound source (i.e., overlap in space and time between the source and receiver). For example, accumulation time for mobile sources moving fast relative to the receiver is driven primarily by the source's characteristics (i.e., speed, duty cycle) (NMFS 2018).

Popper et al. (2014) summarise that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours. Due to this, a period of accumulation of 24 h has been applied in this study for SEL, which is similar to that applied for marine mammals in Southall et al. (2007) and NMFS (2018).

Table 10. Criteria for seismic noise exposure for fish and turtles, adapted from Popper et al. (2014).

Type of animal	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL_{24h} or > 213 dB PK	> 216 dB SEL_{24h} or > 213 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Turtles	210 dB SEL_{24h} or > 207 dB PK	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	> 210 dB SEL_{24h} or > 207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: Peak sound level (PK) dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s. All criteria are presented as sound pressure, even for fish without swim bladders, since no data for particle motion exist. Relative risk (high, moderate, or low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

2.2.1. Turtle Behavioural Response

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. McCauley et al. (2000) observed the behavioural response of caged turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 µPa (SPL), the turtles increased their swimming activity and above 175 dB re 1 µPa they began to behave erratically, which was interpreted as an agitated state. The 166 dB re 1 µPa level has been used as the threshold level for a behavioural disturbance response by NMFS and applied in the Arctic Programmatic Environment Impact Statement (PEIS) (NSF 2011). At that time, and in the absence of any data from which to determine the sound levels that could injure an animal, TTS or PTS onset were considered possible at an SPL of 180 dB re 1 µPa (NSF 2011). Some additional data suggest that behavioural responses occur closer to an SPL of 175 dB re 1 µPa, and TTS or PTS at even higher levels (Moein et al. 1995), but the received levels were unknown and the NSF (2011) PEIS maintained the earlier NMFS criteria levels of 166 and 180 dB re 1 µPa (SPL) for behavioural response and injury, respectively. Popper et al. (2014) suggested injury to turtles could occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 µPa^2·s (SEL_{24h}) (Table 10). Sound levels defined by Popper et al. (2014) show that animals are very likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of metres), and a low response if they are far (thousands of meters) from the airgun. Both the NMFS criteria for behavioural disturbance (SPL of 166 dB re 1 µPa) and the Popper et al. (2014) injury criteria were included in this analysis, although the analysis did not consider the ranges at which an animal could suffer impairment, as defined by Popper et al. (2014).

3. Methods

This section details the methodology for predicting source levels, modelling sound propagation, and assessing distances to the selected impact criteria.

3.1. Acoustic Source Model

The source levels and directivity of the airgun array were predicted with JASCO's Airgun Array Source Model (AASM), which accounts for:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

The array was modelled over AASM's full frequency range, up to 25 kHz. Details of the model are described in Appendix B.

3.2. Sound Propagation Models

Four sound propagation models (Appendix C) were used to predict the acoustic field around the airgun array for frequencies from 5 Hz to 25 kHz:

- Range-dependent parabolic equation model (Marine Operations Noise Model, MONM)
- Range-dependent ray tracing model (BELLHOP)
- Full Waveform Range-dependent Acoustic Model (FWRAM)
- Wavenumber integration model (VSTACK).

The models were used in combination to characterise the acoustic fields at short and long ranges in terms of SEL, SPL, PK, and PK-PK.

3.3. Parameter Overview

The specifications of the airgun array source modelled at all sites and the environmental parameters used in the propagation models are described in detail in Appendix D.

The airgun array under consideration for the proposed Duntroon MSS is a 8.8 × 16.8 m 3260 in^3 seismic array consisting of two strings towed at a depth of 7 m, Figure D-4, Table D-2. The firing pressure will be 2000 psi.

A single sound speed profile that provided the greatest propagation across the period January to May and September to November was applied, which occurs during the month of May.

3.4. Accumulated SEL

3.4.1. Method overview

During a seismic survey, a new portion of sound energy is introduced into the environment with each pulse from the airgun array. While some impact criteria are based on per-pulse energy released, others, such as the marine mammal SEL criteria used in this report (Section 2.1) consider the total acoustic energy marine fauna is subjected to over 24 hours. An accurate assessment of the cumulative acoustic field depends not only on the parameters of each impulse, but also on the number of impulses delivered over a period and the relative position of the impulses.

When there are many seismic pulses, it becomes computationally prohibitive to perform sound propagation modelling for every single event. The offset between the consecutive seismic impulses is small enough, however, that the environmental parameters that influence sound propagation are virtually the same for many impulse points. The acoustic fields can, therefore, be modelled for a subset of seismic pulses and estimated at several adjacent ones. After sound fields from representative impulse locations are calculated, they are adjusted to account for the source position for nearby impulses.

Although estimating the cumulative sound field with the described approach is not as precise as modelling sound propagation at every impulse location, small-scale, site-specific sound propagation features tend to blur and become less relevant when sound fields from adjacent impulses are summed. Larger scale sound propagation features, primarily dependent on water depth, dominate the cumulative field. The accuracy of the present method acceptably reflects those large-scale features, thus providing a meaningful estimate of a wide area SEL field in a computationally feasible framework.

3.4.2. Scenario definition

Because modelling the thousands of impulses needed to represent 24 hours of seismic operation is time consuming, we estimated the acoustic fields based on nine per-pulse model sites from representative source locations; these formed the library of representative footprints. The survey lines within the 24-hour exposure calculation were segmented into zones by classifying impulse points into one of nine representative sites based on geographic similarity (Figure 3). One scenario, which represents possible methods for acquisition because the design is not yet finalised, was defined to assess accumulated SEL over 24 hours of seismic operation along the supplied survey lines.

To produce maps of cumulative received sound level distribution and calculate distances to specified maximum over depth sound level thresholds, the sound level was calculated at a subset of points within the modelled region. The radial grids of sound levels of the modelled sites at each point were then resampled (by linear triangulation) to produce a regular Cartesian grid. These grids were transposed geographically to each impulse location along the survey lines, based on similar water depths at the modelled location and at the impulse location. The sound field grids from all impulses were summed, using Equation A-6, to produce the cumulative sound field grid. The produced grids had a cell size of 50 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields.

We postulated a scenario in which the vessel travelled along Lines 1 and 2 (Figure 1) over 24 hr at a speed of 7.78 km/h (4.2 knots), which conforms to the PGS specifications of an impulse every 16.67 m. The model estimated 8681 seismic events occurred over this period. This period conforms with the requirements of the NMFS (2018) criteria, and is considered sufficient to assess the accumulated sound fields in relation to the adjacent BIAs. The resulting ranges to the relevant thresholds equal the maximum range calculated over 24 hours.

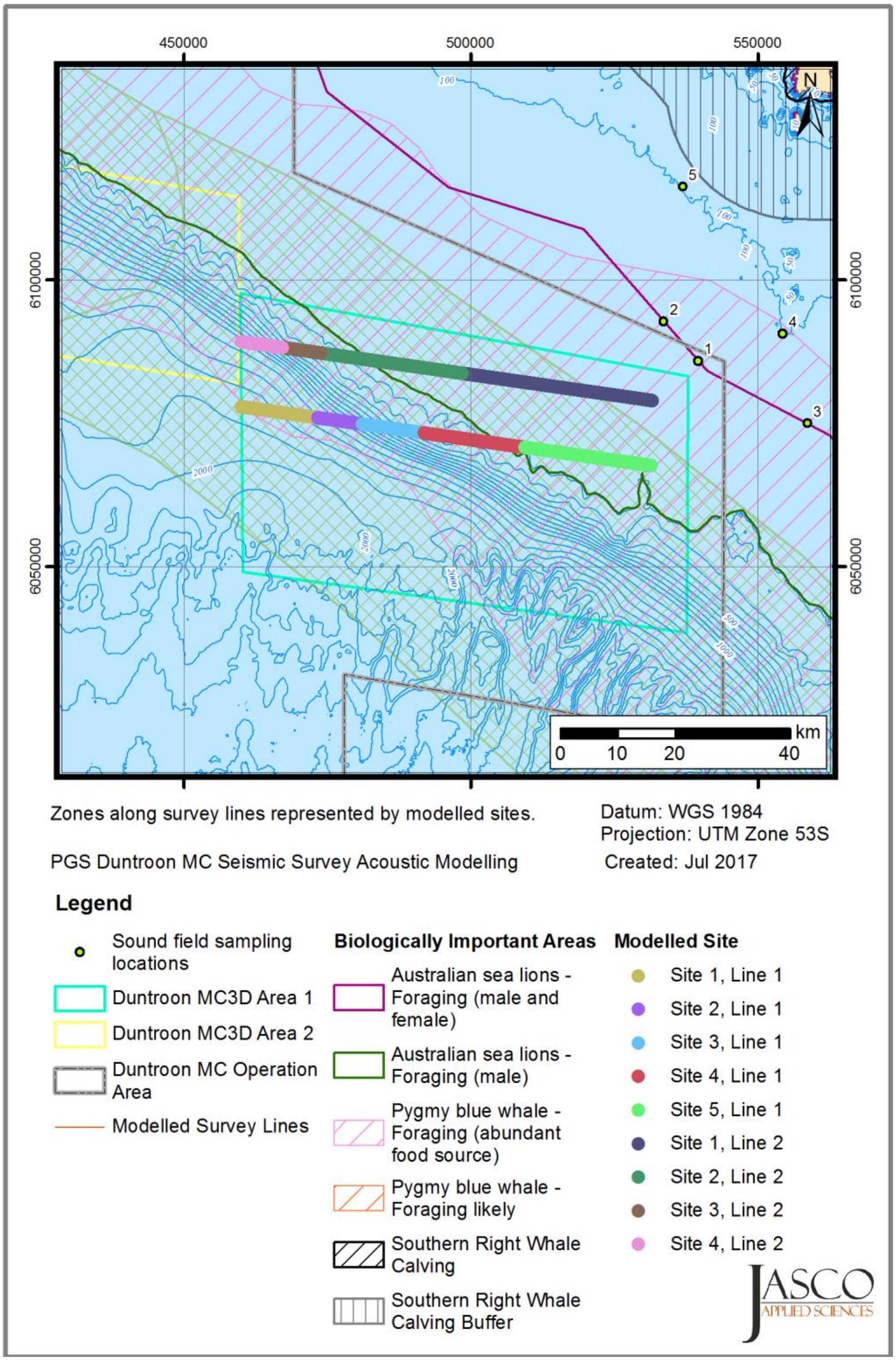

Figure 3. Overview of zones along the modelled survey lines represented by the nine modelled sites.

3.5. Geometry and Modelled Regions

The sound fields were modelled using MONM and BELLHOP models up to distances of 100 km from the source, with a 20 m horizontal separation between receiver points along the modelled radials. Sound fields were modelled with a horizontal angular resolution of $\Delta\theta = 2.5°$ for a total of $N = 144$ radial planes. Receiver depths were chosen to span the entire water column over the modelled areas, from 1 m to a maximum of 5000 m, depending upon the site, with step sizes increasing with depth.

Full waveform model FWRAM was run to a distance of 10 km, with a range step of 20 m, along three radials (each broadside and aft endfire directions) for computational efficiency. The model ran from 5 to 1024 Hz in 0.5 Hz steps to provide a 2 second time-domain window for pulse analysis. This was done to compute SEL-to-SPL conversion functions (Appendix D.2). FWRAM was also used to model the PK levels in the water column.

The nearfield full-waveform model VSTACK was used to model both seafloor PK and PK-PK levels. The maximum modelled range for VSTACK was 500 m. Because VSTACK assumes constant bathymetry, radials were only run in four directions (endfire: fore and aft; broadside: port and starboard). Received levels were computed for test receivers on the seafloor.

4. Results

This section presents the model results as distances to sound level thresholds and as sound field contour maps.

4.1. Acoustic Source Levels and Directivity

The pressure signatures of the individual airguns and the composite 1/3-octave-band point-source equivalent directional levels of the arrays were modelled with AASM (Section 3.1). Although AASM accounts for the effects of surface-reflected signals on bubble oscillations and inter-bubble interactions in the notional pressure signatures of each airgun, the signal reflected off the water surface (known as surface ghost) is not included in the far-field source signatures; however, the acoustic propagation models account for those surface reflections because they are a property of the propagating medium rather than the source.

The horizontal and vertical overpressure signatures, corresponding power spectrum levels, and the horizontal directivity plots for the array is provided in Appendix B.2.

To help compare these results to the outputs of other airgun array source models, Table 11 presents the vertical source level that accounts for the surface ghost, and lists the broadband PK, and per-pulse SEL source levels of the array in the endfire, broadside, and vertical directions.

Table 11. Source level specifications in the horizontal plane for the 3260 in^3 array, for a 7 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$) (dB re 1 µPa^{2}m^2)	Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa^{2}m^{2}s)		
		10–2000 Hz	2000–25000 Hz	10–25000 Hz
Broadside	249.5	224.9	186.9	224.9
Endfire	246.2	223.5	186.9	223.5
Vertical (no ghost)	255.6	228.6	194.6	228.6
Vertical (with ghost)	255.6	231.1	197.5	231.1

4.2. Single Pulse Sound Fields

Single pulse sound fields were modelled at:

- Ten sites along two possible survey lines in in 3-D Survey Area 1 (Table 2).
- Two sites in in 3-D Survey Area 2 (Table 3).
- Four sites relevant to seafloor PK and PK-PK metrics (Table 7).

Distances to isopleths for maximum-over-depth per-pulse SEL and SPL are presented in Tables 12 and 14, and Tables 13 and 15 respectively. The maximum-over-depth LF-weighted SPL isopleths from Line 2 Site 5 are presented in Table 16. Table 17 presents distances to the PK thresholds based on the NOAA Technical Guidance (NMFS 2018). The SPL at the Neptune Islands and the SRW BIAs from the closest per-pulse modelled site are presented in Table 18, with LF-weighted SPLs at the boundaries of the SRW BIAs shown in Table 19.

To assist with the assessment of sound levels received by marine fauna in the upper 600 m of the water column, maximum-over-depth results, where the depth range is restricted to the upper 600 m, are presented for per-pulse SEL and SPL in Tables 21 and 23, Tables 22 and 24 respectively. The ensonified area for SPL footprints for both the entire water column and depths less than or equal to

600 m for the 170, 160, and 150 dB re 1 µPa isopleths are presented in Table 25 (3-D Survey Area 1) and Table 27 (3-D Survey Area 2), with differences provided in Table 26 for 3-D Survey Area 1. Distances to seafloor PK and PK-PK metrics were determined through considering the four broadside and endfire transects, and the results are presented in Tables 28 and 29.

Considering 3-D Survey Area 1, Figures 4–11 show example maps of maximum-over-depth sound level in per-pulse SEL and SPL for:

- A site in deep water (Site 1, Line 1),
- The site with the largest 160 dB re 1 µPa R_{max} (Site 2, Line 1),
- A site on the continental shelf edge (Site 4, Line 1), and
- A site on the continental shelf (Site 1, Line 2).

Corresponding vertical slices of the estimated sound fields for per-pulse SEL and SPL are shown in Figures 18–23, which demonstrate the distribution of sound in the water column in the broadside and endfire directions. The sound fields in the offshore broadside direction at longer ranges are shown in a vertical slice of per-pulse SEL for Site 2, Line 1 (Figure 24), and SPL for Site 3, Line 2 (Figure 25).

Maps for the two additional modelling sites in 3-D Survey Area 2 are shown in Figures 12–15, with associated vertical slice plots in Figures 26–30. The sound fields in the offshore broadside direction at longer ranges are shown in a vertical slice of per-pulse SEL for Site A (Figure 31).

A map for an additional modelling site in the 3-D Survey Area 1 closest to the SRW BIAs (Site 5, Line 2) is shown in Figure 16. The map shows that the levels within the BIAs are below 140 dB re 1µPa, with levels at the BIA boundaries shown in Table 18. The LF-weighted SPL sound fields at this site are shown in Figure 17, with levels at the BIA boundaries shown in Table 19.

The decay of seafloor PK and PK-PK as the distance from the source increases are shown in Figures 38 and 39. These figures show the maximum predicted level from each of the four modelled transects, one in each of the broadside and endfire directions.

4.2.1. Tabulated Results

4.2.1.1. Entire water column

Table 12. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth per-pulse SEL isopleths from the nine modelled single-shot sites (five sites along Line 1; four sites along Line 2). The tow direction is 098° along Line 1 and 278° along Line 2. The 160 dB re 1 µPa²·s isopleth (bold values) is associated with the DEWHA (2008) criterion.

Per-pulse SEL (L_E; dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Line 1	**1496 m**		**1001 m**		**501 m**		**164 m**		**135 m**	
190	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
180	0.16	0.13	0.16	0.13	0.16	0.13	0.17	0.15	0.18	0.16
170	0.51	0.42	0.52	0.42	0.53	0.47	0.83	0.68	1.03	0.70
160†	**1.75**	**1.54**	**3.20**	**2.52**	**2.88**	**2.29**	**4.00**	**2.98**	**4.47**	**3.50**
150	9.12	7.26	20.17	11.86	13.94	10.75	10.06	8.16	11.60	9.55
140	43.51	31.95	74.48	47.52	88.48	69.88	60.16	47.22	24.62	18.43
130	108	91.81	137	109	141*	113*	141*	114*	91.24	64.35
Line 2	**127 m**		**141 m**		**348 m**		**747 m**			
190	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06		
180	0.18	0.17	0.18	0.16	0.16	0.14	0.16	0.13		
170	1.02	0.88	0.82	0.68	0.94	0.83	0.52	0.42		
160†	**4.12**	**3.48**	**4.32**	**3.33**	**2.51**	**2.06**	**3.18**	**2.45**		
150	11.39	9.31	10.76	8.53	15.97	11.33	17.38	15.54		
140	24.25	19.58	47.58	32.48	101	64.30	70.47	47.84		
130	72.12	39.52	122	104	141*	114*	137	113		

* Radii extend beyond modelling boundary.
† Low power zone assessment criteria DEWHA (2008).

Table 13. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth SPL isopleths from the nine modelled single-shot sites (five sites along Line 1; and four sites along Line 2) The tow directions for Line 1 is 098° and 278° along Line 2.

SPL (L_p; dB re 1 µPa)	Site 1		Site 2		Site 3		Site 4		Site 5	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Line 1	**1496 m**		**1001 m**		**501 m**		**164 m**		**135 m**	
190	0.14	0.12	0.14	0.12	0.14	0.12	0.15	0.12	0.15	0.14
180	0.45	0.36	0.45	0.37	0.46	0.38	0.76	0.63	0.72	0.60
170	1.42	1.24	2.68	2.20	2.59	2.07	3.24	2.46	3.63	2.80
166†	**4.45**	**3.57**	**4.43**	**3.46**	**3.58**	**2.82**	**4.89**	**3.81**	**5.38**	**4.32**
160‡	**7.60**	**6.08**	**11.89**	**9.78**	**10.77**	**6.48**	**7.87**	**6.32**	**9.09**	**7.38**
150	37.84	28.29	48.94	42.21	60.53	45.60	38.25	32.07	19.24	14.62
140	107	89.89	133	100	141*	114*	128	103	65.85	38.56
130	141*	116*	141*	116*	141*	118*	141*	115*	141*	109*
Line 2	**127 m**		**141 m**		**348 m**		**747 m**			
190	0.16	0.14	0.15	0.14	0.14	0.12	0.14	0.12		
180	0.73	0.61	0.72	0.60	0.84	0.44	0.45	0.37		
170	3.61	2.86	3.59	2.82	2.28	1.80	2.75	2.11		
166†	**5.13**	**4.30**	**5.30**	**4.17**	**3.69**	**2.96**	**4.16**	**3.33**		
160‡	**8.71**	**7.16**	**8.71**	**6.81**	**11.05**	**6.67**	**12.75**	**6.25**		
150	20.36	16.32	33.92	20.63	59.16	42.25	54.60	43.47		
140	43.02	34.41	106	94.12	141*	114*	132	108		
130	114	92.61	141*	113*	141*	119*	141*	118*		

* Radii extend beyond modelling boundary.
† Threshold for turtle behavioural response to impulsive noise (NSF 2011).
‡ Marine mammal behavioural threshold for impulsive sound sources (NMFS 2013).

Table 14. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth per-pulse SEL isopleths from the two modelled sites in 3-D Survey Area 2, and Line 2 Site 5 from 3-D Survey Area 2. (Tables 2 and 3).

Per-pulse SEL (L_E; dB re 1 µPa²·s)	Site A 496 m depth		Site B 950 m depth		Line 2, Site 5 128 m depth	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.06	0.06	0.06	0.06	0.61	0.60
180	0.16	0.13	0.16	0.13	0.19	0.16
170	0.56	0.48	0.51	0.42	1.05	0.90
160†	**2.78**	**2.23**	**3.03**	**2.52**	**4.11**	**3.50**
150	13.86	12.36	11.83	9.43	21.37	16.53
140	69.07	49.64	48.69	37.85	40.82	33.79
130	128	106	106	90.22	106.52	89.39

† Low power zone assessment criteria DEWHA (2008).

Table 15. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth SPL isopleths from the two modelled sites in 3-D Survey Area 2, and Line 2 Site 5 in 3-D Survey Area 2 (Tables 2 and 3).

SPL (L_p; dB re 1 µPa)	Site A 496 m depth		Site B 950 m depth		Line 2, Site 5 128 m depth	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.14	0.12	0.14	0.12	0.16	0.14
180	0.46	0.40	0.45	0.37	0.74	0.62
170	2.55	1.99	2.66	2.28	3.31	2.87
166†	**4.00**	**3.31**	**3.84**	**3.17**	**5.03**	**4.25**
160‡	**13.05**	**8.66**	**9.10**	**6.72**	**8.99**	**7.13**
150	65.65	41.90	43.29	32.91	21.37	16.53
140	117	97.73	105	90.18	40.82	33.79
130	141*	119*	141*	119*	107	89.39

* Radii extend beyond modelling boundary.
† Threshold for turtle behavioural response to impulsive noise (NSF 2011).
‡ Marine mammal behavioural threshold for impulsive sound sources (NMFS 2013).

Table 16. LF-weighted SPL: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth LF-weighted SPL isopleths from Line 2 Site 5 in 3-D Survey Area 2 (Table 2).

LF-weighted SPL ($L_{p,LF}$; dB re 1 µPa)	Line 2, Site 5 128 m depth	
	R_{max}	$R_{95\%}$
190	0.08	0.07
180	0.49	0.45
170	1.95	1.61
160*	5.89	5.05
150	16.40	12.85
140‡	34.80	27.92
130	99.30	58.01
120†	120.14	95.77

† 10% probability of response for migrating mysticetes, Wood et al. (2012).
‡ 50% probability of response for migrating mysticetes, Wood et al. (2012).
* 90% probability of response for migrating mysticetes, Wood et al. (2012).

Table 17. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (km) from the 3260 in^3 array to modelled maximum-over-depth peak pressure level (PK) thresholds based on the NOAA Technical Guidance (NMFS 2018) for marine mammals, and Popper et al. (2014) for fish and turtles, at five of the modelling sites (Tables 2 and 3).

Hearing group	PK threshold (L_{pk}; dB re 1 µPa)	Site 1, Line 2		Site 3, Line 2		Site 4, Line 2		Site A		Site B	
		R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Low-frequency cetaceans (PTS)	219	0.03		0.03		0.03		0.03		0.03	
Low-frequency cetaceans (TTS)	213	0.07		0.07		0.07		0.07		0.07	
Mid-frequency cetaceans (PTS)	230	<0.02		<0.02		<0.02		<0.02		<0.02	
Mid-frequency cetaceans (TTS)	224	<0.02		<0.02		<0.02		<0.02		<0.02	
High-frequency cetaceans (PTS)	202	0.45	0.37	0.23	0.19	0.23	0.19	0.23	0.19	0.23	0.19
High-frequency cetaceans (TTS)	196	0.98	0.61	0.60	0.37	0.60	0.38	0.60	0.38	0.60	0.38
Phocid pinnipeds in water (PTS)	218	0.04		0.04		0.04		0.04		0.04	
Phocid pinnipeds in water (TTS)	212	0.07		0.07		0.07		0.07		0.07	
Otariid pinnipeds in water (PTS)	232	<0.02		<0.02		<0.02		<0.02		<0.02	
Otariid pinnipeds in water (TTS)	226	<0.02		<0.02		<0.02		<0.02		<0.02	
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles, fish eggs, and larvae	207	0.14	0.11	0.14	0.11	0.14	0.11	0.14	0.11	0.14	0.11

Table 18. Received maximum-over-depth SPL midway between the Neptune Islands and at the boundaries of the SRW BIAs from the closest modelling sites.

Modelling Site	Location name	Location	Received SPL (L_p; dB re 1 µPa)
Line 2, Site 1	Neptune Islands	35° 17' 0.10" S, 136° 4' 57.60" E	120
Line 2, Site 5	Boundary of SRW Calving Buffer BIA	35° 07' 34.74" S, 135° 31' 02.23" E	137
	Boundary of SRW Calving BIA	34° 57' 17.87" S, 135° 36' 29.65" E	125

Table 19. Received maximum-over-depth LF-weighted SPL at the boundaries of the SRW BIAs from the closest modelling site, Line 2, Site 5, for comparison to the Wood et al. (2012) behavioural exposure criteria.

Location name	Location	Received LF-weighted SPL ($L_{p,LF}$; dB re 1 µPa)
Boundary of SRW Calving Buffer BIA	35° 07' 34.74" S, 135° 31' 02.23" E	132.8
Boundary of SRW Calving BIA	34° 57' 17.87" S, 135° 36' 29.65" E	121.8

Table 20. Maximum (R_{max}) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth 178 dB re 1µPa PK-PK , assessed along the three FWRAM modelling transects (maximum presented) at five of the modelling sites (Tables 2 and 3).

PK-PK (L_{pk-pk}; dB re 1 µPa)	Distance R_{max} (km)				
	Site 1, Line 2	Site 3, Line 2	Site 4, Line 2	Site A	Site B
178	8.05	19.50	19.79	15.50	14.55

4.2.1.2. Depths ≤600 m

Table 21. Depths ≤600 m: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth per-pulse SEL isopleths from the nine modelled sites (five sites along Line 1; four sites along Line 2). The tow direction is 098° along Line 1 and 278° along Line 2.

Per-pulse SEL (L_E; dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Line 1	**1496 m**		**1001 m**		**501 m**		**164 m**		**135 m**	
190	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
180	0.16	0.13	0.16	0.13	0.16	0.13	0.17	0.15	0.18	0.16
170	0.51	0.42	0.52	0.42	0.53	0.47	0.83	0.68	1.03	0.70
160†	**1.71**	**1.39**	**1.78**	**1.44**	**2.25**	**1.81**	**4.00**	**2.98**	**4.47**	**3.50**
150	8.57	7.29	20.17	11.99	13.72	7.50	10.06	8.17	11.60	9.55
140	43.22	28.44	74.48	39.23	64.29	30.39	55.91	39.71	24.62	18.43
130	108	88.91	137	108	140	113	141*	97.92*	73.06	56.95
Line 2	**127 m**		**141 m**		**348 m**		**747 m**			
190	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06		
180	0.18	0.17	0.18	0.16	0.16	0.14	0.16	0.13		
170	1.02	0.88	0.82	0.68	0.94	0.83	0.52	0.42		
160†	**4.12**	**3.48**	**4.32**	**3.33**	**2.41**	**2.00**	**2.31**	**1.95**		
150	11.39	9.31	10.76	8.53	15.97	11.18	17.38	15.69		
140	24.25	19.58	47.58	20.10	62.49	51.93	70.01	47.17		
130	72.12	35.34	108	98.88	141*	110*	134	111		

† Low power zone assessment criteria DEWHA (2008).

Table 22. Depths ≤600 m: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in³ array to modelled maximum-over-depth SPL isopleths from the nine modelled sites (five sites along Line 1; and four sites along Line 2) The tow direction is 098° along Line 1 and 278° along Line 2.

SPL (L_p; dB re 1 µPa)	Site 1		Site 2		Site 3		Site 4		Site 5	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Line 1	**1496 m**		**1001 m**		**501 m**		**164 m**		**135 m**	
190	0.14	0.12	0.14	0.12	0.14	0.12	0.15	0.12	0.15	0.14
180	0.45	0.36	0.45	0.37	0.46	0.38	0.76	0.63	0.72	0.60
170	1.41	1.15	1.44	1.18	1.98	1.58	3.24	2.46	3.63	2.80
166†	**2.25**	**1.87**	**2.64**	**2.16**	**3.09**	**2.61**	**4.89**	**3.81**	**5.38**	**4.32**
160‡	**6.68**	**5.58**	**11.89**	**9.98**	**6.59**	**5.20**	**7.87**	**6.32**	**9.09**	**7.38**
150	34.30	26.62	42.75	32.50	31.16	27.20	38.15	15.83	19.24	14.62
140	107	79.89	133	98.17	136	114	102	94.66	65.85	36.27
130	141*	116*	141*	116*	141*	117*	141*	112*	117	89.73
Line 2	**127 m**		**141 m**		**348 m**		**747 m**			
190	0.16	0.14	0.15	0.14	0.14	0.12	0.14	0.12		
180	0.73	0.61	0.72	0.60	0.84	0.44	0.45	0.37		
170	3.61	2.86	3.59	2.82	2.02	1.71	2.16	1.80		
166†	**5.13**	**4.30**	**5.30**	**4.17**	**3.12**	**2.71**	**2.94**	**2.39**		
160‡	**8.71**	**7.16**	**8.71**	**6.81**	**11.05**	**6.34**	**12.75**	**6.20**		
150	20.36	16.32	17.93	14.25	54.60	40.87	54.60	44.32		
140	40.44	31.57	106	98.33	124	104	132	106		
130	83.48	64.23	119	102	141*	119*	141*	118*		

* Radii extend beyond modelling boundary.
† Threshold for turtle behavioural response to impulsive noise (NSF 2011).
‡ Marine mammal behavioural threshold for impulsive sound sources (NMFS 2013).

Table 23. Depths ≤600 m: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in³ array to modelled maximum-over-depth SEL isopleths from the two modelled sites in 3-D Survey Area 2 (Table 3).

Per-pulse SEL (L_E; dB re 1 µPa²·s)	Site A 496 m depth		Site B 950 m depth	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.06	0.06	0.06	0.06
180	0.16	0.13	0.16	0.13
170	0.56	0.48	0.51	0.42
160†	**2.34**	**1.87**	**1.76**	**1.44**
150	13.86	12.40	11.83	9.89
140	53.86	39.50	45.78	38.20
130	123	98.98	106	87.49

† Low power zone assessment criteria DEWHA (2008).

Table 24. Depths ≤600 m: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3260 in^3 array to modelled maximum-over-depth SPL isopleths from the two modelled sites in 3-D Survey Area 2 (Table 3)

SPL (L_p; dB re 1 µPa)	Site A 496 m depth		Site B 950 m depth	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.14	0.12	0.14	0.12
180	0.46	0.40	0.45	0.37
170	2.01	1.63	1.47	1.23
166†	**3.27**	**2.69**	**2.76**	**2.37**
160‡	**13.05**	**8.70**	**9.10**	**6.63**
150	33.71	30.51	43.29	37.03
140	103	90.89	104	85.71
130	141*	119*	141*	119*

* Radii extend beyond modelling boundary.
† Threshold for turtle behavioural response to impulsive noise (NSF 2011).
‡ Marine mammal behavioural threshold for impulsive sound sources (NMFS 2013).

Table 25. Maximum-over-depth SPL total ensonified area (km^2): entire water column (EWC) and depths ≤600 m from the nine modelled sites Five sites along Line 1; and four sites along Line 2, the area is equivalent to the footprint defined by R_{max}.

SPL (L_p; dB re 1 µPa)	Site 1		Site 2		Site 3		Site 4		Site 5	
	EWC	≤600 m	EWC	≤600 m	EWC	≤600 m	EWC	≤600 m	EWC	≤600 m
Line 1	**1496 m**		**1001 m**		**501 m**		**164 m**		**135 m**	
170	4.7	3.7	9.3	3.8	8.4	6.9	13.1	13.0	16.4	16.4
160	74.4	24.3	72.7	68.4	74.3	64.3	103	103	123	123
150	1121	867	1505	1221	1554	1020	895	552	569	569
Line 2	**127 m**		**141 m**		**348 m**		**747 m**			
170	16.4	16.4	15.6	15.6	7.3	7.1	9.9	4.9		
160	124	124	114	114	78.3	72.7	77.1	66.4		
150	603	603	580	523	1500	1006	1833	1601		

Table 26. Difference in maximum-over-depth SPL ensonified area (km^2) between entire water column and depths ≤600 m from the nine modelled sites (five sites along Line 1; and four sites along Line 2).

SPL (L_p; dB re 1 µPa)	Site 1	Site 2	Site 3	Site 4	Site 5
Line 1	**1496 m**	**1001 m**	**501 m**	**164 m**	**135 m**
170	1.0	5.5	1.5	0	0
160	50.1	4.3	10.0	0	0
150	254	284	534	343	0
Line 2	**127 m**	**141 m**	**348 m**	**747 m**	
170	0	0	0.2	5.0	
160	0	0	5.6	10.7	
150	0	57	494	232	

Table 27. Maximum-over-depth SPL total ensonified area (km^2): entire water column (EWC) and depths ≤600 m from the two modelled sites in 3-D Survey Area 2. The area is equivalent to the footprint defined by R_{max}.

SPL (L_p; dB re 1 µPa)	Site A 496 m (depth)		Site B 950 m (depth)	
	EWC	≤600 m	EWC	≤600 m
170	8.2	7.3	9.4	3.9
160	105	103	97.9	74.9
150	1224	1037	1142	941

4.2.1.3. Seafloor

Table 28. Maximum (R_{max}) horizontal distances (in m) from the 3260 in^3 array to modelled seafloor PK from four transects (Table 7). A dash indicates that the threshold was not reached.

Hearing group/animal type	PK Threshold (L_{pk}; dB re 1 µPa)	Distance R_{max} (m)			
		Site C 200 m	Site D 1099 m	Site E 649 m	Site F 160 m
Fish: No swim bladder (also applied to sharks)	213	-	-	-	28
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles, fish eggs, and larvae	207	123	-	-	150

Table 29. Maximum (R_{max}) horizontal distances (in m) from the 3260 in^3 array to modelled seafloor PK-PK for comparison to results in Payne et al. (2008), and Day et al. (2016a).A dash indicates that the sound level was not reached.

PK-PK (L_{pk-pk}; **dB re 1 µPa)**	**Distance R_{max} (m)**			
	Site C 200 m	Site D 1099 m	Site E 649 m	Site F 160 m
213†	102	-	-	129
212†	130	-	-	159
211†	164	-	-	192
210†	200	-	-	216
209†	243	-	-	238
202‡	718	120	396	669

† Day et al. (2016a).
‡ Payne et al. (2008)

4.2.2. Maps and Graphs

4.2.2.1. Entire water column sound level contour maps

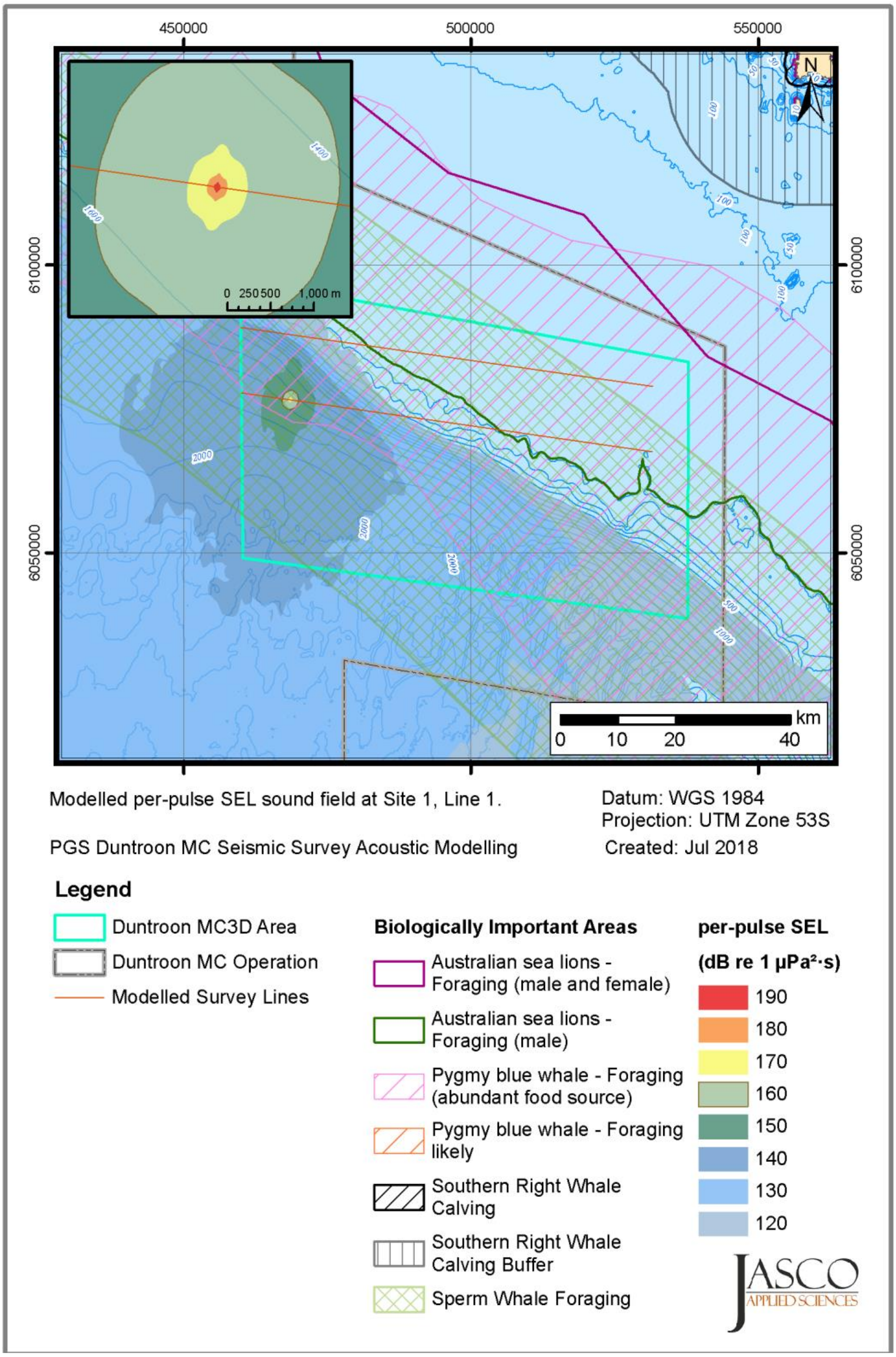

Figure 4. Site 1, Line 1: Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

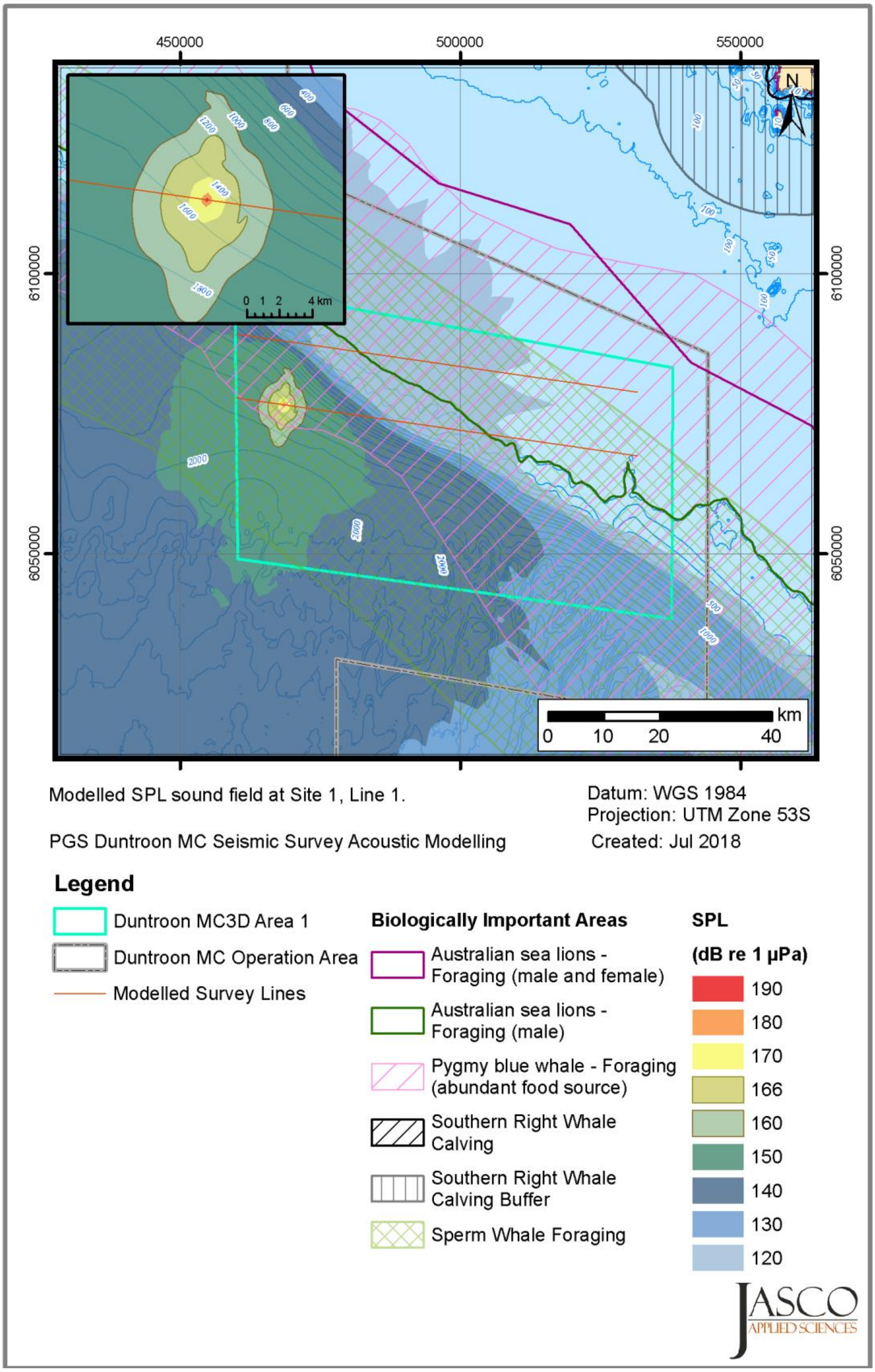

Figure 5. Site 1, Line 1: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

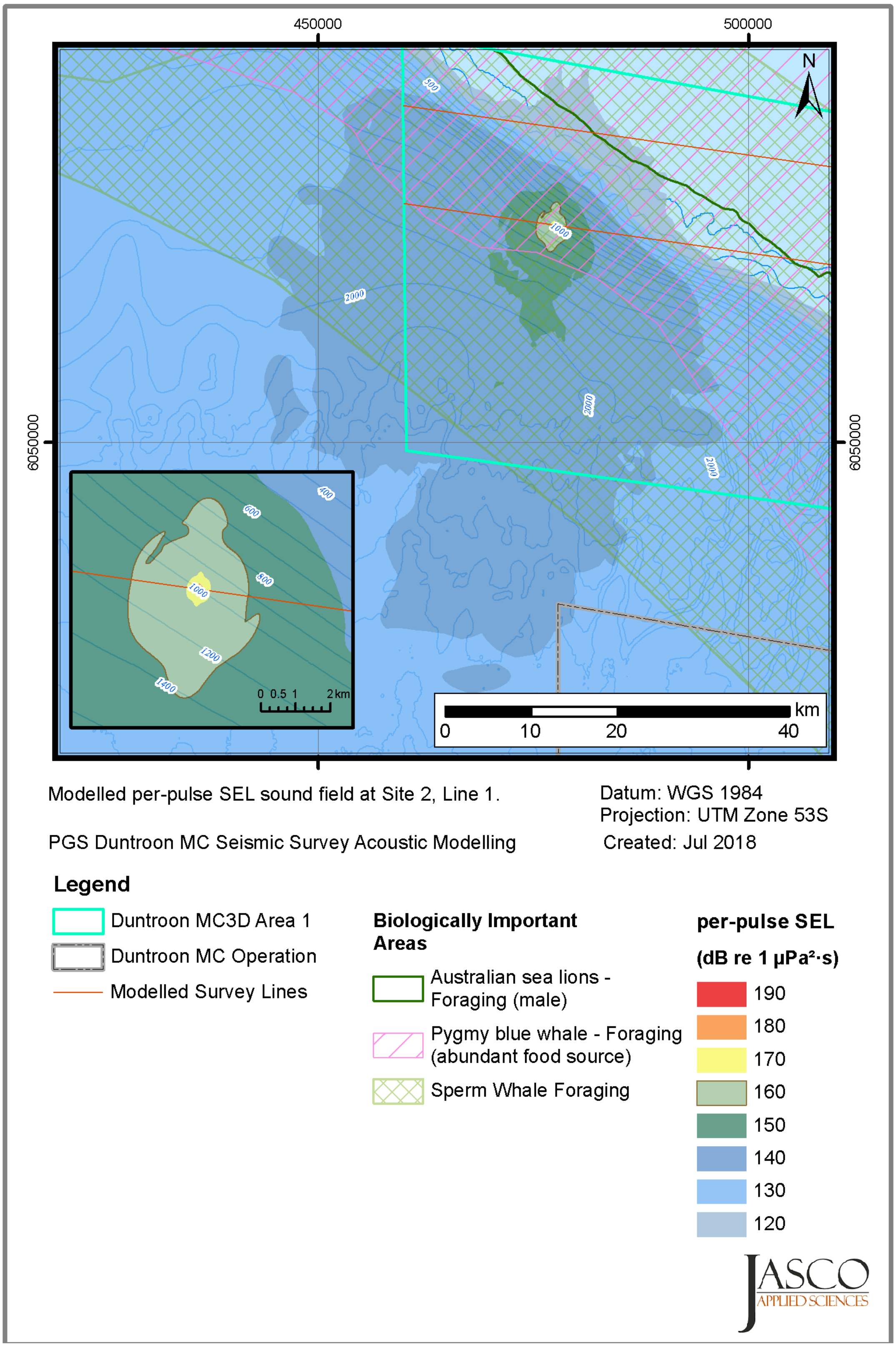

Figure 6. Site 2, Line 1: Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

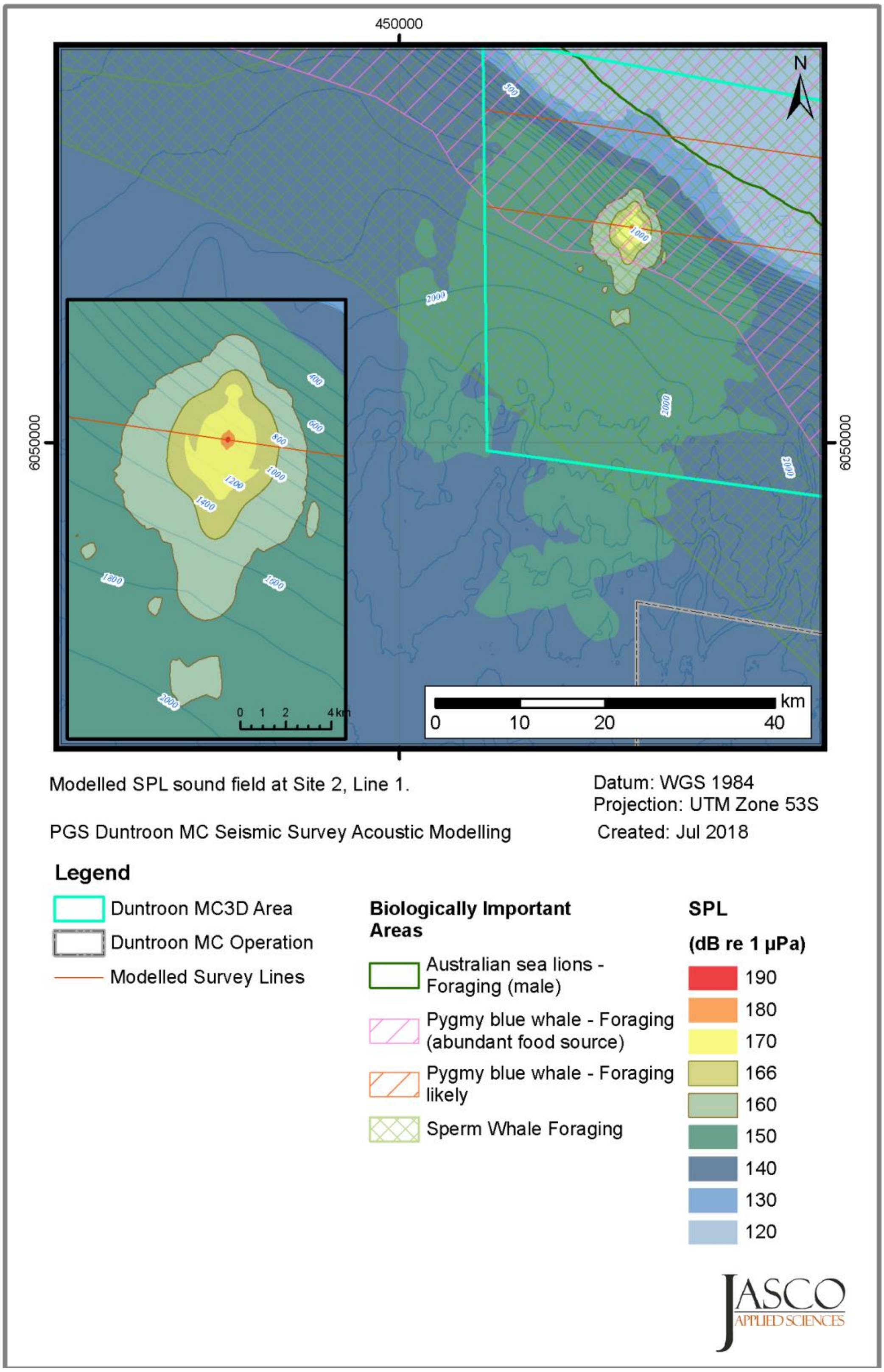

Figure 7. Site 2, Line 1: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

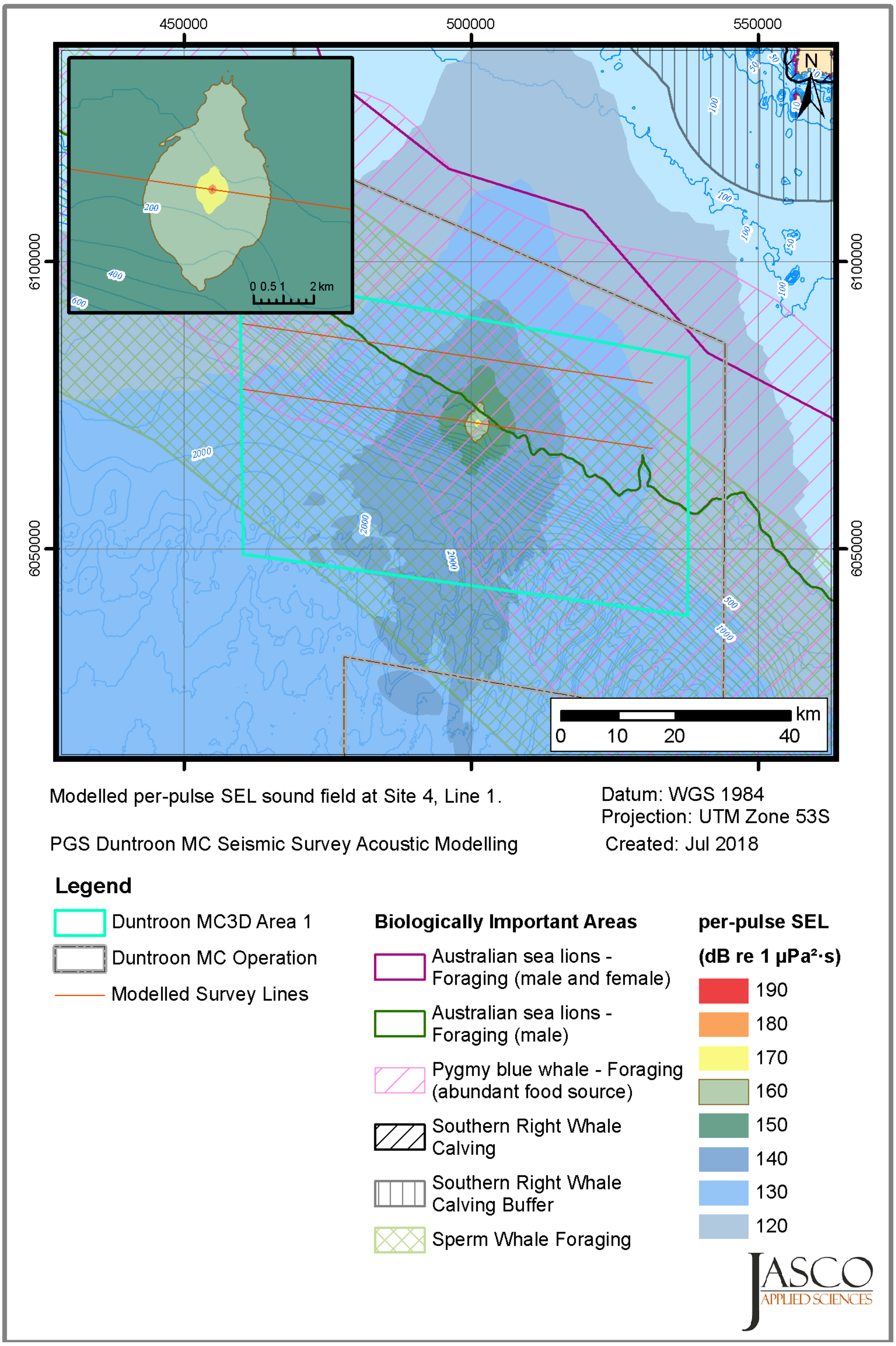

Figure 8. Site 4, Line 1: Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

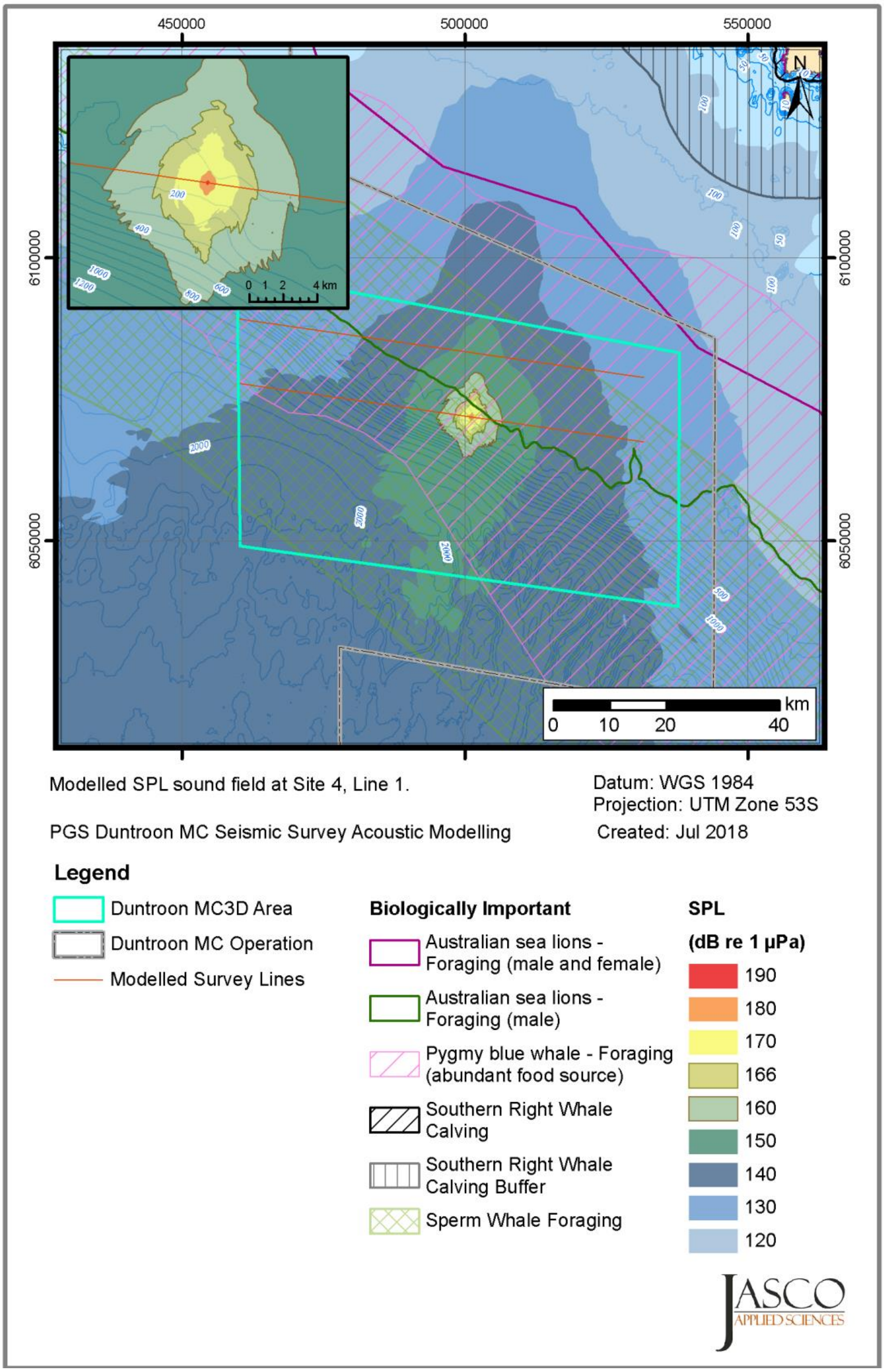

Figure 9. Site 4, Line 1: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

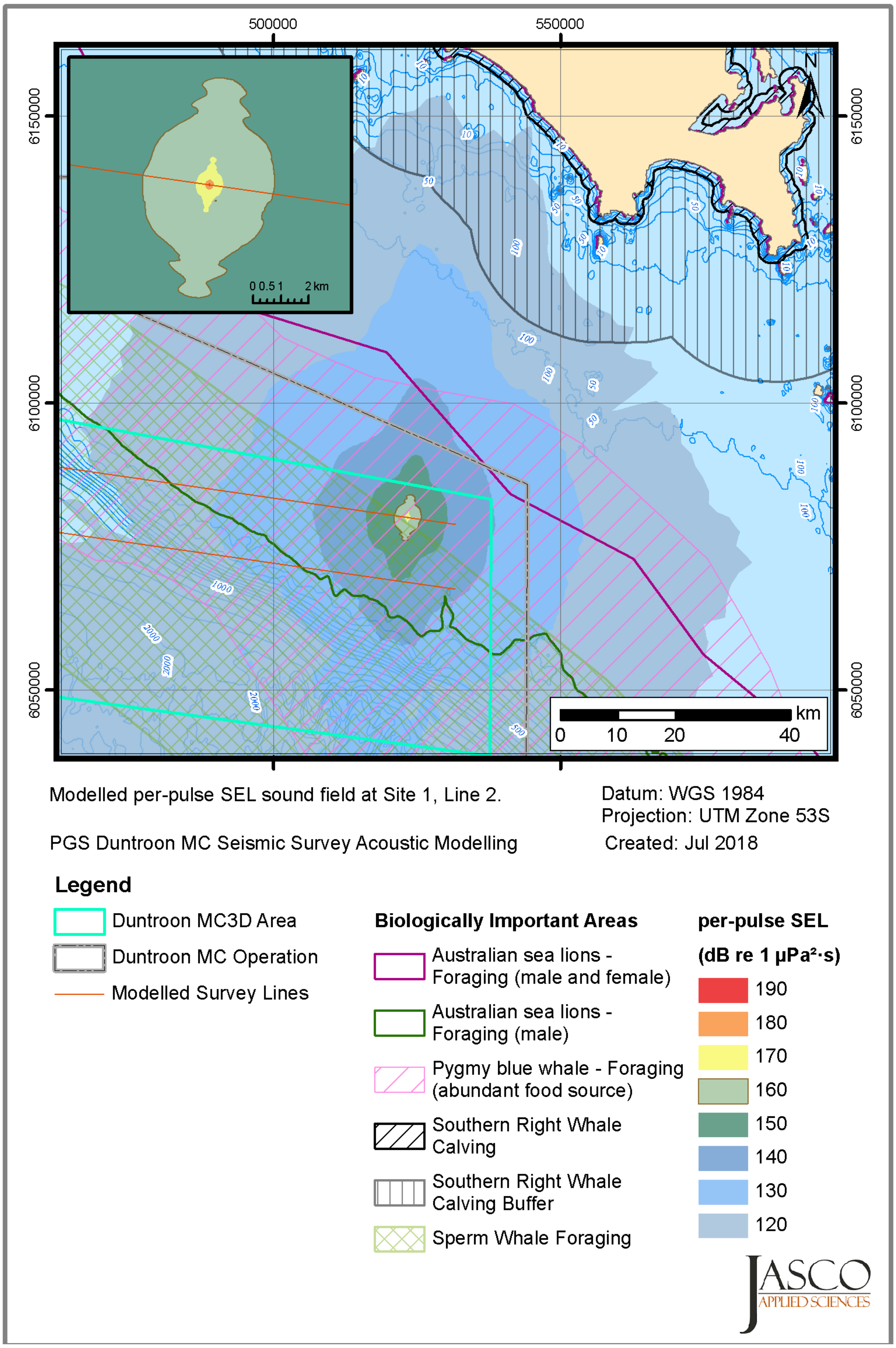

Figure 10. Site 1, Line 2: Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

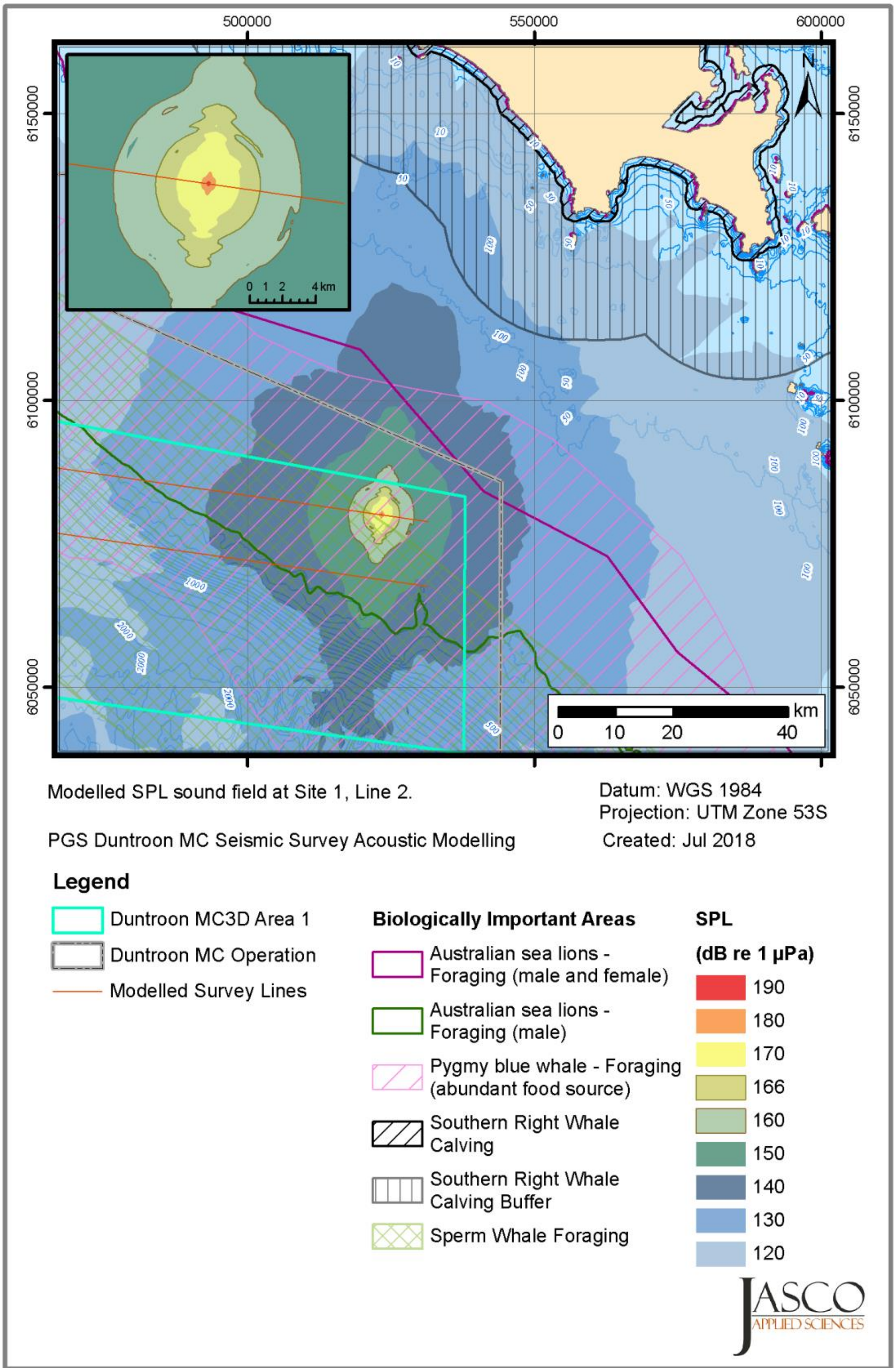

Figure 11. Site 1, Line 2: Sound level contour map showing maximum-over-depth SPL results for the 3260 in^3 array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

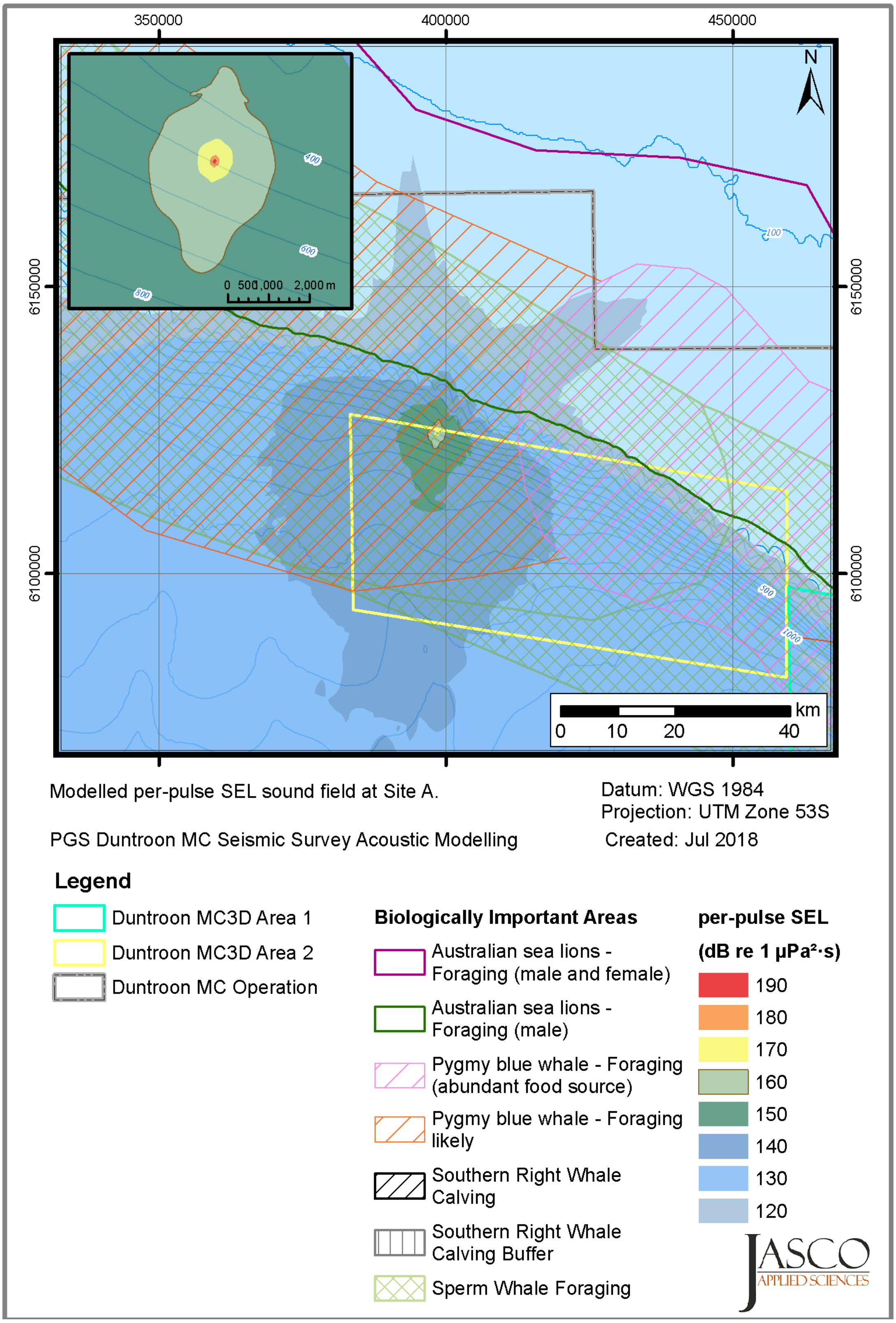

Figure 12. Site A: Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

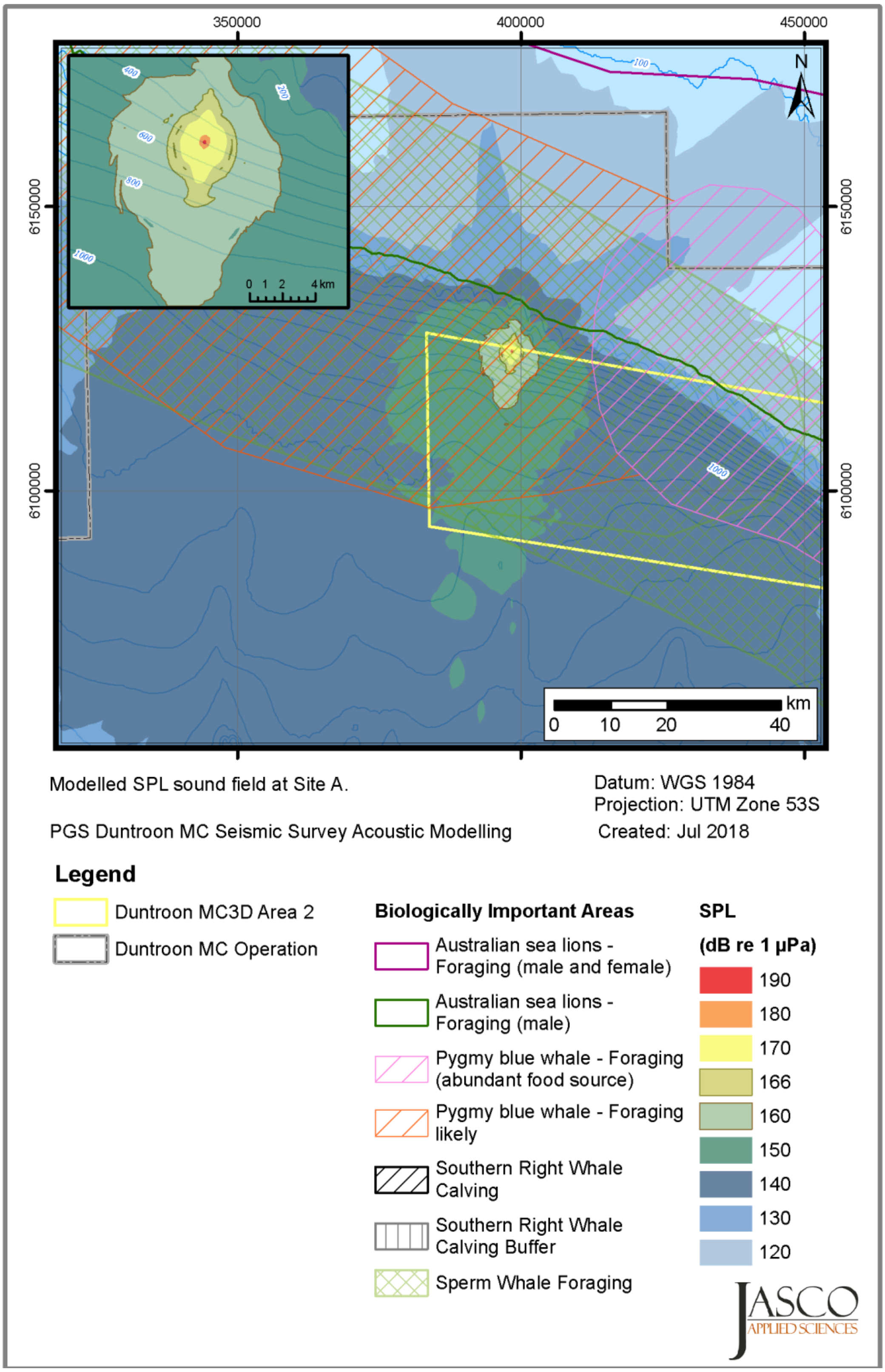

Figure 13. Site A: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

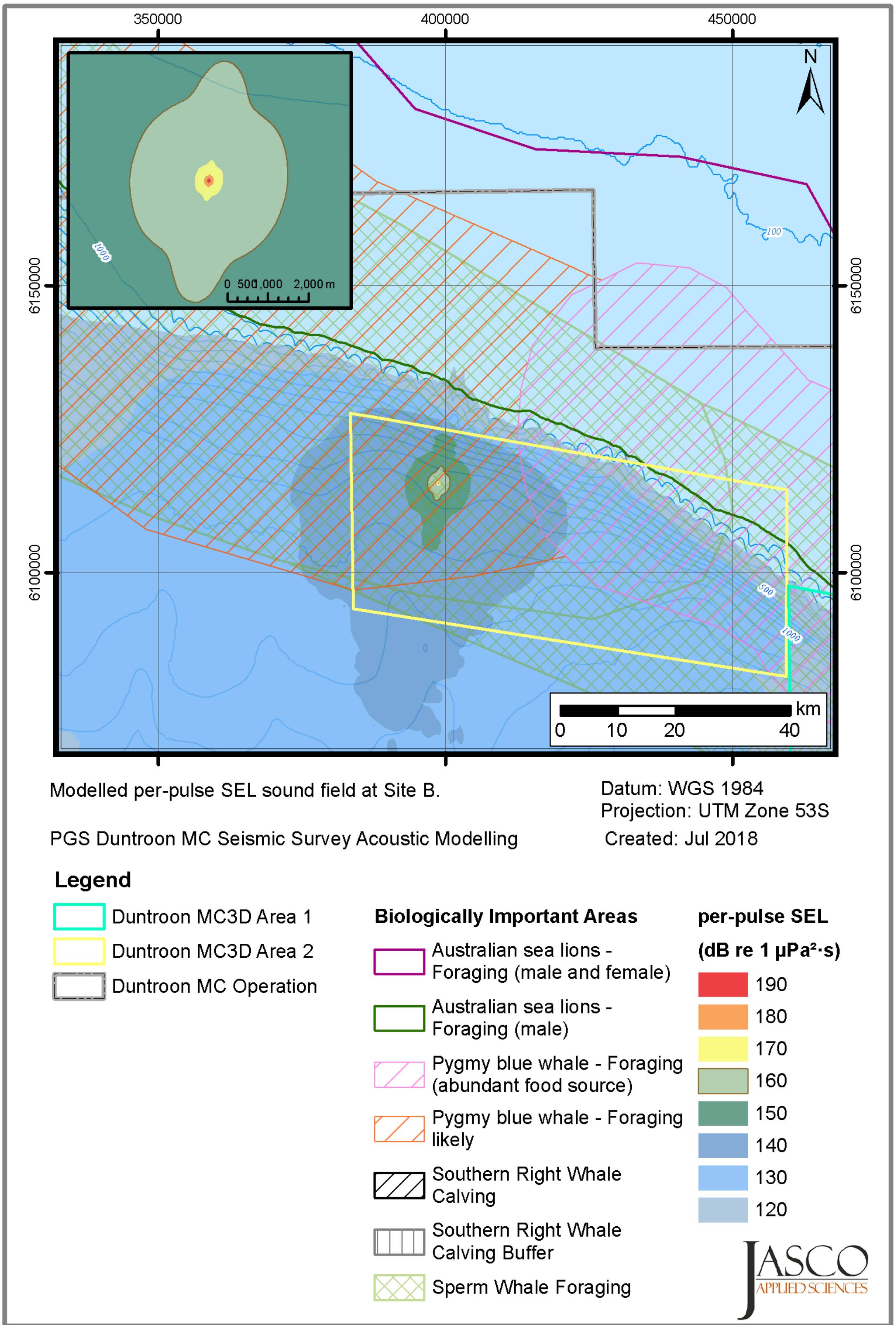

Figure 14. Site B: Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

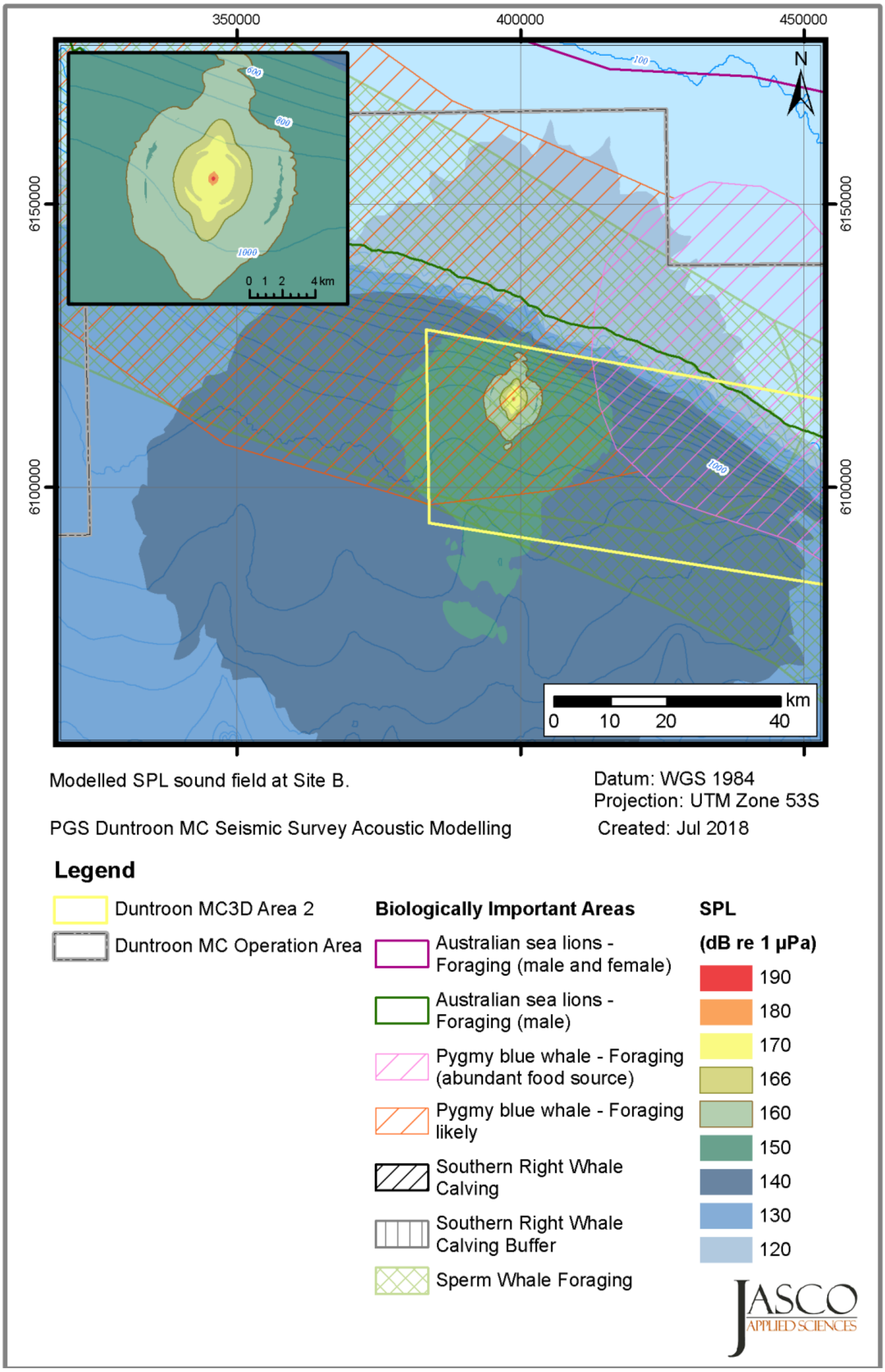

Figure 15. Site B: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

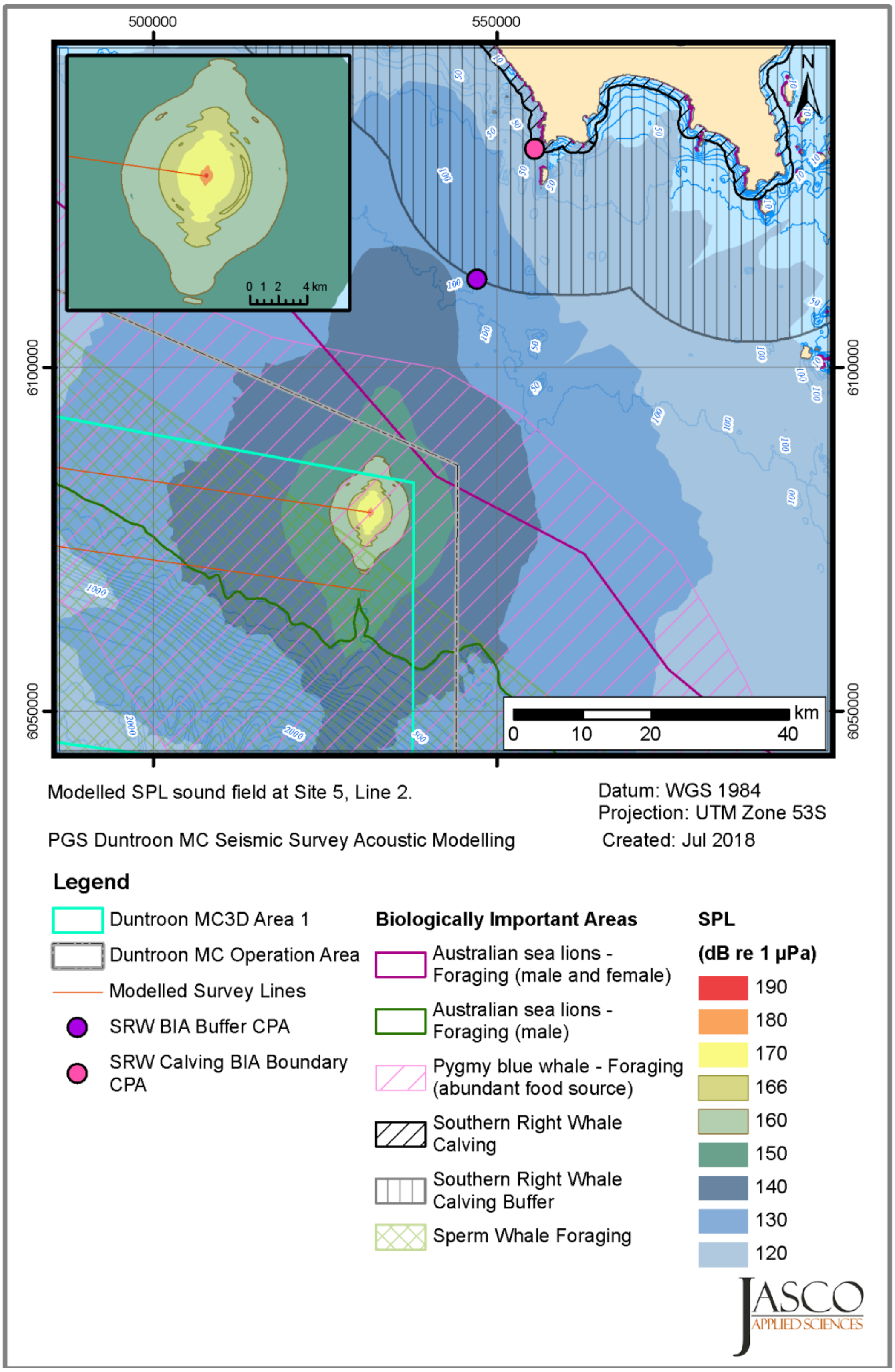

Figure 16. Line 2, Shot 5: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 278° at the closest point to the SRW BIAs, receiver locations for sound levels at the boundaries are shown as circles. Insert shows a close-up of the contours around the source.

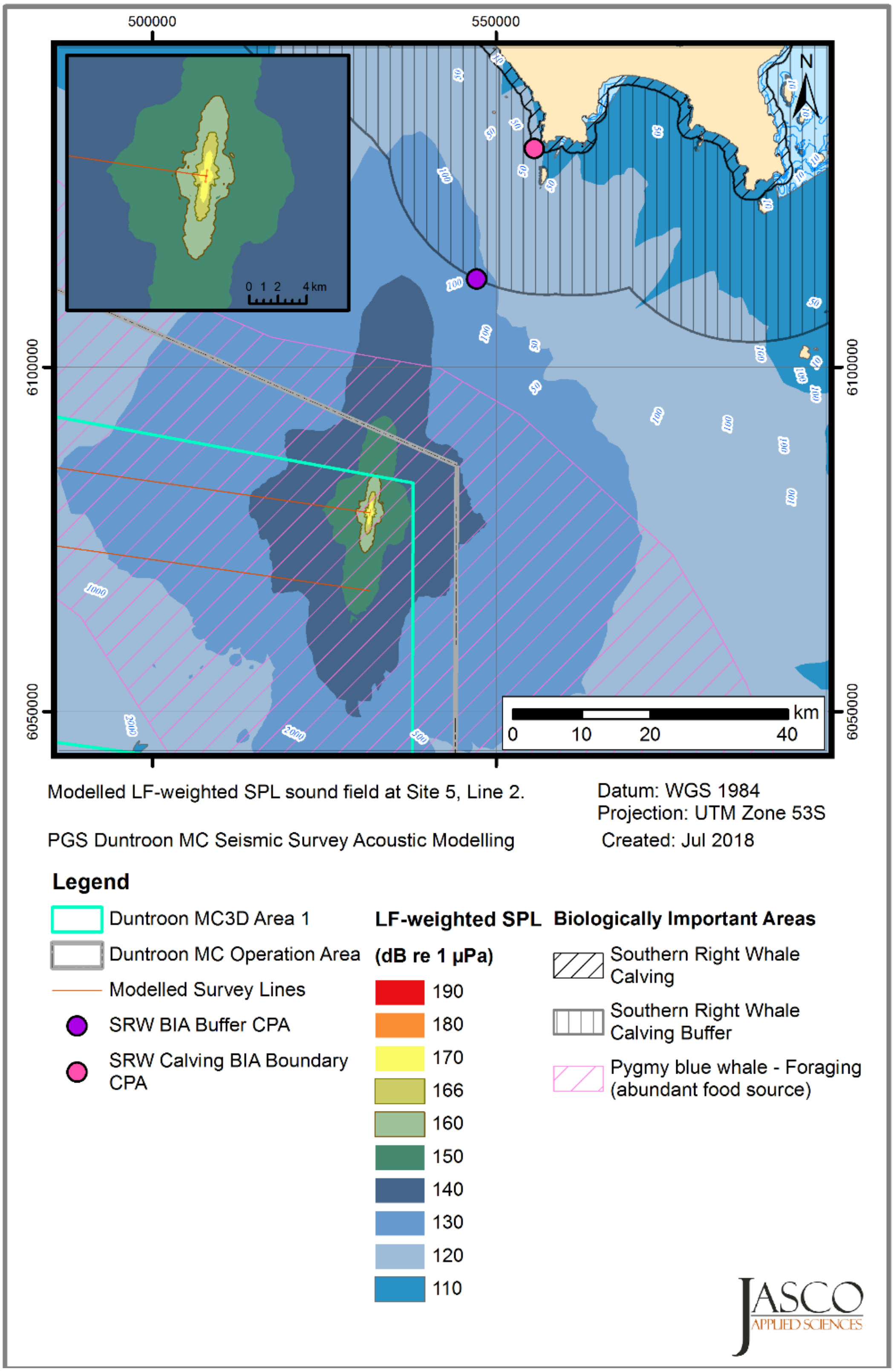

Figure 17. Line 2, Shot 5: Sound level contour map showing maximum-over-depth LF-weighted SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 278° at the closest point to the SRW BIAs, receiver locations for sound levels at the boundaries are shown as circles. Insert shows a close-up of the contours around the source.

4.2.2.2. Entire water column: vertical slice

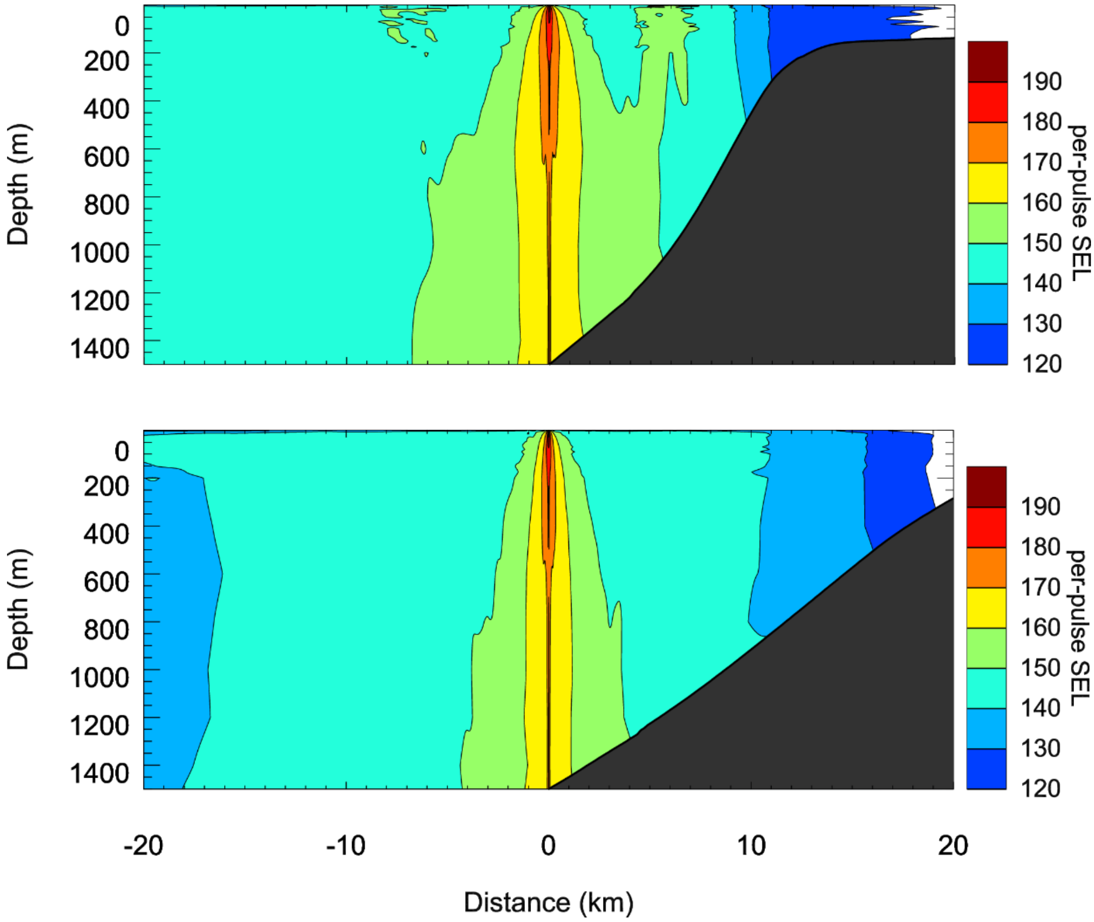

Figure 18. Site 1, Line 1: Predicted unweighted per-pulse SEL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 7 m and the tow direction is 098°.

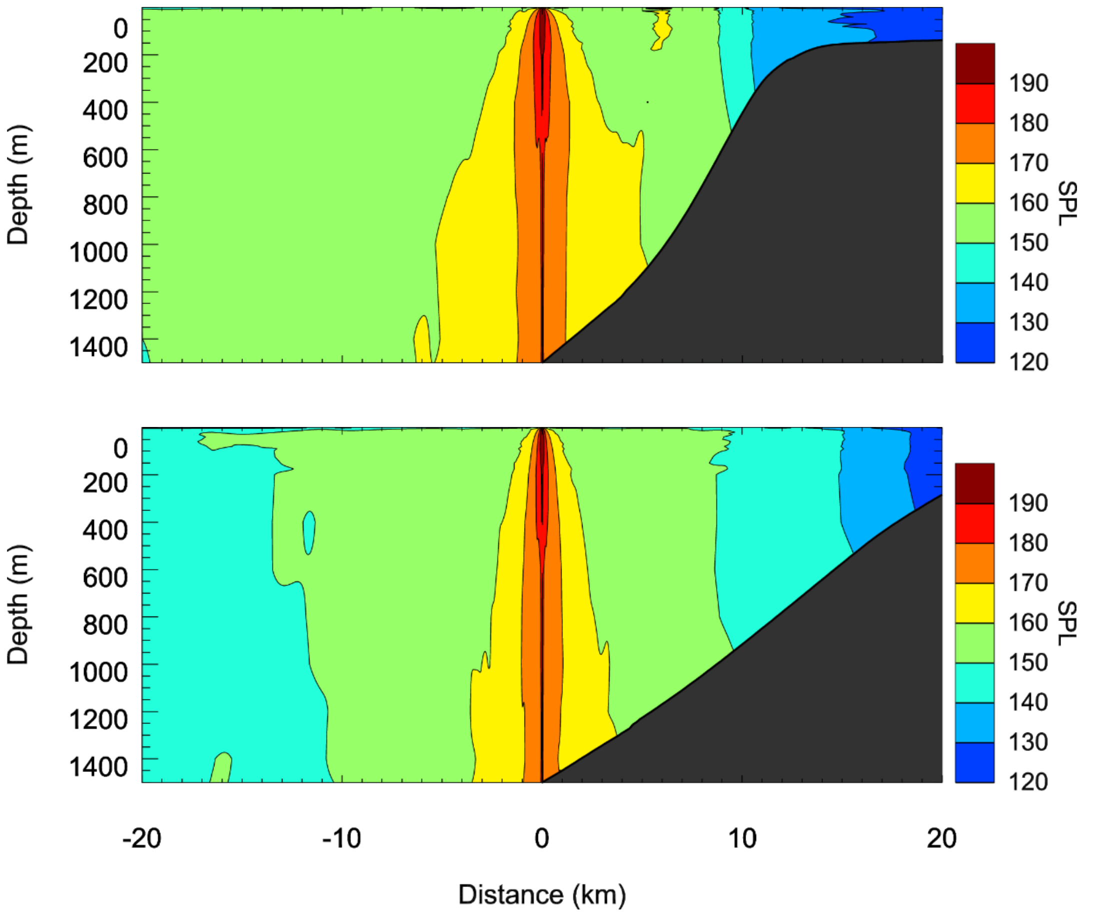

Figure 19. Site 1, Line 1: Predicted unweighted SPL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 7 m and the tow direction is 098°.

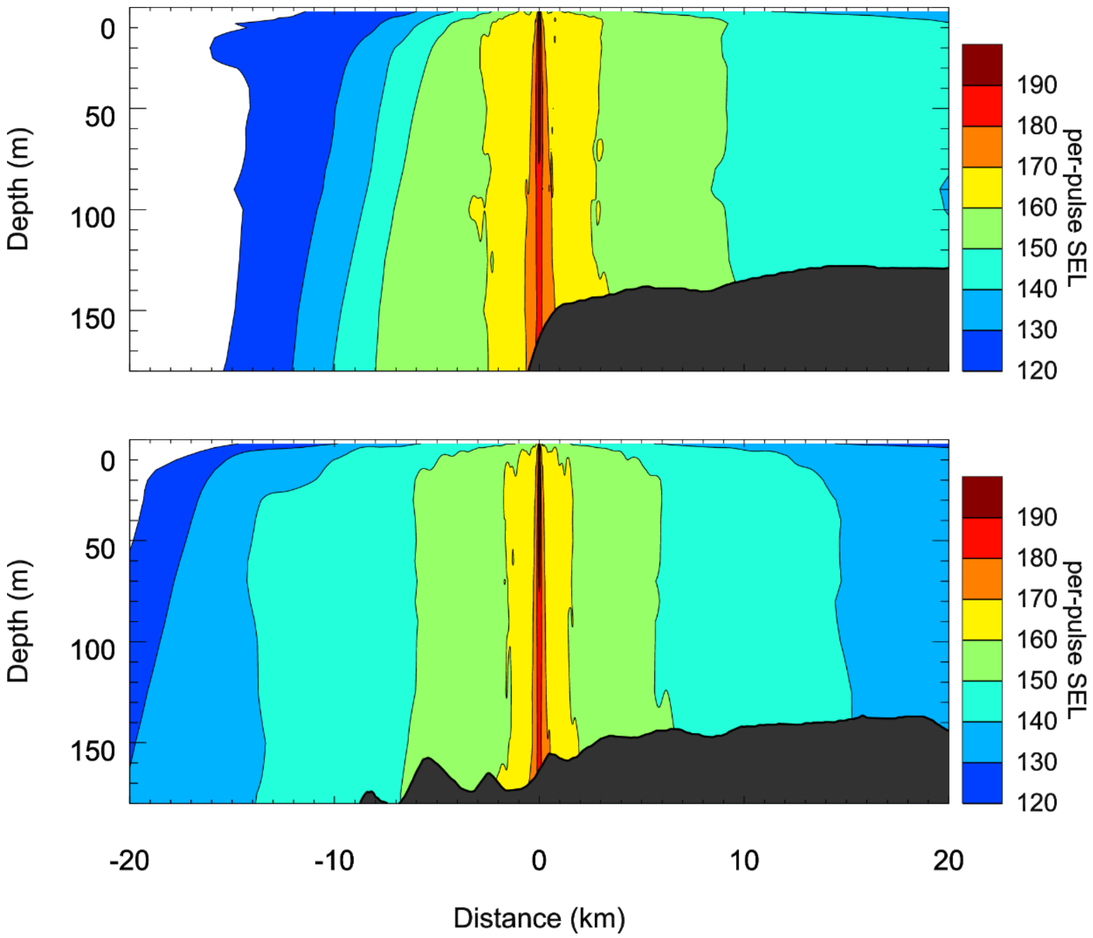

Figure 20. Site 4, Line 1: Predicted unweighted per-pulse SEL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 7 m and the tow direction is 098°. White signifies below 120 dB.

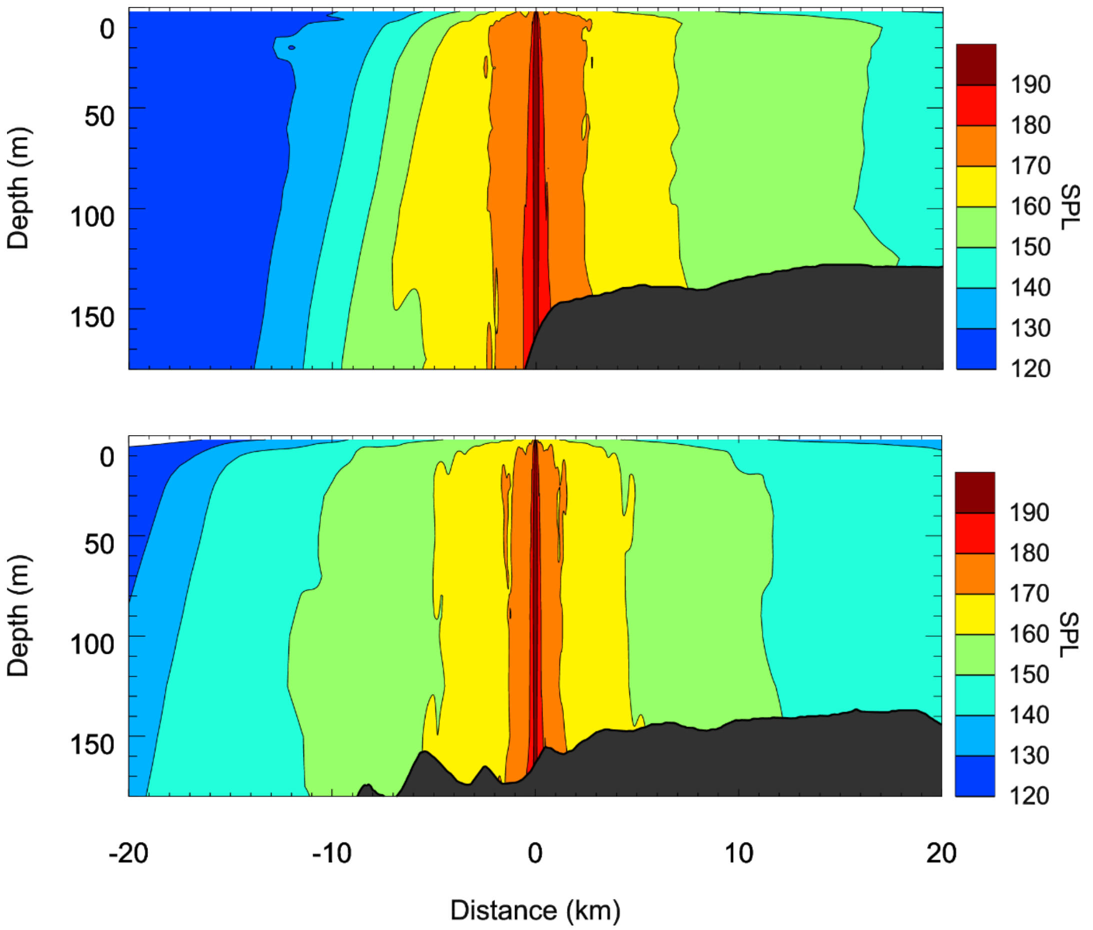

Figure 21. Site 4, Line 1: Predicted unweighted SPL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 7 m and the tow direction is 098°.

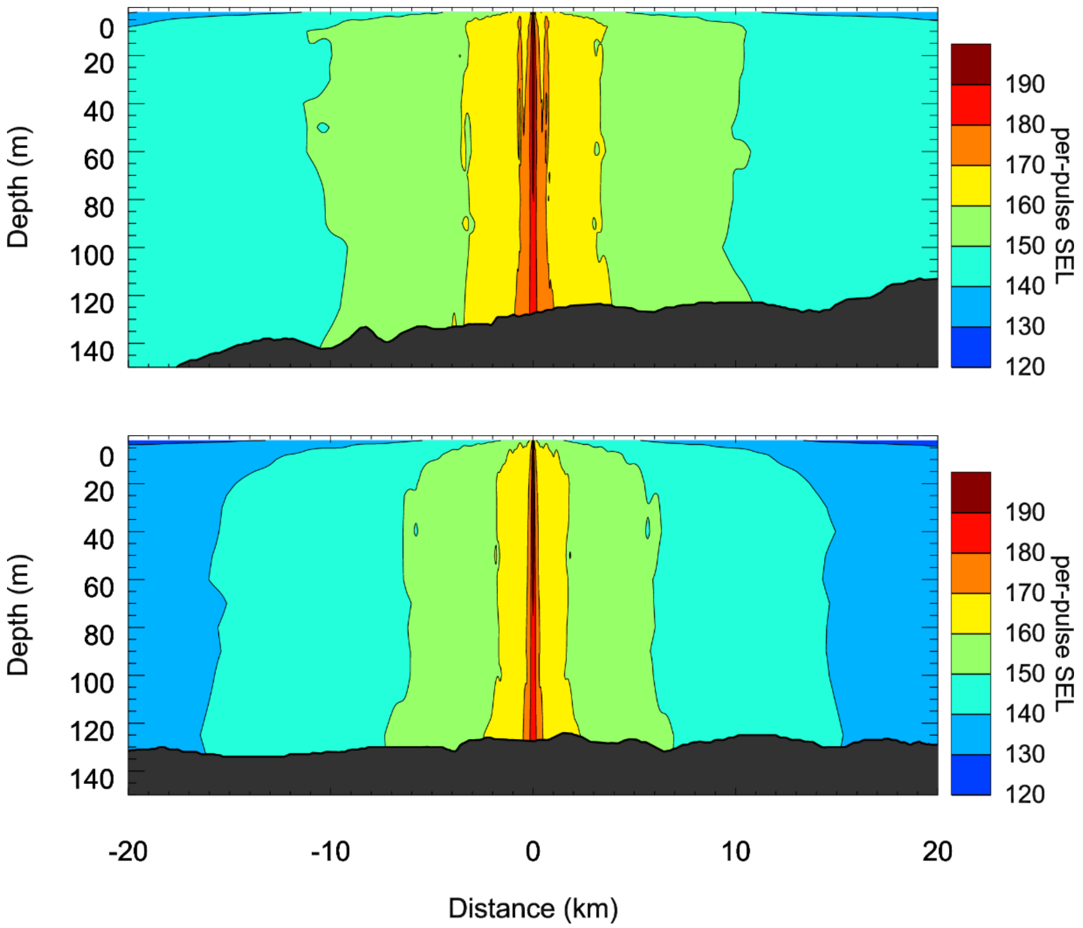

Figure 22. Site 1, Line 2: Predicted unweighted per-pulse SEL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 7 m and the tow direction is 098°.

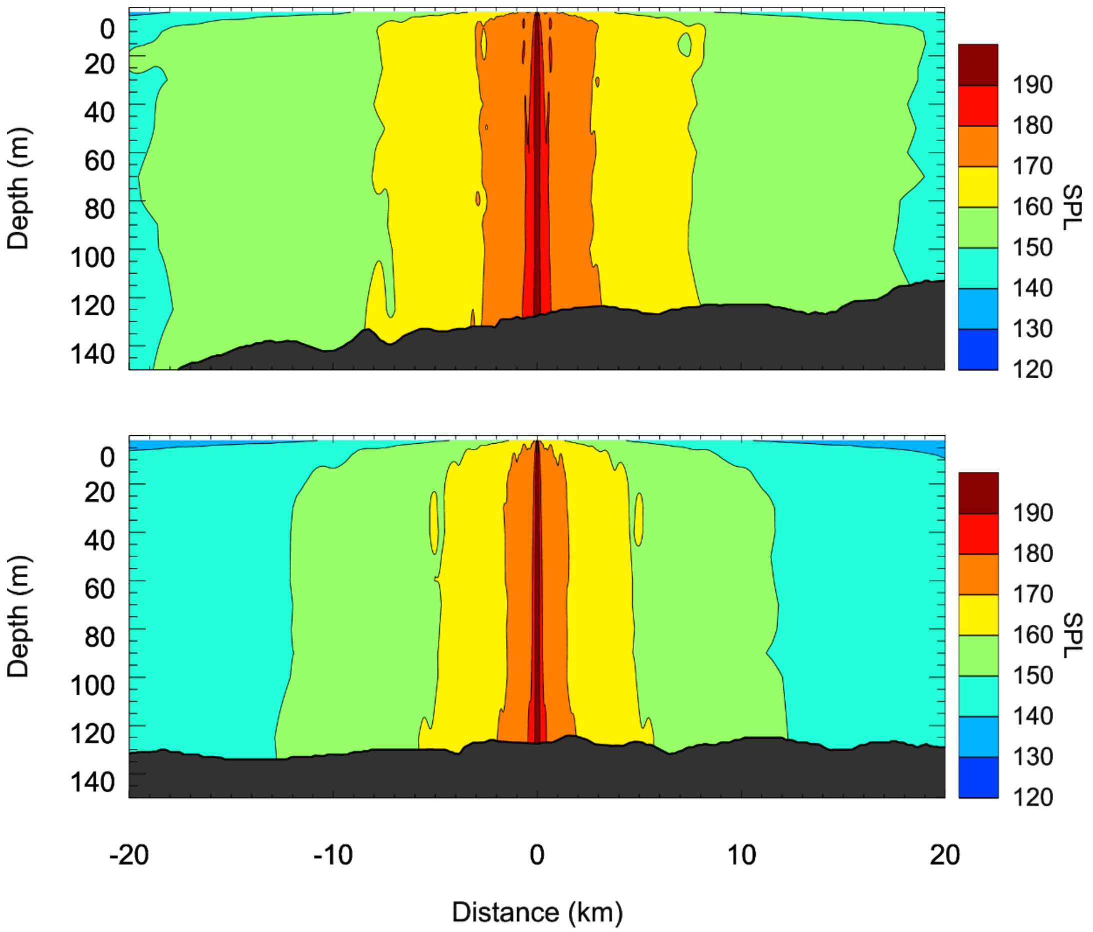

Figure 23. Site 1, Line 2: Predicted unweighted SPL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 7 m and the tow direction is 098°.

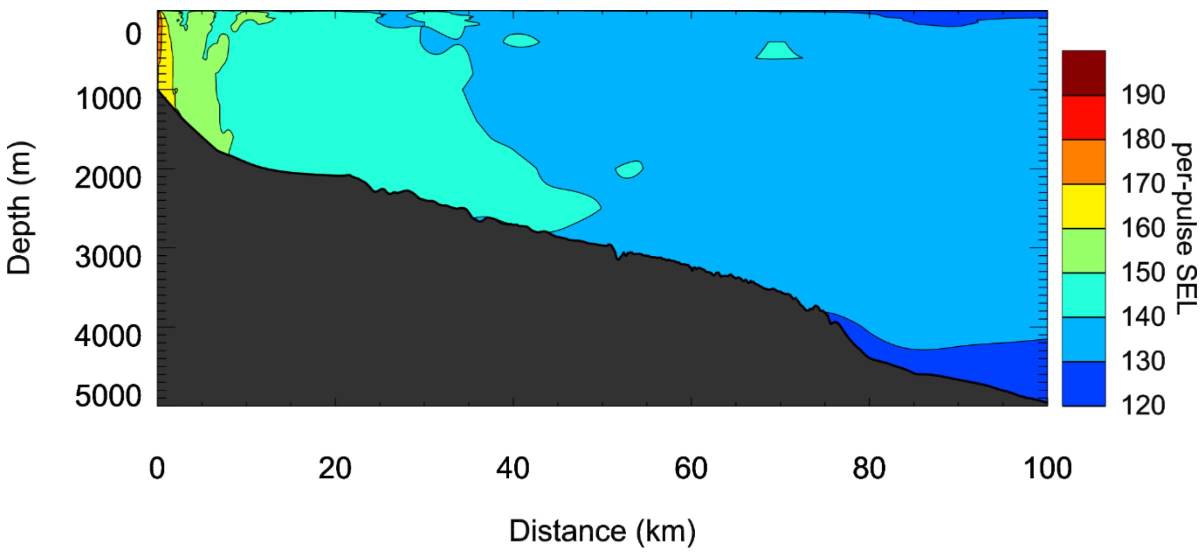

Figure 24. Site 2, Line 1: Predicted unweighted per-pulse SEL in the offshore direction as a vertical slice. Levels are shown along a single transect from broadside offshore along an azimuth of 188°. The source depth is 7 m and the tow direction is 278°.

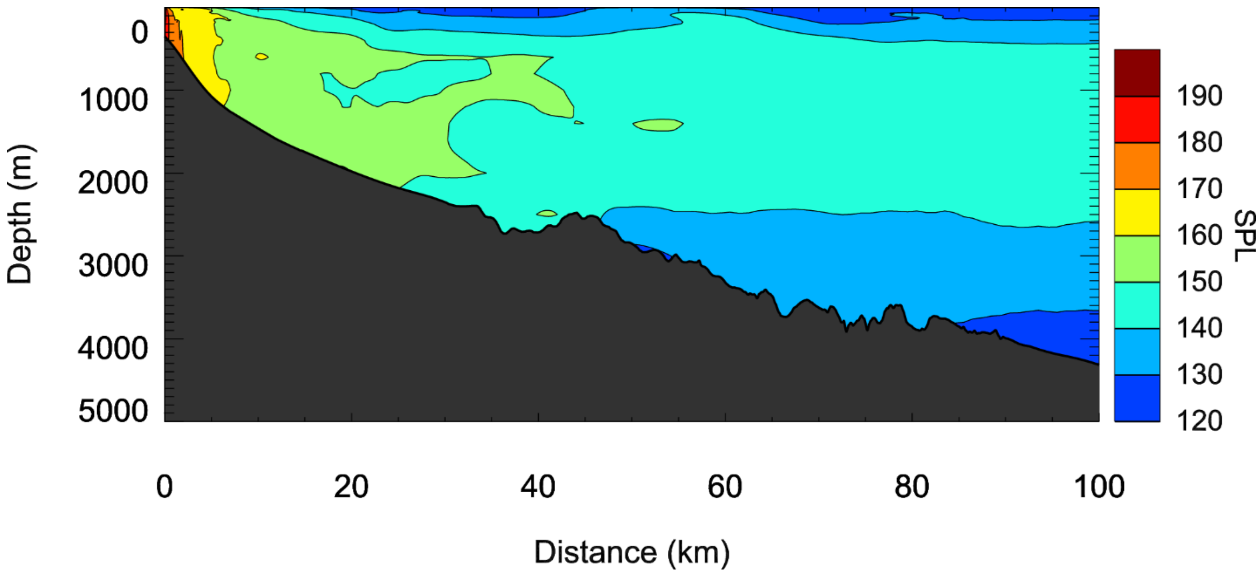

Figure 25. Site 3, Line 2: Predicted unweighted SPL in the offshore direction as a vertical slice. Levels are shown along a single transect from broadside offshore along an azimuth of 188°. The source depth is 7 m and the tow direction is 278°.

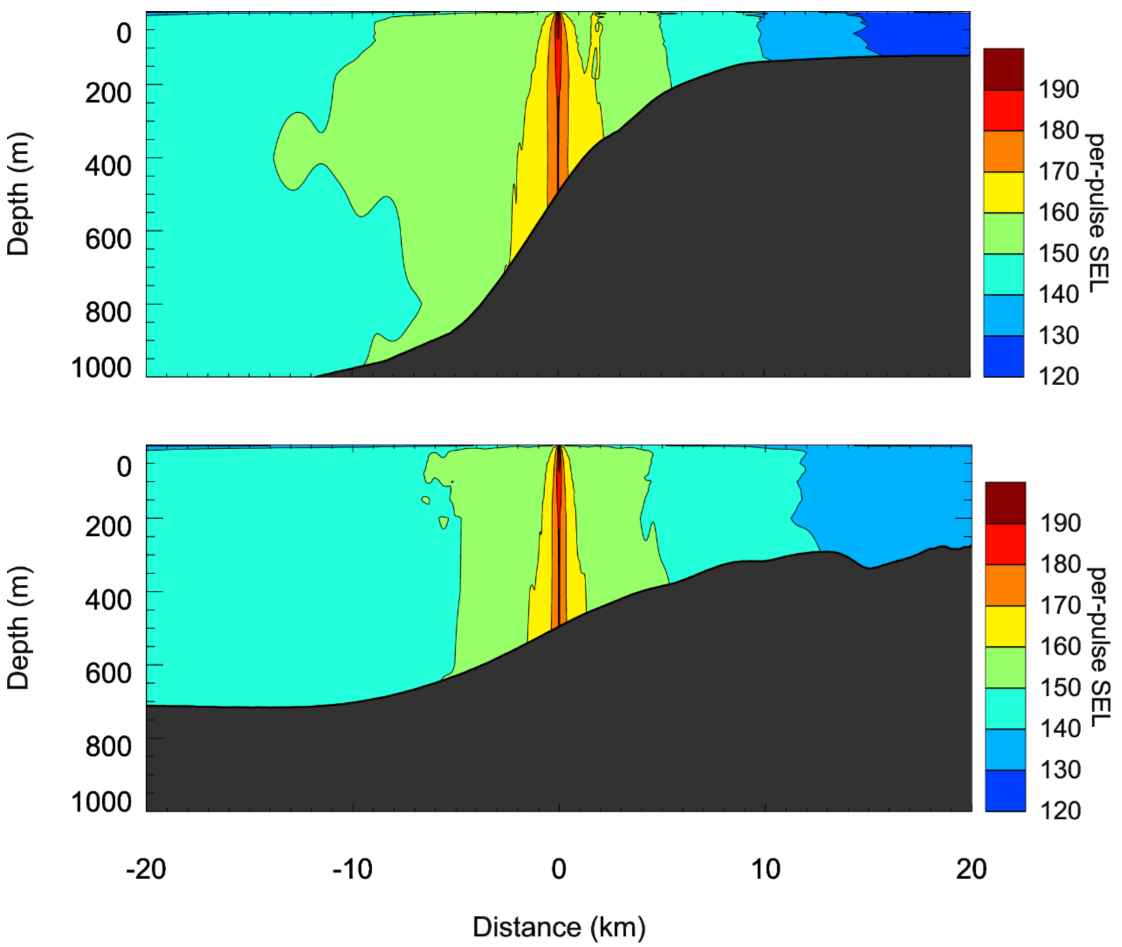

Figure 26. Site A: Predicted unweighted per-pulse SEL as vertical slices. Levels are shown along a single transect from broadside towards shore (azimuth of 008°; top) and eastern endfire (azimuth of 098°; bottom). The source depth is 7 m and the tow direction is 278°.

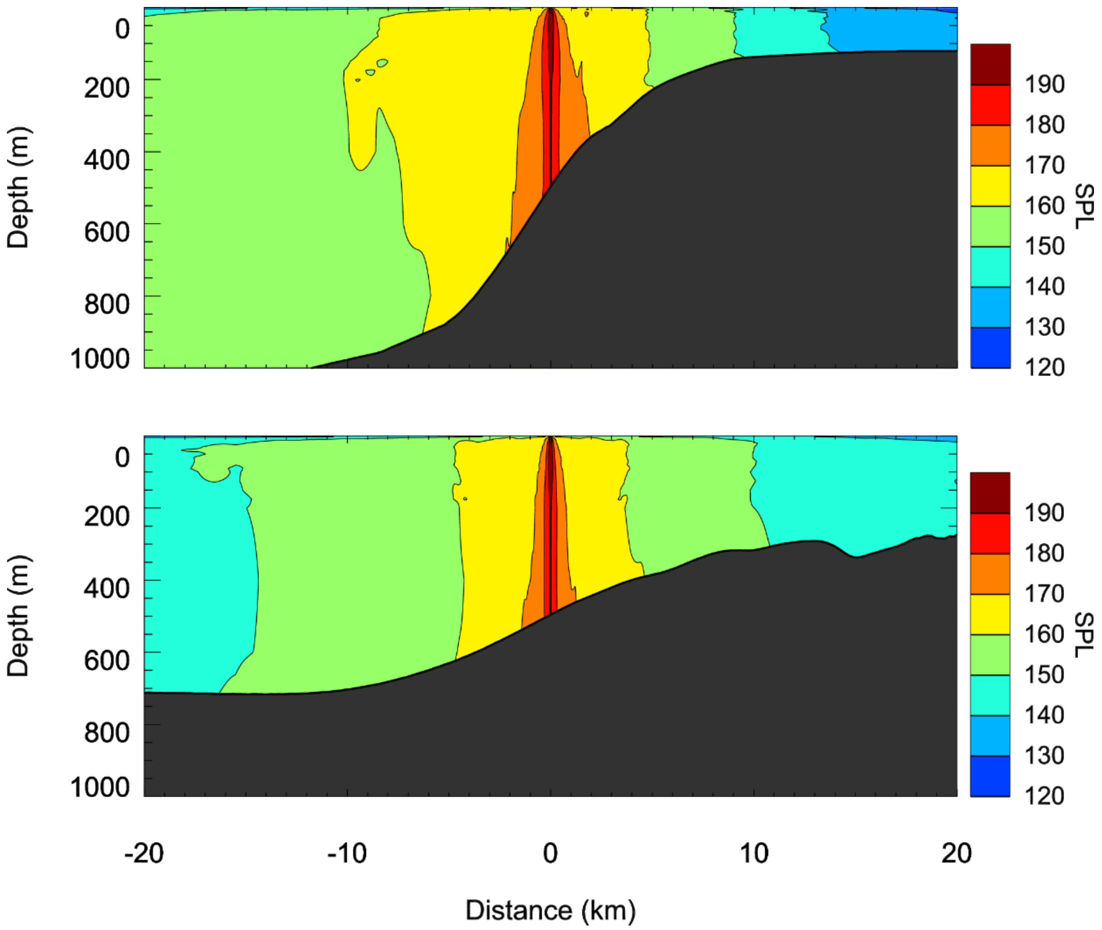

Figure 27. Site A: Predicted unweighted SPL as vertical slices. Levels are shown along a single transect from broadside towards shore (azimuth of 008°; top) and eastern endfire (azimuth of 098°; bottom). The source depth is 7 m and the tow direction is 278°.

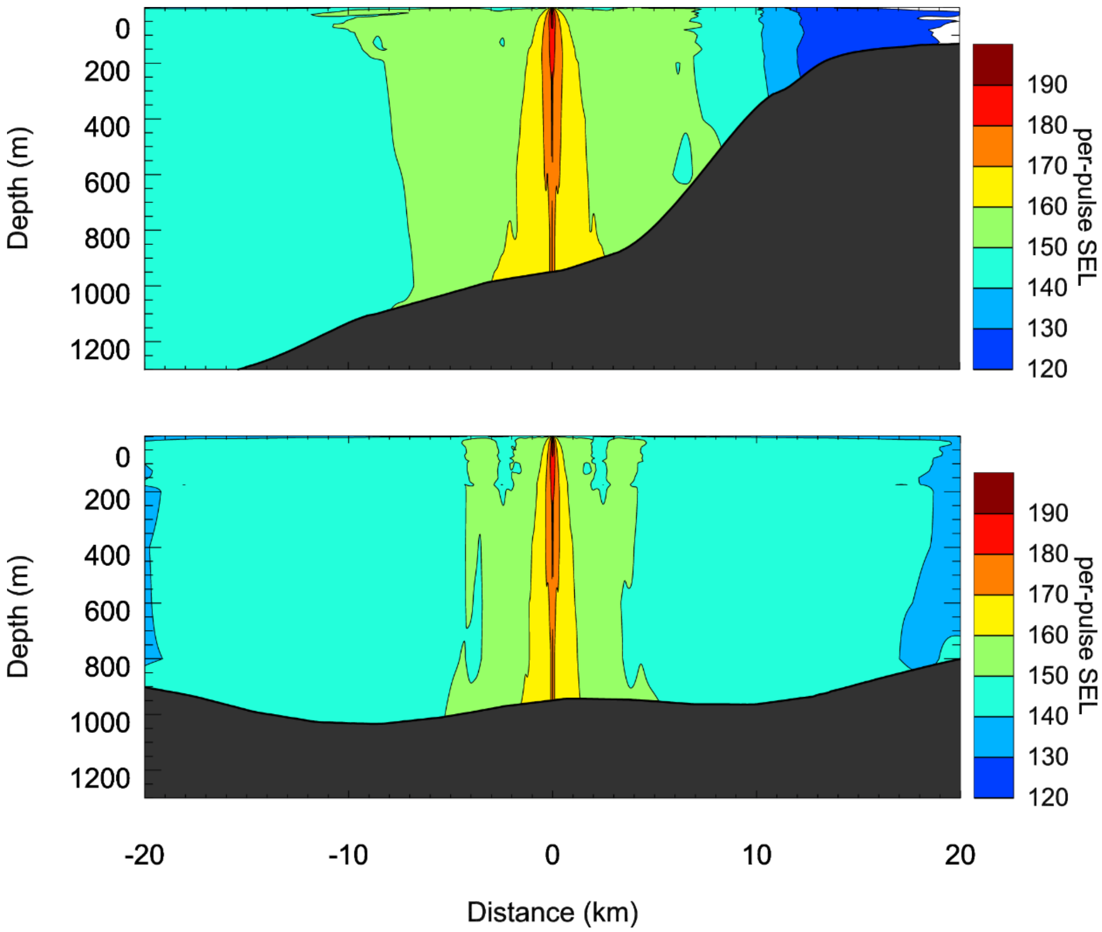

Figure 28. Site B: Predicted unweighted per-pulse SEL as vertical slices. Levels are shown along a single transect from broadside towards shore (azimuth of 008°; top) and eastern endfire (azimuth of 098°; bottom). The source depth is 7 m and the tow direction is 278°.

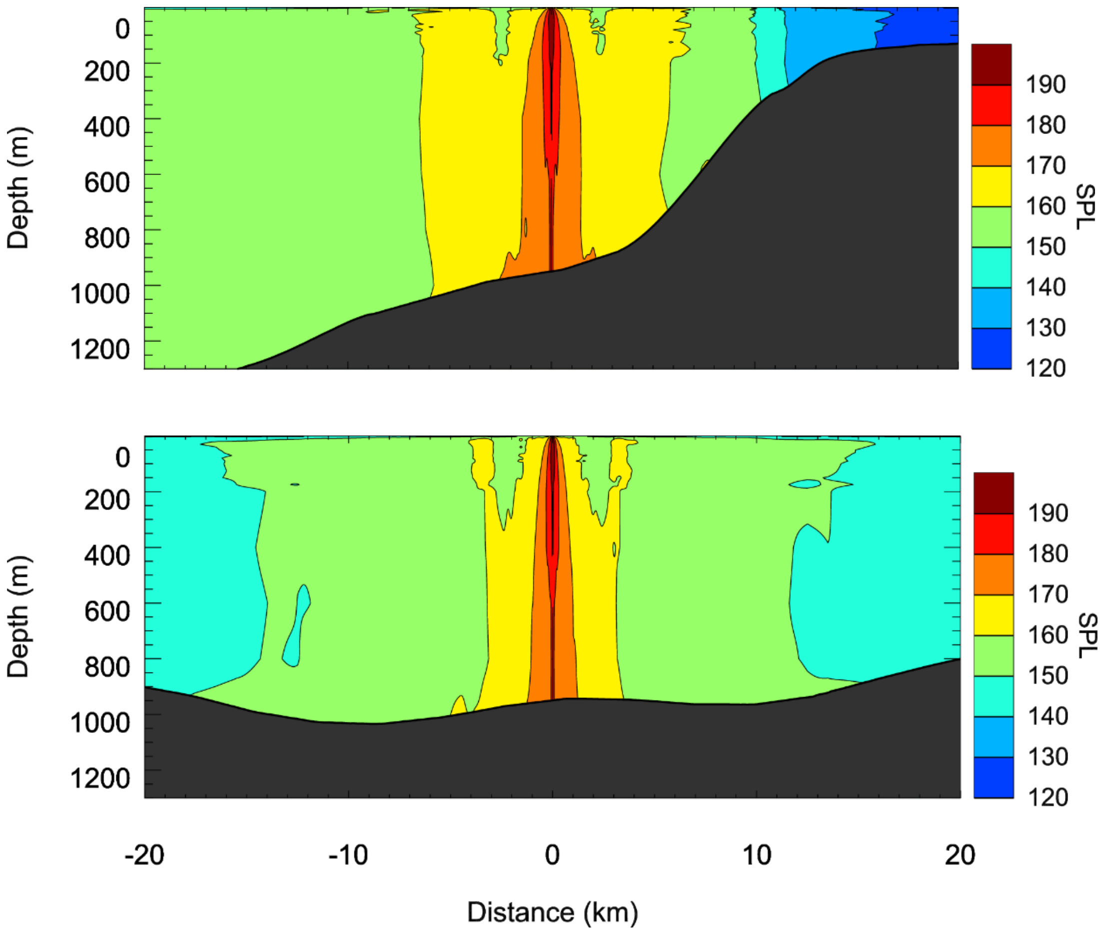

Figure 29. Site B: Predicted unweighted SPL as vertical slices. Levels are shown along a single transect from broadside towards shore (azimuth of 008°; top) and eastern endfire (azimuth of 098°; bottom). The source depth is 7 m and the tow direction is 278°.

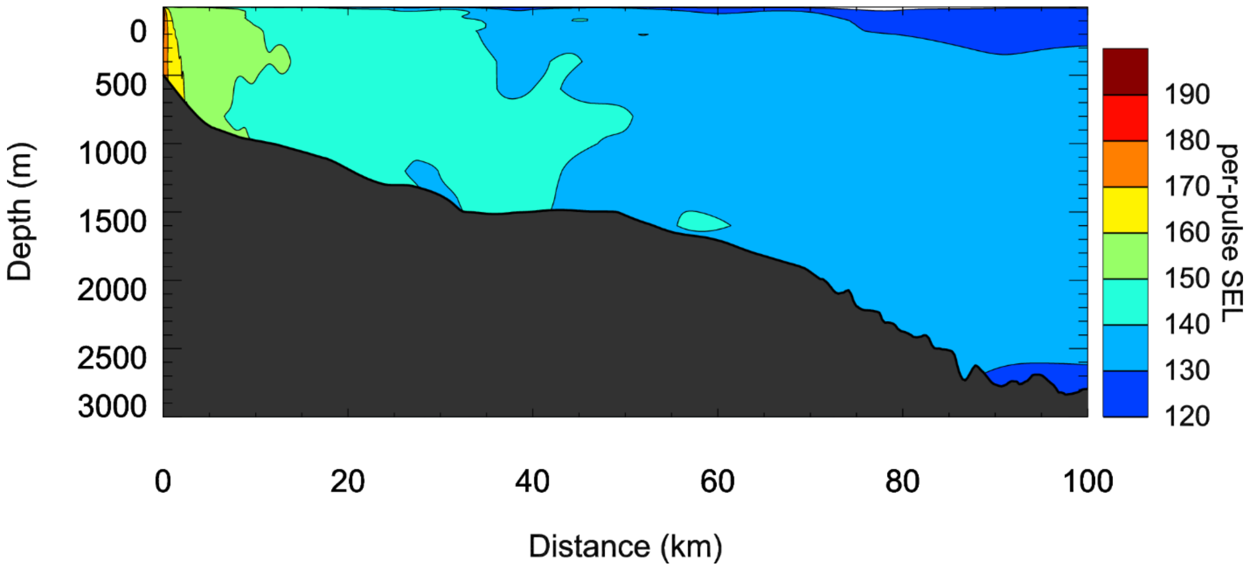

Figure 30. Site A: Predicted unweighted per-pulse SEL in the offshore direction as a vertical slice. Levels are shown along a single transect from broadside offshore along an azimuth of 188°. The source depth is 7 m and the tow direction is 278°.

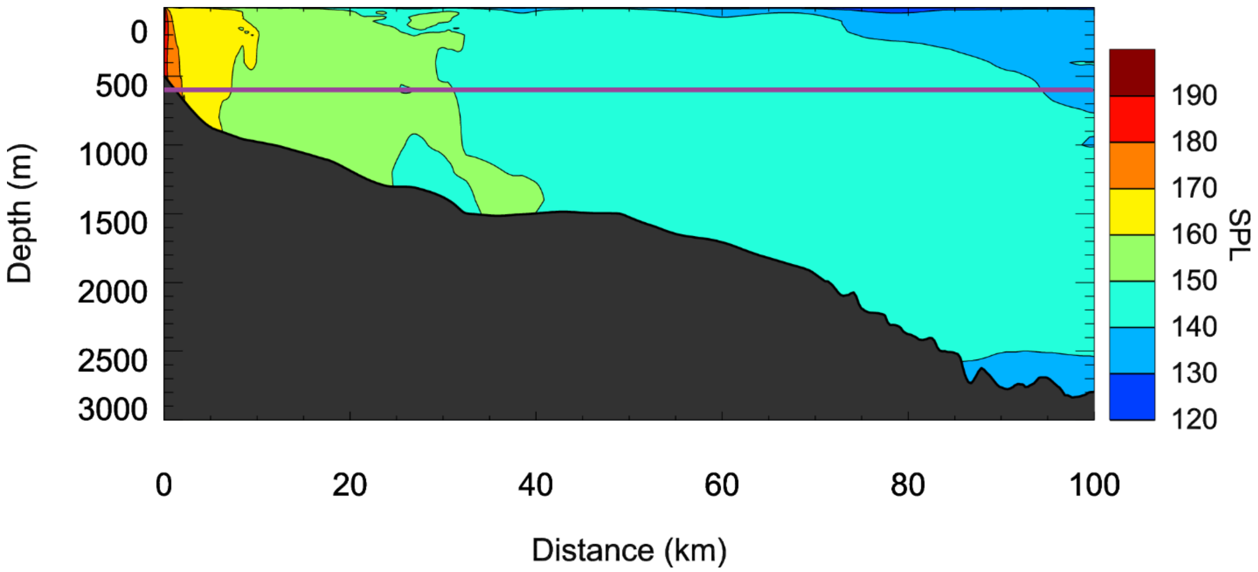

Figure 31. Site A: Predicted SPL in the offshore direction as a vertical slice. Levels are shown along a single transect from broadside offshore along an azimuth of 188°. The source depth is 7 m and the tow direction is 278°. The purple line indicates water depth of 600 m.

4.2.2.3. Depths ≤600 m: sound level contour maps

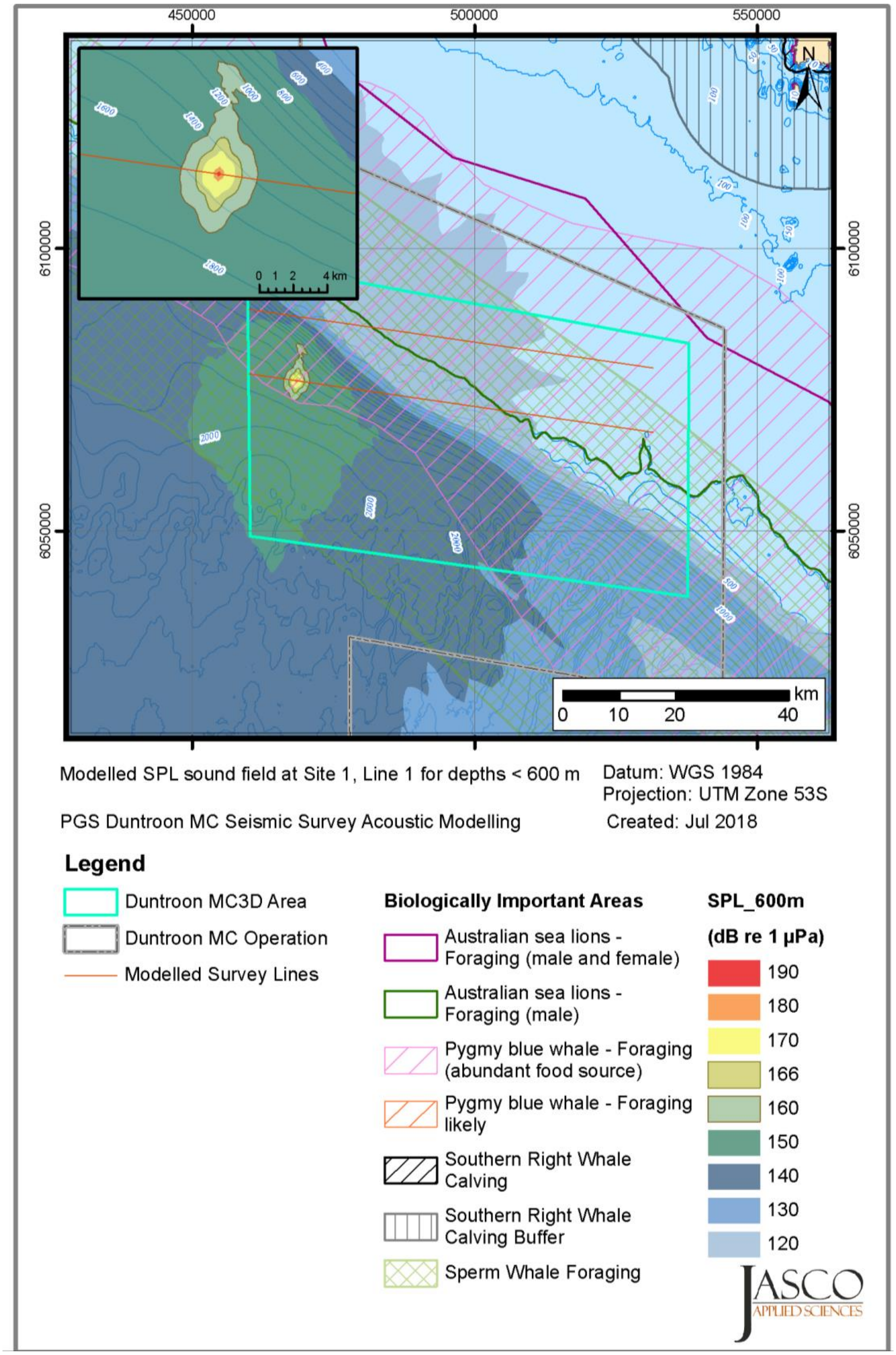

Figure 32. Depths ≤600 m - Site 1, Line 1: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

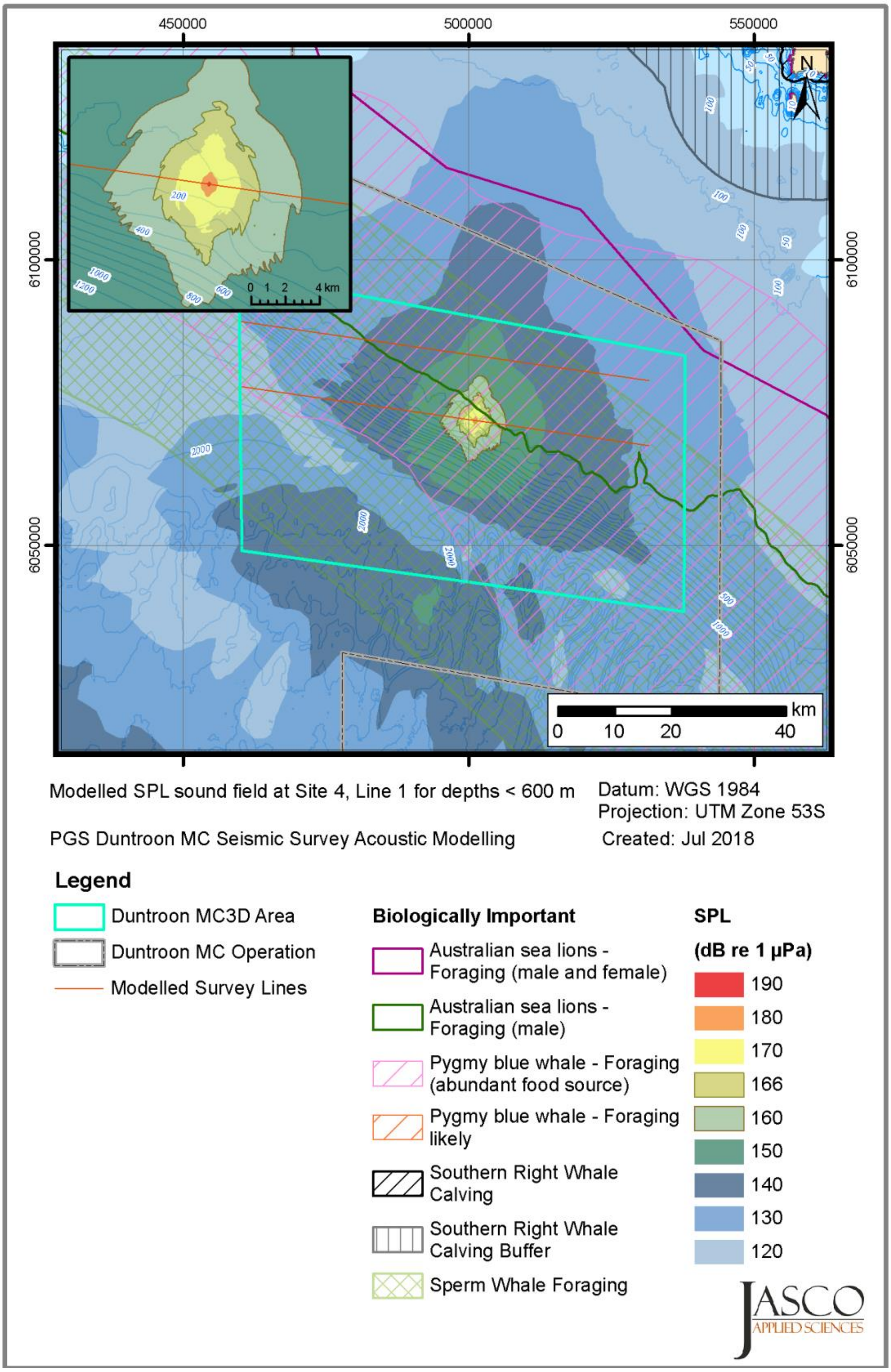

Figure 33. Depths ≤600 m - Site 4, Line 1: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 098°. Insert shows a close-up of the contours around the source.

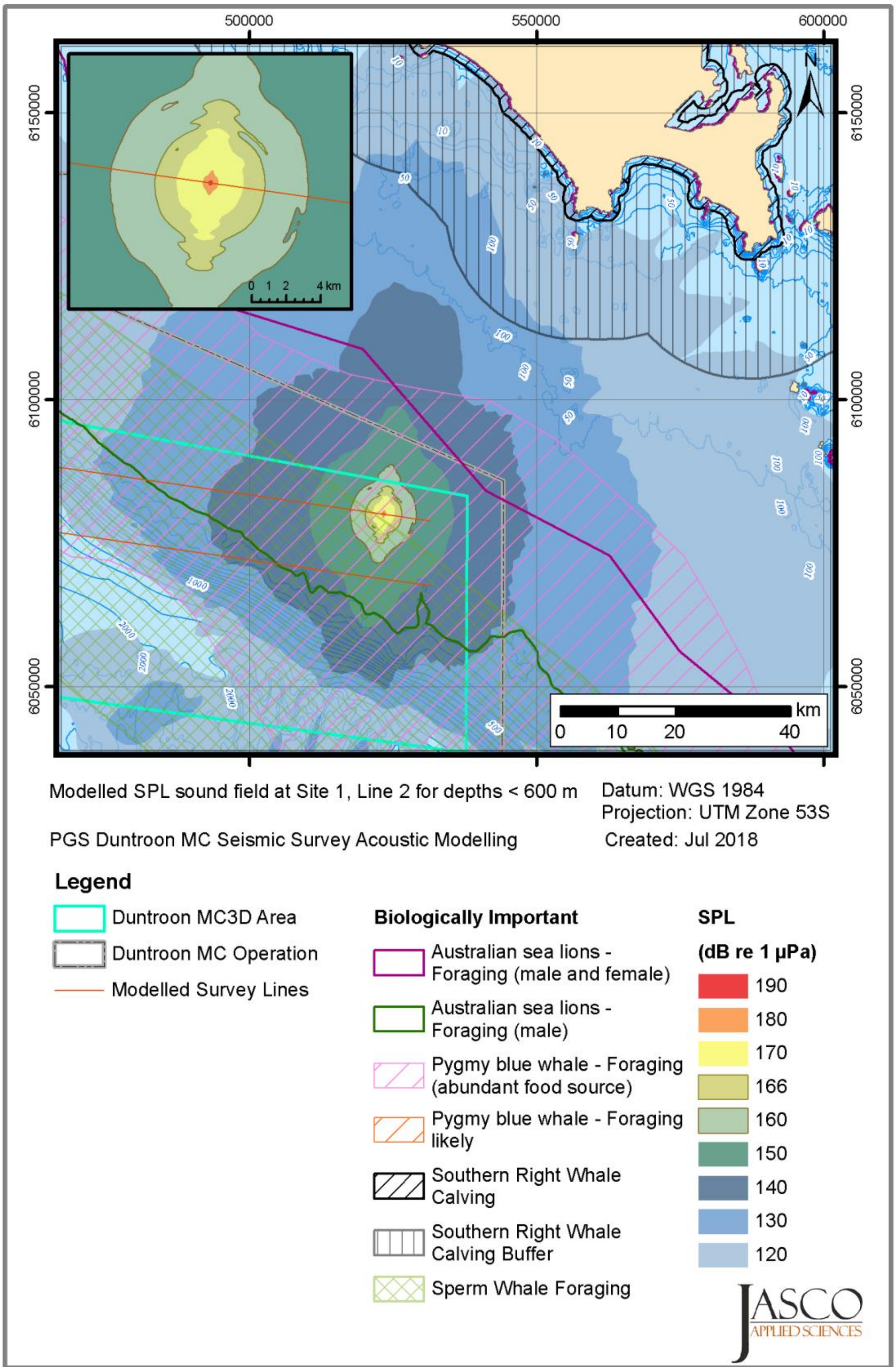

Figure 34. Depths ≤600 m - Site 1, Line 2: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

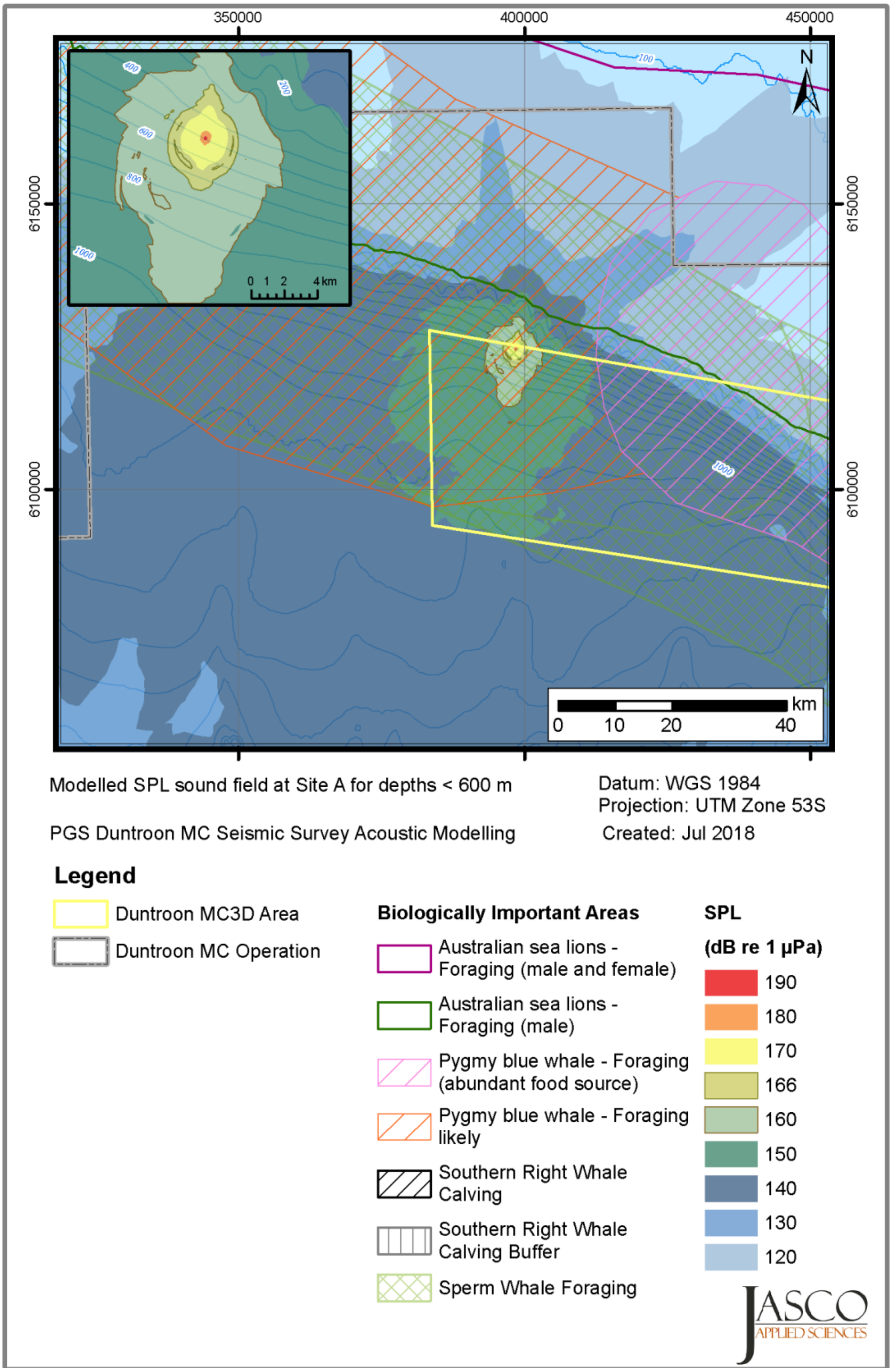

Figure 35. Depths ≤600 m - Site A: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

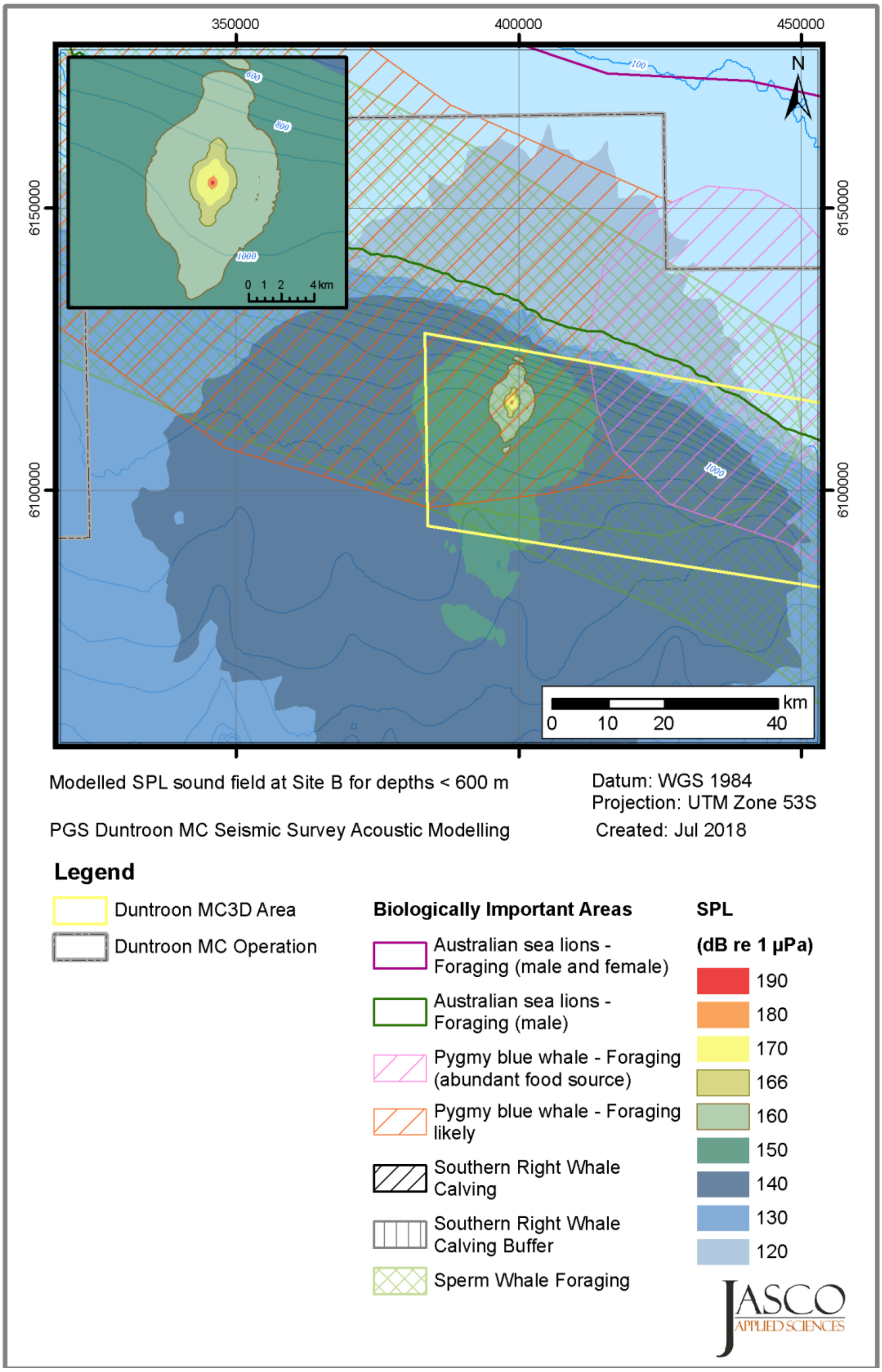

Figure 36. Depths ≤600 m - Site B: Sound level contour map showing maximum-over-depth SPL results for the 3260 in³ array towed at 7 m depth, on a heading of 278°. Insert shows a close-up of the contours around the source.

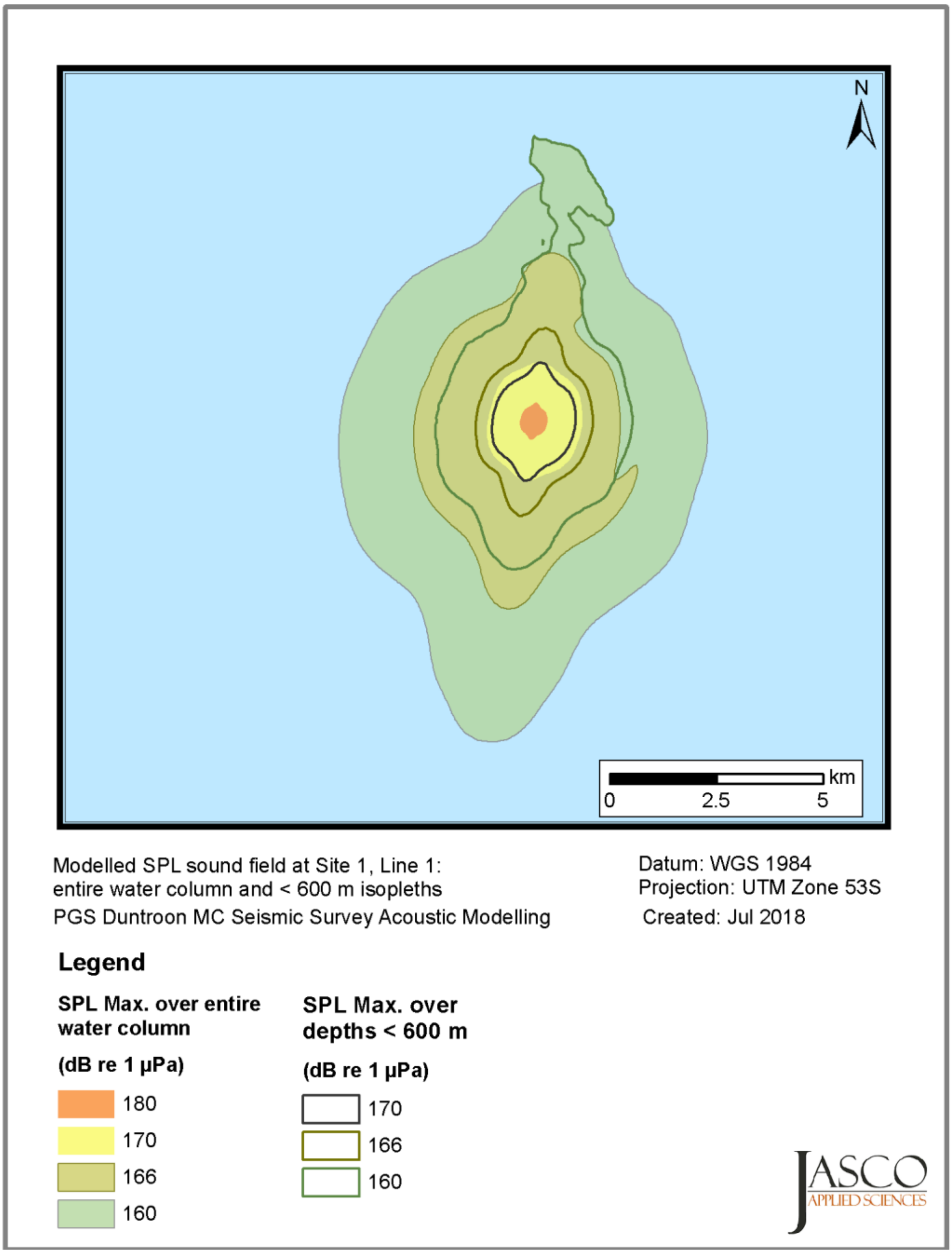

Figure 37. Site 1, Line 1: Sound level contour map comparing unweighted maximum-over-depth per-pulse SEL results for the entire water column and depths ≤600 m for the 3260 in³ array towed at 7 m depth, on a heading of 098°.

4.2.2.4. Seafloor levels

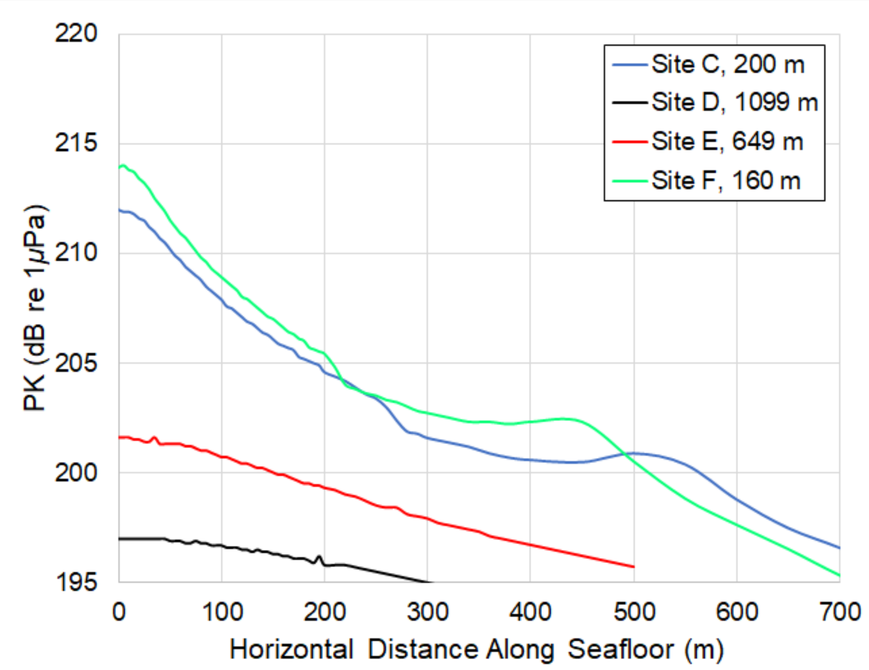

Figure 38. Predicted maximum PK along the seafloor at Sites C–F , depths at each site specified in the legend. Levels are the maximum of four transects, assessing both broadside and endfire directions. The source depth is 7 m.

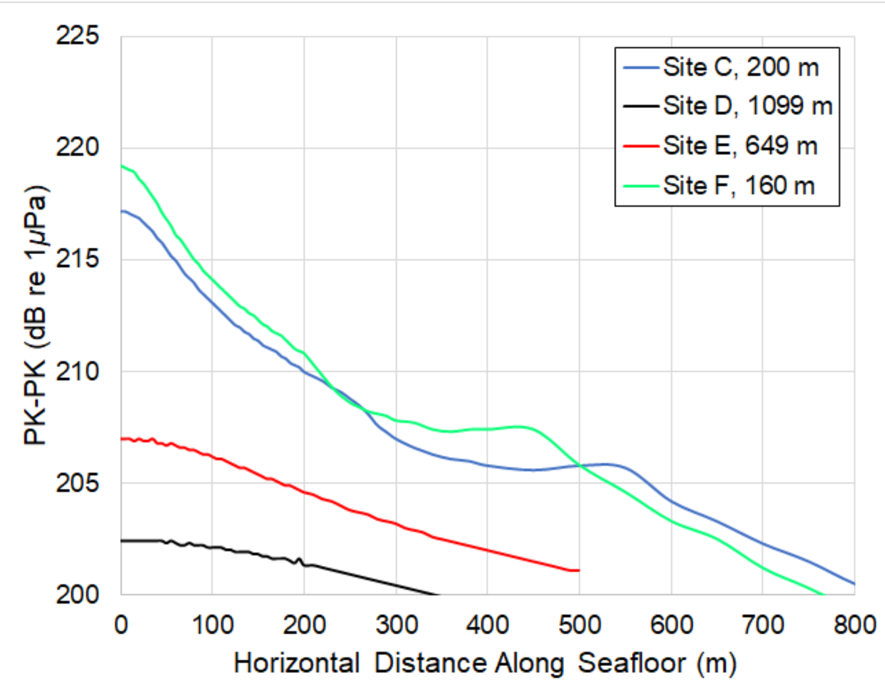

Figure 39. Predicted maximum PK-PK along the seafloor at Sites C–F, depths at each site specified in the legend. Levels are the maximum of four transects, assessing both broadside and endfire directions. The source depth is 7 m.

4.3. Accumulated Sound Exposure Levels

The SEL_{24h} results for acquisition within 3-D Survey Area 1 are presented in this section. Table 30 shows the estimated distances to the SEL-based injury and TTS criteria for marine mammals as per the NOAA Technical Guidance (NMFS 2018), along with the ensonified area. The results for the cumulative exposure criterion for potential TTS onset in fish in the water column and at the seafloor is shown in Table 31. Table 32 lists the estimated received level for each hearing group at the five sampling locations described in Table 5. The results for the SEL-based injury criteria (NMFS 2018) for low-frequency cetaceans considering only depths less than or equal to 600 m are shown in Table 33.

Maps displaying the corresponding sound fields and threshold contours for the entire water column are shown in Figures 40–44, while unweighted seafloor sound fields are shown in Figure 46. The sound levels associated with the accumulated SEL criteria for fish injury (Section 2.2) were not reached at the seafloor. Low-frequency cetacean weighted sound fields at depths less than or equal to 600 m and threshold contours are shown in Figure 45.

The modelled scenario assumes an impulse spacing of 16.67 m and that consecutive survey lines are 11.4 km apart. Higher received levels and longer distances to sound level thresholds could result if impulses or lines were closer together.

4.3.1. Tabulated Results

4.3.1.1. Entire water column

Table 30. Maximum-over-depth results for frequency-weighted SEL 24 h PTS thresholds based on the NOAA Technical Guidance (NMFS 2018) over the entire water column. A dash indicates that the threshold was not reached.

Hearing group	PTS			TTS		
	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	183	0.76	160	168	88.1	6470
Mid-frequency cetaceans	185	–	–	170	–	–
High-frequency cetaceans	155	–	–	140	0.14	38.5
Phocid pinnipeds in water	185	–	–	170	0.27	54.9
Otariid pinnipeds in water	203	–	–	188	–	–

Table 31. Results for SEL_{24h} fish TTS criteria ($L_{E,24h}$; 186 dB re 1 µPa²·s), for the entire water column (maximum-over-depth) and seafloor receptors.

SEL_{24h} isopleth ($L_{E,24}$; dB re 1 µPa²·s)	Location	R_{max} (km)	Area (km²)
186	Maximum-over-depth	4.97	823
	Seafloor	4.92	780

Table 32. Received frequency-weighted SEL 24 h ($L_{E,24h}$; dB re 1 µPa²·s) at five sampling locations. LF = Low-frequency cetaceans, MF = Mid-frequency cetaceans, HF = High-frequency cetaceans, PW = Phocid pinnipeds in water, OW = Otariid pinnipeds in water.

Location		SEL ($L_{E,LF,24h}$)	SEL ($L_{E,MF,24h}$)	SEL ($L_{E,HF,24h}$)	SEL ($L_{E,PW,24h}$)	SEL ($L_{E,OW,24h}$)
1	Closest point between the array and the sea lion BIAs	165.1	125.9	117.1	152.5	150.9
2	Closest point between the broadside of the array and the sea lion BIAs	168.8	126.6	117.4	154.6	151.6
3	Closest point between the endfire of the array and the sea lion BIAs	157.1	119.7	110.8	145.6	144.6
4	Closest point between the array and the 100 m isobath	156.8	120.7	111.9	146.0	145.5
5	Closest point between the broadside of the array and the 100 m isobath	160.3	120.7	111.8	147.2	145.5

4.3.1.2. Depths ≤600 m

Table 33. Depths ≤600 m: Maximum-over-depth results for frequency-weighted SEL 24 h ($L_{E,24h}$; dB re 1 µPa²·s) thresholds based on the NOAA Technical Guidance (NMFS 2018) for water depths ≤600 m.

Hearing group	Weighted SEL_{24h} ($L_{E,24}$; dB re 1 µPa²·s)	PTS		Weighted SEL_{24h} ($L_{E,24}$; dB re 1 µPa²·s)	TTS	
		R_{max} (km)	Area (km²)		R_{max} (km)	Area (km²)
Low-frequency cetaceans	183	0.76	159	168	42.3	4,181

4.3.2. Sound Level Contour Maps

4.3.2.1. Entire water column

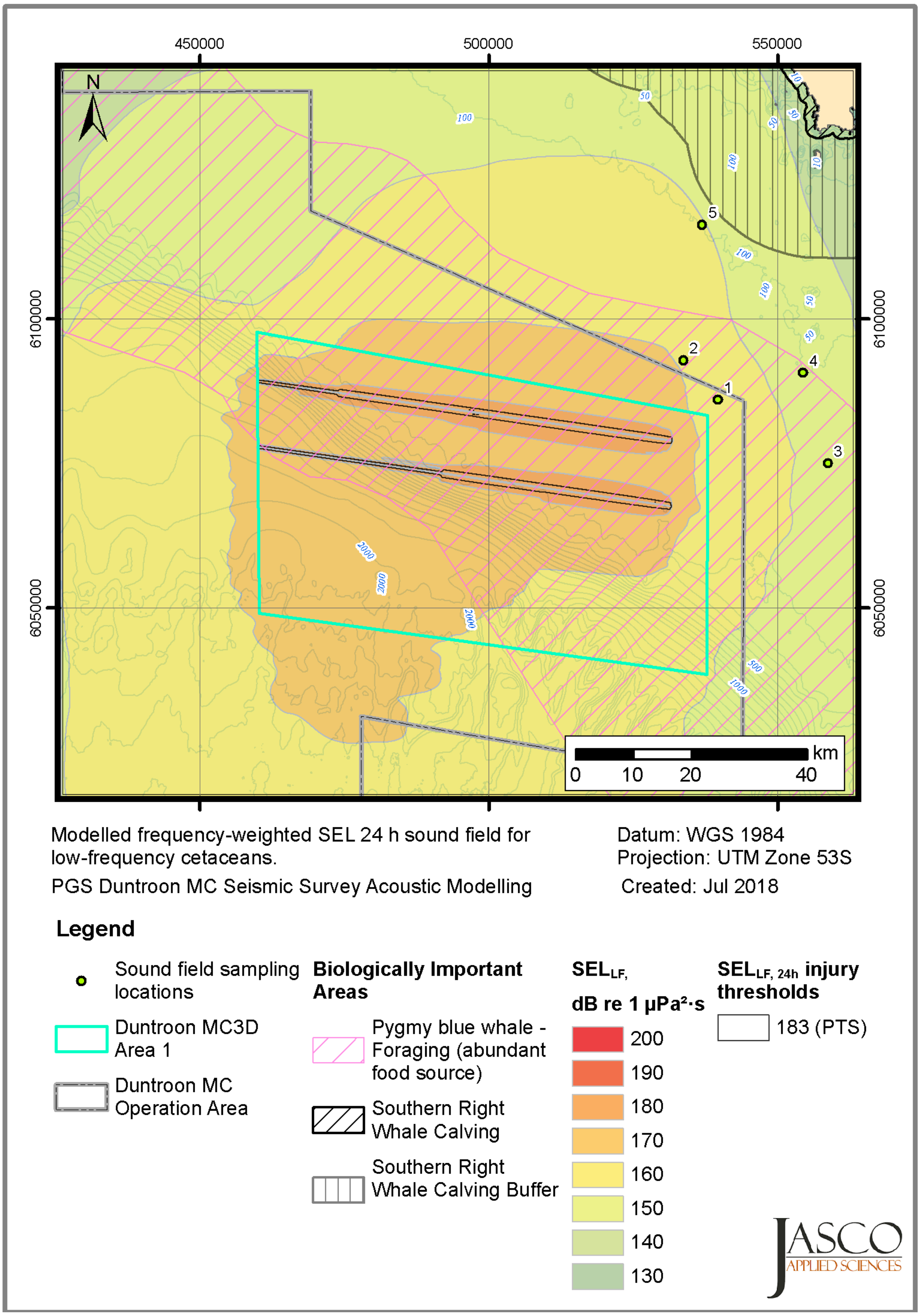

Figure 40. Low-frequency cetaceans (LF): Sound level contour map showing frequency-weighted maximum-over-depth SEL results accumulated over 24 h.

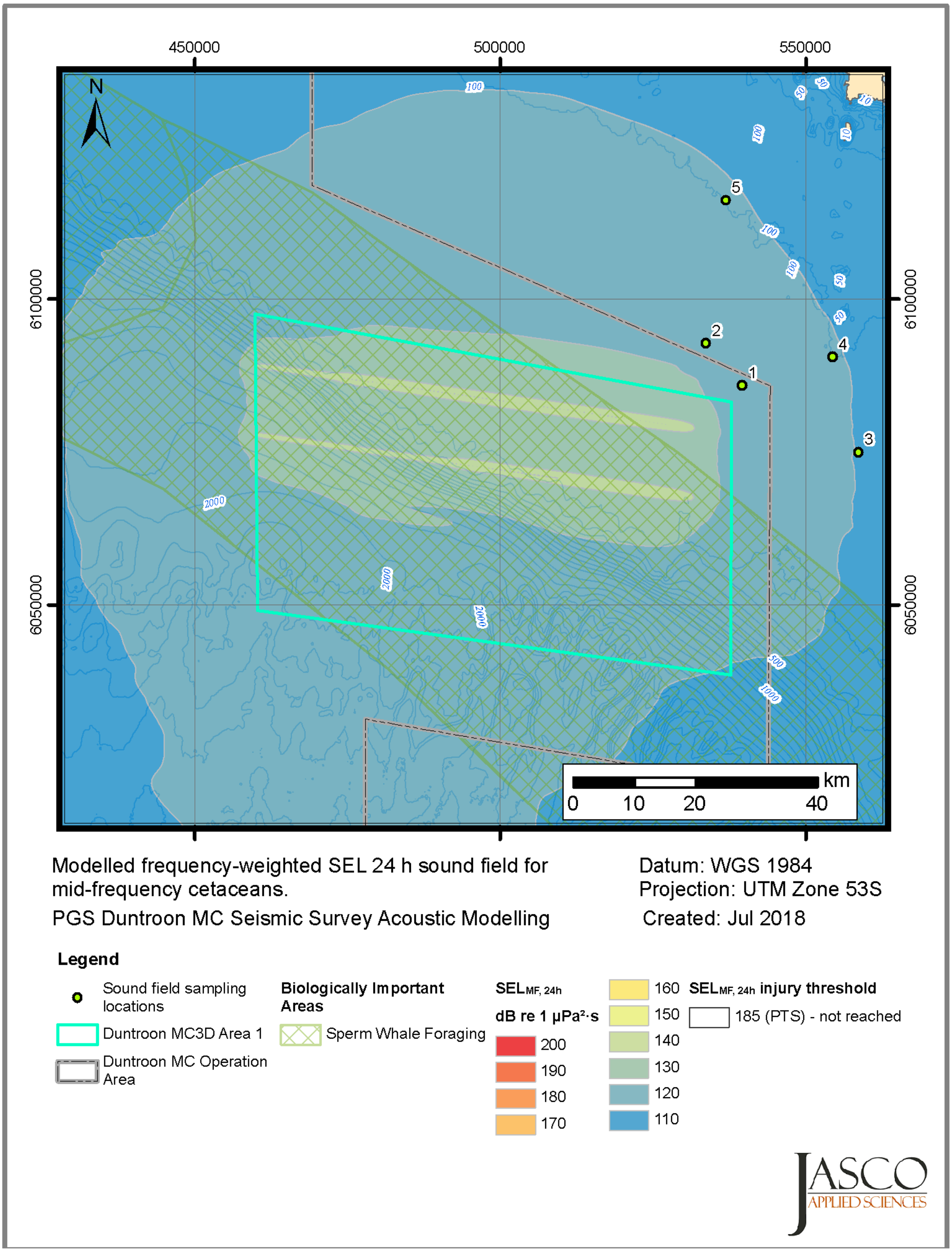

Figure 41. Mid-frequency cetaceans (MF): Sound level contour map showing frequency-weighted maximum-over-depth SEL results accumulated over 24 h.

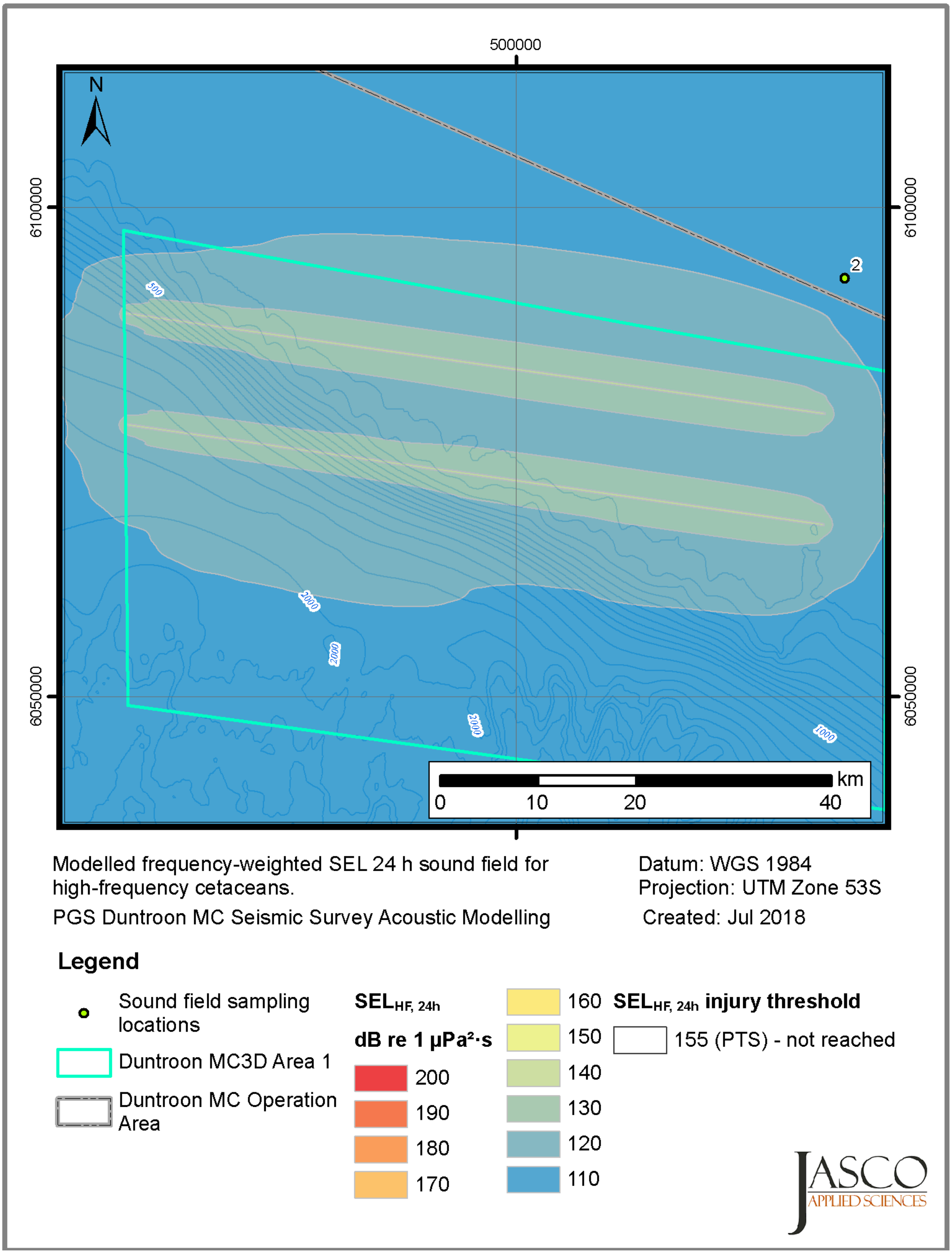

Figure 42. High-frequency cetaceans (HF): Sound level contour map showing frequency-weighted maximum-over-depth SEL results accumulated over 24 h.

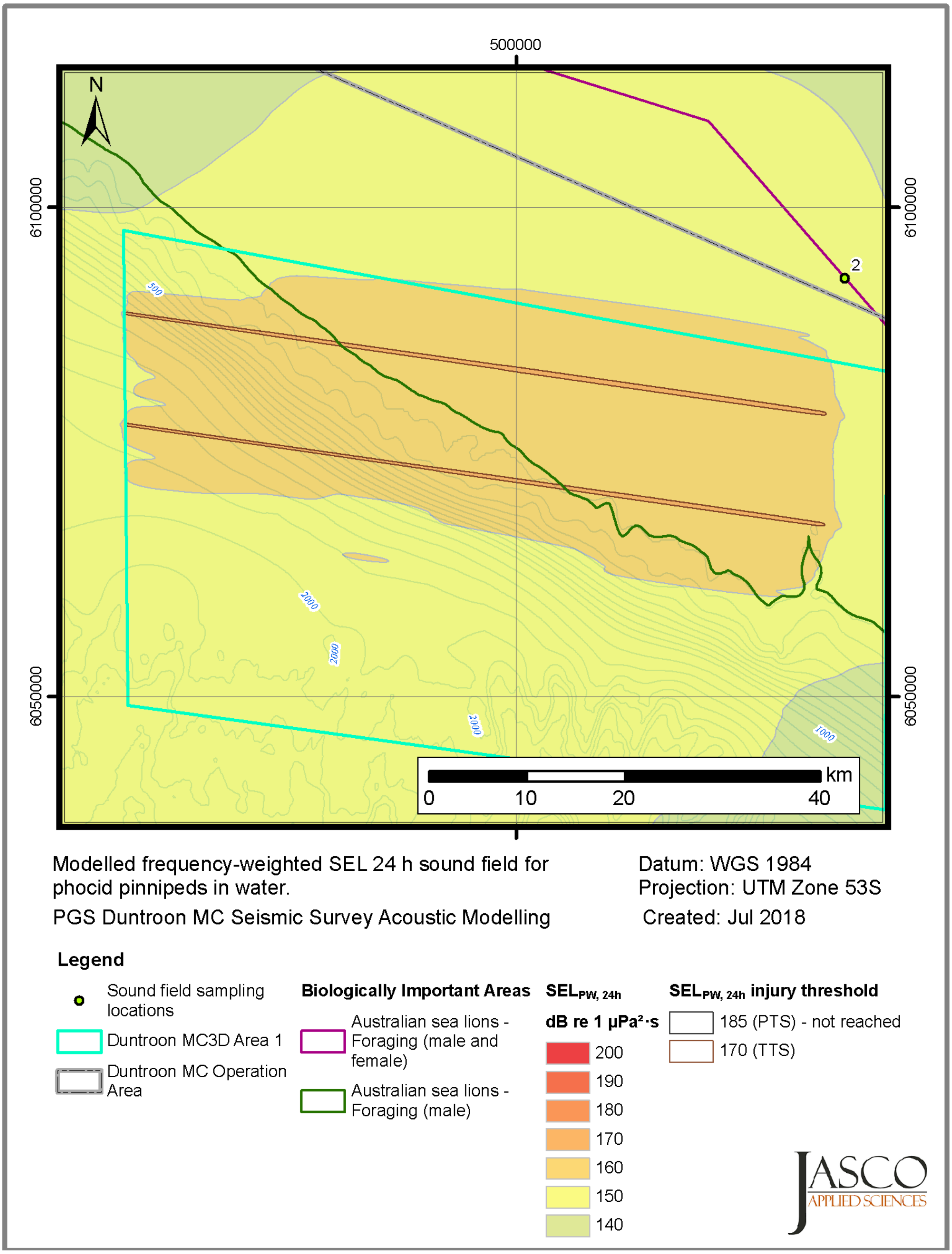

Figure 43. Phocid pinnipeds in water (PW): Sound level contour map showing frequency-weighted maximum-over-depth SEL results accumulated over 24 h.

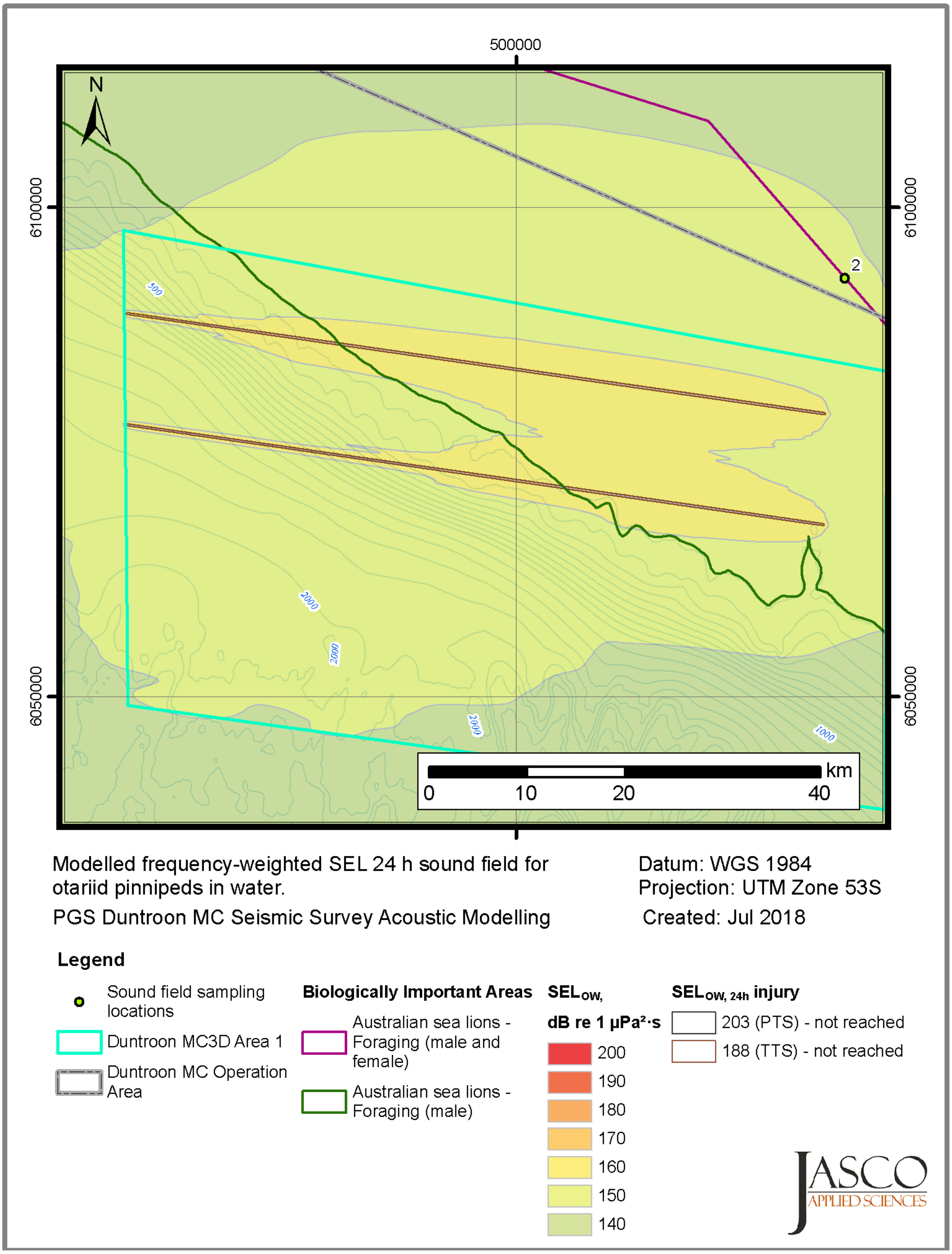

Figure 44. Otariid pinnipeds in water (OW): Sound level contour map showing frequency-weighted maximum-over-depth SEL results accumulated over 24 h.

4.3.2.2. Depths ≤600 m

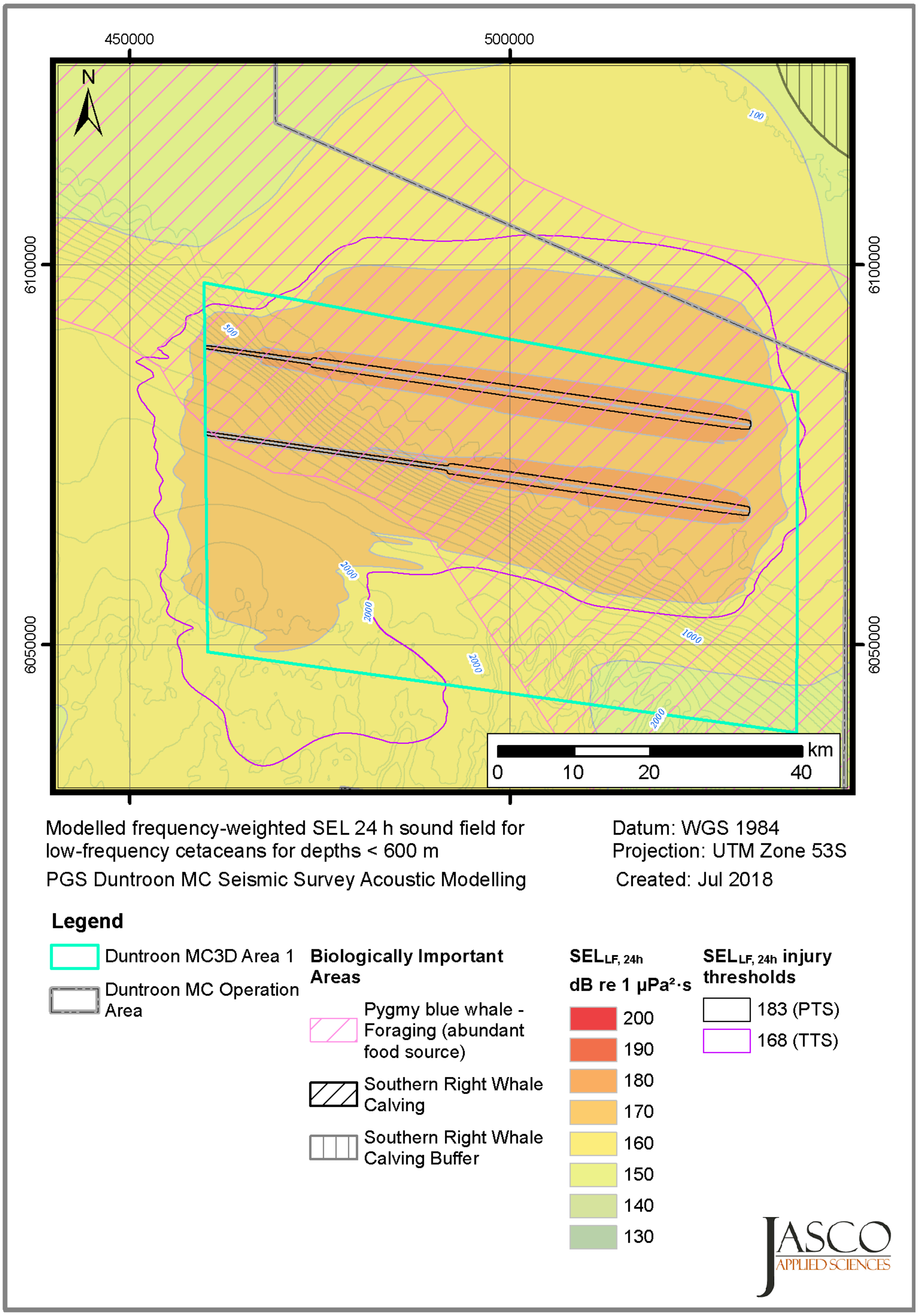

Figure 45. Depths ≤600 m: Low-frequency cetaceans (LF): Sound level contour map showing frequency-weighted maximum-over-depth SEL results accumulated over 24 h.

4.3.2.3. Seafloor

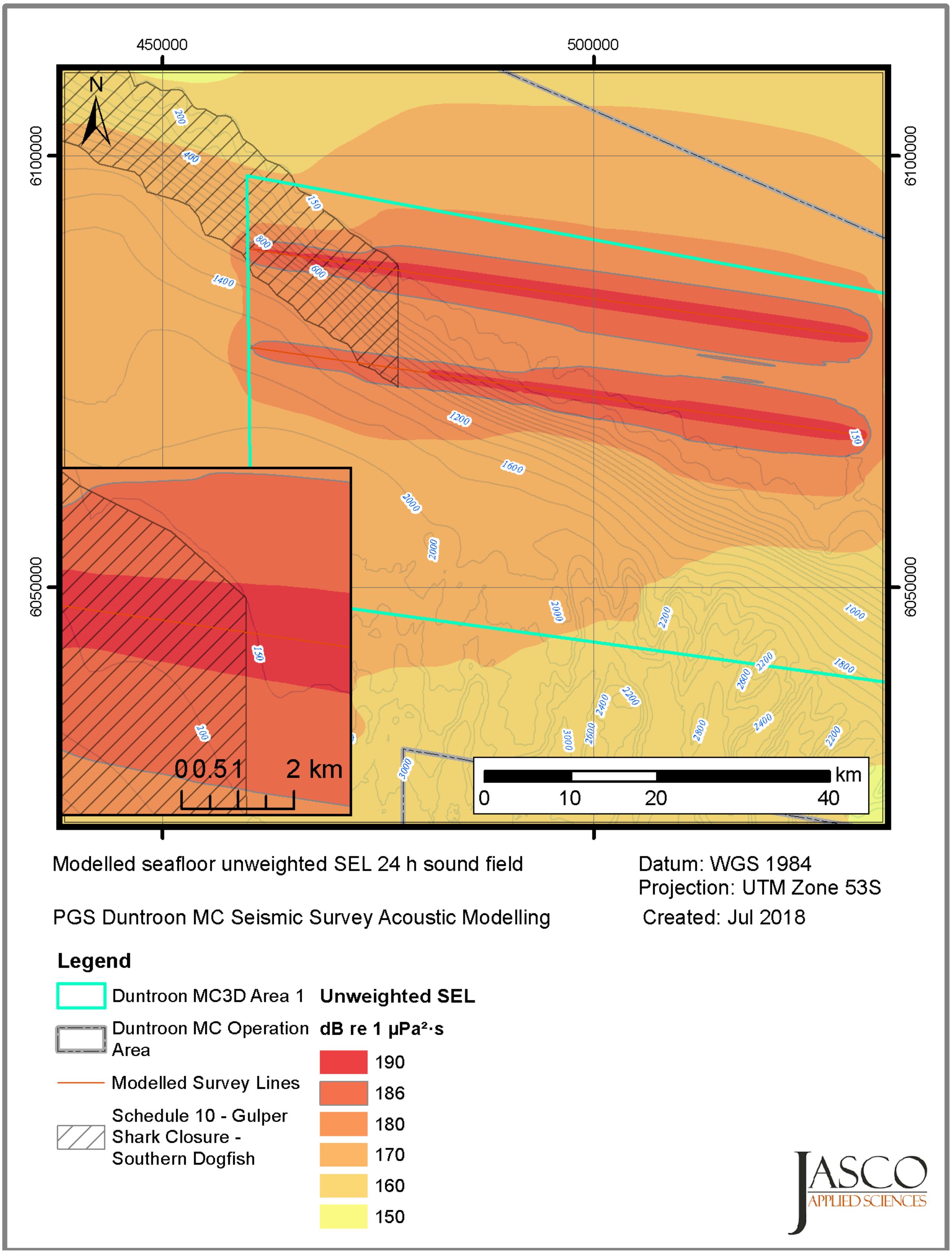

Figure 46. Sound level contour map showing unweighted seafloor SEL results accumulated over 24 h. The maximum distance to the seafloor 186 dB re 1 µPa²·s isopleth at the eastern boundary of the Southern Dogfish closure is 2.88 km.

5. Discussion and Conclusion

5.1. Overview

This modelling study predicted underwater sound levels associated with the 3-D component for PGS's proposed Duntroon Marine Seismic Survey. The underwater sound field was modelled for a 3260 in^3 airgun array (Appendix D.4) for water column sound speed profiles from May, the month with the highest noise transmission as determined from sound speed profiles (Appendix D.3.2). May was chosen to ensure precautionary estimates of distances to received sound level thresholds over the duration of the survey. The modelling also accounted for variations in site-specific bathymetry (Appendix D.3.1) and local geoacoustic properties (Appendix D.3.3).

The overall broadband (10–25000 Hz) unweighted per-pulse SEL source level of the 3260 in^3 array was 224.9 dB re 1 µPa^2·s in the broadside direction and 223.5 dB re 1 µPa^2·s in the endfire direction. The peak pressure level in the same directions was 249.5 and 246.2 dB re 1 µPa respectively (Table 11); most of the acoustic energy is output at lower frequencies, in the tens to hundreds of hertz. Although there was little difference in the broadband source levels in the endfire and broadside directions, below a few hundred Hz some directivity caused slightly higher emissions in the broadside direction at those frequencies.

5.2. Single pulse sound fields

The modelling results for the Duntroon MSS reflect the nature of the bathymetry within the survey area, which encompasses the continental shelf, the shelf edge, and deep water within the GAB. The ranges to SEL isopleths associated with levels of 160 dB re 1 µPa^2·s and higher typically decrease as the depth increases (Table 12).

The alignment of the acquisition lines with the continental shelf and the source directivity causes broadside lobes to propagate strongly in the offshore direction as depth increases. This is particularly noticeable in the SPL maps at Sites 1, 2, and 4, Line 1 (Figures 5, 7, and 9) and Site A (Figure 13). The modelled sites close to the shelf slope, which includes all Sites apart from Sites 1 and 5 on Line 1, and Sites 1 and 2 on Line 2, are all influenced by the presence of the slope. The presence of the slope supports long range propagation towards deeper water, which includes the western endfire and southern broadside directions. Site 3, Line 1, exhibits the strongest propagation in all offshore directions because depth increases with distance. While transmission loss is higher in the upslope direction, the strong directionality of the array typically results in distances to isopleths in the upslope direction still being greater than those in the endfire (along shelf break) direction. For the deepest site, Site 1, Line 1, the deep water reduces the reflection rate close to the source which limits the range to noise thresholds close to the source. At greater distances, however, the noise footprint is predominantly controlled by the bathymetry, with greater propagation towards deeper waters because less energy is lost to seabed interactions.

Prominent refractions and coherent focusing of sound in the southern broadside direction appear in the model results. These are illustrated in the examples at Site 2, Line 1 and Site A in the SPL maps (Figures 7 and 13), and the vertical slice plots which also include Site 3, Line 2 (Figures 24, 25, and 27). Sections of the footprint separated from the main coherent sound field can be described as 'sound islands'. These are apparent in the aforementioned examples for isopleths of 160 dB re 1 µPa^2·s and lower at long ranges are due to coherent focusing of sound in the homogeneous environment considered in the modelling. The environment is actually non-homogenous, with seafloor and sea surface roughness, along with localised variations in temperature and salinity. Therefore these 'sound islands', particularly the smaller ones, are not likely to exist, as the coherent focusing that creates them will be disrupted by scattering and refraction caused by roughness and inhomogeneities. To reduce the influence of the homogeneous modelling environment, range-dependent smoothing is applied according to the method of Harrison and Harrison (1995) to simulate the average transmission loss over the frequencies of each 1/3-octave-band (a Gaussian window with standard deviation of one quarter of the bandwidth was used). The outcome of the smoothing is likely a more realistic representation of what could be observed in a hon-homogeneous environment. The predicted per-pulse SEL and SPL R_{max} radii in

Tables 12–17 for isopleths of 150 dB re 1 µPa²·s or 160 dB re 1 µPa and lower are not statistically representative of the sound field shape and extent, therefore the $R_{95\%}$ distance is recommended for use in the impact assessment to represent distances to these isopleths.

As the water depth increases, the ensonified area at depths less than or equal to 600 m decreases (Table 26) due to the sound speed profile being downwards refracting from 50–1200 m, trapping more energy at lower depths. The corresponding R_{max} distance is in some cases the same considering the entire water column or just depths ≤600 m, comparing Tables 12 and 21, this is because the bathymetry can influence the refraction of energy. For instance, if the modelling site is in close proximity to the slope, the influence of the slope causes upwards refraction in the upslope direction (Figure 18).

The closest modelled site to the Neptune Islands (Site 1, Line 2) results in a received level at a point midway between the islands, 76.6 km away, of 120 dB re 1 µPa (Table 18). The closest corner of point of the 3-D Survey Area 1 to this location is 61.7 km. The sound levels at the Neptune Islands if the array was to operate at the closest corner of point of 3-D Survey Area 1 are expected to be below 130 dB re 1 µPa (Figure 11). The closest modelled site to the SRW BIAs (Site 5, Line 2) results in received levels of 137 and 125 dB re 1 µPa at the boundaries of the calving buffer BIA and the calving BIA, respectively (Table 18). The LF-weighted SPL at the same locations is 4.2 and 3.2 dB lower than the unweighted equivalent, with the received levels being 132.8 and 121.8 dB re 1 µPa respectively (Table 19; Figure 17). Therefore the sound levels within the SRW BIAs are associated with a 10% probability of behavioural response according to the Wood et al. (2012) behavioural exposure criteria used in this analysis for calving and migrating SRW.

Considering the modelled sites in 3-D survey Area 1, The distance to the isopleth associated with the NMFS (2013) marine mammal behavioural response criterion of 160 dB re 1 µPa ranged from 6.08 to 9.78 km based on $R_{95\%}$ distances, or 7.60 to 12.75 km based on R_{max} distances (entire water column, Table 13), with the longest ranges occurred at the sites located around the shelf break. The minimum difference between the R_{max} and $R_{95\%}$ distances is 1.52 km (Site 1, Line 1), and the maximum is 6.5 km (Site 4, Line 2). However, as discussed previously, the $R_{95\%}$ distances are recommended for this isopleth. The distances to the threshold for turtle behavioural response, 166 dB re 1 µPa (SPL) (NSF 2011), ranged from 2.82 to 4.32 km based on $R_{95\%}$ distances, or 3.58 to 5.38 km based on R_{max} distances (entire water column, Table 13). Considering only depths ≤600 m, the distances for turtle behavioural response ranged from 1.87 to 4.32 km based on $R_{95\%}$ distances, or 2.25 to 5.38 km based on R_{max} distances (depths ≤600 m, Table 22). Tables 25 and 27 present the total ensonified area for the entire water column and depths ≤600 m; the latter is more biologically relevant for determining the potential area of effect on mysticetes and turtles in terms of behavioural disturbance. This ensonified area is also more representative of the region of effect than the R_{max} or $R_{95\%}$ distances.

To place in context the modelled sites in 3-D Survey Area 2, A and B, with those at a similar depth in 3-D Survey Area 1, Line 1 Site 2 and Site 3, the resulting radii have been compared in Table 34. The radii for sound levels from 160 dB re 1 µPa²·s and higher are similar, with the greatest difference being 170 m. At lower sound levels and greater distances, the difference increases, which is due to the influence of the different bathymetry between the different locations. The bathymetry in 3-D Survey Area 2 has a more gradual slope when compared to that in 3-D Survey Area 1, where the slope is steeper.

The PK and PK-PK at the seafloor (Sections 4.2.1.3 and 4.2.2.4) were examined for comparison to criteria for fish (including sharks) (Section 2.2), and comparison the results in Payne et al. (2008), and Day et al. (2016a). As the sound levels associated with the accumulated SEL criteria for fish injury were not reached at the seafloor, the PK metric is the only relevant metric when considering the potential for injury. The PK metric associated with potential injury for fish without a swim bladder (applied to sharks in the absence of other information) was reached at the seafloor only at Site F (160 m deep), at a distance of 28 m from the centre of the array. At Site F, the distance for other categories of fish was 150 m. At Site C (200 m deep), only the criteria for fish with a swim bladder was reached, and the associated distance was 123 m (Table 28). The PK-PK metric from Payne et al. (2008), 202 dB re 1 µPa, was reached at all assessed sites (Table 29), with the maximum distance of 718 m occurring at Site C, due to the influence of the constructive critical angle bottom reflection (Figure 39).

Table 34. Comparison (distance) between maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the 3260 in^3 array to modelled maximum-over-depth per-pulse SEL isopleths between sites at similar depths in 3-D Survey Area 1 and 2 (Tables 12 and 14).

Per-pulse SEL (L_E; dB re 1 µPa²·s)	Line 1, Site 3 compared to Site A (~500 m depth)		Line 1, Site 2 compared to Site B (~1000 m depth)	
	R_{max} (m)	$R_{95\%}$ (m)	R_{max} (m)	$R_{95\%}$ (m)
190	0	0	0	0
180	0	0	0	0
170	−3	−1	1	0
160	10	6	170	0

5.3. Multiple pulse sound fields

This study also considered one scenario to assess the accumulated SEL of multiple airgun pulses over 24 hours of seismic operation, which was also based on the NMFS (2018) criteria. The model, which measured the cumulative effects of noise, considered the change in location and the azimuth of the source at each impulse point. The model predicts that unmitigated (no shut-downs) would result in effects criteria exceedance as follows:

- The PTS criteria were exceeded only for the low-frequency cetaceans, at a maximum horizontal distance of 760 m from each acquisition line (Table 30, Figure 40).
- TTS in pinnipeds was assessed to occur only in phocid pinnipeds, and at maximum horizontal distances of 270 m (Table 30, Figure 43). Therefore, TTS is not predicted to occur in otariid pinnipeds, a group that includes Australian sea lions (Figure 44).

Considering only depths ≤600 m (Table 33, Figure 45), the distance to the PTS criteria for low-frequency cetaceans remains the same. The R_{max} for lower isopleths is also similar that for the entire water column and is determined by distances in the offshore direction. However, the total ensonified area at depths ≤600 m is significantly smaller for lower sound levels than it is for the entire water column, due to the downwards refracting sound speed profile. The R_{max} is highly direction dependent and does not represent the ensonification distances along the slope nor on the continental shelf.

The 24-h SEL is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding 24-h SEL radii for low-frequency cetaceans are larger than those for peak pressure criteria, but they represent an unlikely worst-case scenario. More realistically, marine mammals (or fish) would not stay in the same location or at the same range for 24 hours. Therefore, a reported radius for 24-h SEL criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (either PTS or TTS) if it remained in that range for 24 hours.

Location 2 (Table 32) had the highest received levels over 24 hours, this sound field sampling location was on the boundary of the male and female Australian sea lion BIA. This sampling location was exposed to the broadside aspect of the array while the seismic vessel was traversing both Lines 1 and 2, and therefore represents a worst case ensonification of the BIA. The SEL 24 h at this location for otariid pinnipeds was 151.6 dB re 1 µPa²·s. The received levels at both sampling locations on the 100 m isobath for otariid pinnipeds were identical (145.5 dB re 1 µPa²·s) and well below the TTS criterion. The maximum levels at the sampling location on the BIA boundary in the direction of Kangaroo Island (Location 3) was 144.6 dB re 1 µPa²·s for otariid pinnipeds and 157.1 dB re 1 µPa²·s for low-frequency cetaceans.

5.4. Summary

This section summarises the results in the context of the criteria and specific sound levels considered in the study (Section 2).

Marine Mammals

- NMFS (2018) marine mammal injury criteria: The results considered both metrics within the criteria for Permanent Threshold Shift (PTS) (PK and SEL_{24h}). The furthest distance associated with either metric is required to be applied. The maximum distances along with the relevant metric and the location of the results are summarised in Table 35. Because the array is not a point source (8.8 × 16.8 m), the actual ranges from the edge of the airgun array are small for mid-frequency cetaceans, phocid and otariid pinnipeds.
- Based on the marine mammal injury criteria (NMFS 2018), temporary threshold shifts (non-injurious) in otariid pinnipeds such as the Australian sea lion are not predicted to occur at distances beyond the aperture of the array. However, TTS could occur in phocid pinnipeds at a maximum horizontal distance of 270 m from the 3260 in^3 seismic airgun array, considering PK and SEL_{24h} metrics (Tables 17 and Table 30).
- United States National Marine Fisheries Service (NMFS; 2013) acoustic threshold for behavioural effects in marine mammals: Airgun sounds exceeded the sound pressure level (SPL) threshold of 160 dB re 1 µPa for behavioural effects on marine mammals within 7.16 or 8.61 km of the 3260 in^3 seismic airgun array (Tables 13 and 15, $R_{95\%}$ distances) at the shallowest site (127 m, Site 1 Line 2) and Site A (496 m) respectively, considering the entire water column. The model represents best estimates of distances to the criteria, and although pockets of coherently-focussed sound do influence the R_{max} results on a site dependent basis, the $R_{95\%}$ distances are likely more representative of distances.
- Received sound levels at the boundary of the SRW calving and calving buffer BIAs were examined from the closest modelled site, and expressed in terms of unweighted and NMFS (2018) low-frequency (LF) weighted SPL. The LF weighted SPL is reported for comparison to the Wood et al. (2012) probabilistic disturbance threshold for migrating mysticetes, which have been demonstrated to respond to seismic airgun noise at lower received sound levels when compared to mysticetes in other behavioural states. The thresholds for migrating mysticetes are a 10% response likelihood at a weighted SPL of 120 dB re 1 µPa, 50% at a weighted SPL of 140 dB re 1 µPa, and a 90% response likelihood at a weighted SPL of 160 dB re 1 µPa.
    - Unweighted sound levels at the boundaries of the calving buffer BIA and calving BIA are predicted to be 137 dB and 125 re 1 µPa (SPL), respectively (Figure 16; Table 18).
    - LF-weighted sound levels at the boundaries of the calving buffer BIA and calving BIA are predicted to be 132.8 dB and 121.8 re 1 µPa (SPL), respectively (Figure 17; Table 19). This is associated with a 10% probability of behavioural response according to the Wood et al. (2012) behavioural exposure criteria used in this analysis for calving and migrating SRW.

Table 35. Summary of marine mammal PTS (injurious) onset distances. The per-pulse modelling resolution was 20 m.

Relevant hearing group	Metric associated with PTS onset	Distance R_{max} (m)	Result location
Low-frequency cetaceans†	SEL_{24h}; $L_{E,24h}$	760	Table 30
Low-frequency cetaceans in water depths ≤600m†		760	Table 30
Mid-frequency cetaceans	PK; L_{pk}	<20	Table 17
High-frequency cetaceans		450	
Phocid pinnipeds in water		40	
Otariid pinnipeds in water		<20	

† The model does not account for shutdowns.

Table 36. Summary of marine mammal TTS onset distances

Relevant hearing group	Metric associated with longest distance to TTS onset	R_{max} (km)	Result location
Low-frequency cetaceans†	SEL24h; $L_{E,24h}$	88.1	Table 30
Low-frequency cetaceans in water depths ≤600m†		42.3	Table 30
Mid-frequency cetaceans	PK; L_{pk}	<0.02	Table 17
High-frequency cetaceans		0.98	
Phocid pinnipeds in water		0.07	
Otariid pinnipeds in water		<0.02	

† The model does not account for shutdowns.

Turtle Behaviour

- United States NMFS criterion for behavioural effects in turtles: Airgun sounds exceeded the 166 dB re 1 µPa SPL (L_p) threshold for behavioural effects within 1.87 to 4.32 km based on $R_{95\%}$ distances, or 2.76 to 3.27 km based on R_{max} distances at depths ≤600 m (Tables 22 and 24). Depths ≤600 m are likely more biologically relevant for turtles than those below 600 m.

Fish, Turtle Injury, Fish Eggs, and Fish Larvae

- Based on PK (L_{pk}) metrics, acoustic injury (including both lethal and recoverable injuries) could be sustained at the seafloor within a maximum horizontal distance of 28 m of the seismic array for fish without a swim bladder (Site F, 160 m deep) and within a maximum horizontal distance of 150 m for fish with a swim bladder, turtles, fish eggs, and fish larvae (160 m depth) (Table 28).
- The ranges associated with possible mortality, potential mortal injury, and recoverable injury to fish, turtles, fish eggs and larvae from Popper et al. (2014) using the SEL_{24h} ($L_{E,24}$) metric were not reached. As per the criteria, the PK metric should therefore be applied to assess these impacts to fish, turtles, fish eggs, and fish larvae.
- Considering the defined 24 hours of exposure, fish hearing could be temporarily impaired (TTS) within 4.92 km of the airgun array at the seafloor, and 4.97 km in the water column, based on the estimated horizontal R_{max} radii (Table 31). The distances are determined from the shallower water sections of the lines, as in deeper water, the distance to criteria is shorter, being only 2.88 km at the eastern boundary of the Southern Gulper Shark closure area (Figure 46).

Crustaceans, Bivalves and Plankton

- To assist with the assessment of potential effects on crustaceans and bivalves, seafloor PK-PK was assessed at four locations, considering isopleths equivalent to those reported in Day et al. (2016a) along with the distance to a PK-PK of 202 dB re 1 µPa from Payne et al. (2007). The maximum distance to this sound level (202 dB re 1 µPa) is 718 m (Table 29).
- To assist with the assessment of potential effects on plankton, the distances to the sound level of 178 dB re 1 µPa PK-PK from McCauley et al. (2017) were estimated to range between 8 and 19.8 km at the five modelling sites based on R_{max} distances and maximum-over-depth (Table 20).

Glossary

3-D
Three-dimensional

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise a one octave-band. One-third-octave-bands become wider with increasing frequency. Also see octave.

90% time window
The time interval over which the cumulative energy rises from 5% to 95% of the total pulse energy. This interval contains 90% of the total pulse energy. Symbol: T_{90}.

90% sound pressure level (90% SPL)
The root-mean-square sound pressure levels calculated over the 90%-energy time window of a pulse. Used only for pulsed sounds.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

audiogram
A graph of hearing threshold level (sound pressure levels) as a function of frequency, which describes the hearing sensitivity of an animal over its hearing range.

auditory weighting function (frequency-weighting function)
Auditory weighting functions account for marine mammal hearing sensitivity. They are applied to sound measurements to emphasise frequencies that an animal hears well and de-emphasise frequencies they hear less well or not at all (Southall et al. 2007, Finneran and Jenkins 2012, NOAA 2013).

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

bandwidth
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI/ASA S1.13-2005 R2010).

bar
Unit of pressure equal to 100 kPa, which is approximately equal to the atmospheric pressure on Earth at sea level. 1 bar is equal to $10^{6\ \mathrm{Pa}}$ or $10^{11\ \mu\mathrm{Pa}}$.

BIA
Biologically Important Area (http://www.environment.gov.au/marine/marine-species/bias)

broadside direction
Perpendicular to the travel direction of a source. Compare to endfire direction.

cetacean
Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

compressional wave
A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

endfire direction
Parallel to the travel direction of a source. Also see broadside direction.

ensonified area
The total area ensonified in conjunction with a specified isopleth.

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

functional hearing group
Grouping of marine mammal species with similar estimated hearing ranges. Southall et al. (2007) proposed the following functional hearing groups: low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

geoacoustic
Relating to the acoustic properties of the seafloor.

GAB
Great Australian Bight

hearing threshold
The sound pressure level that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hertz (Hz)
A unit of frequency defined as one cycle per second.

high-frequency cetacean
The functional hearing group that represents odontocetes specialised for using high frequencies.

impulsive sound
Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 R2006). For example, seismic airguns and impact pile driving.

low-frequency cetacean
The functional hearing group that represents mysticetes (baleen whales).

maximum-over-depth (MOD)
The maximum value over all modelled depths above the sea floor.

mid-frequency cetacean
The functional hearing group that represents some odontocetes (dolphins, toothed whales, beaked whales, and bottlenose whales).

MC
Multi-Client

MSS
Marine Seismic Survey

mysticete
Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate but use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and the grey whale (*Eschrichtius robustus*).

non-impulsive sound
Sound that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time (typically only small fluctuations in decibel level) that impulsive signals have (ANSI/ASA S3.20-1995 R2008). Marine vessels, aircraft, machinery, construction, and vibratory pile driving are examples.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete
The presence of teeth, rather than baleen, characterises these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The toothed whales' skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

peak pressure level (PK)
The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak pressure level. Unit: decibel (dB).

peak-to-peak pressure level (PK-PK)
The difference between the maximum and minimum instantaneous pressure levels. Unit: decibel (dB).

permanent threshold shift (PTS)
A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

pinniped
A common term used to describe all three groups that form the superfamily Pinnipedia: phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

power spectrum density
The acoustic signal power per unit frequency as measured at a single frequency. Unit: $\mu Pa^2/Hz$, or $\mu Pa^2 \cdot s$.

power spectrum density level
The decibel level ($10\log_{10}$) of the power spectrum density, usually presented in 1 Hz bins. Unit: dB re 1 $\mu Pa^2/Hz$.

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

pulsed sound
Discrete sounds with durations less than a few seconds. Sounds with longer durations are called continuous sounds.

received level
The sound level measured at a receiver.

shear wave
A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seafloor can be converted to compressional waves in water at the water-seafloor interface.

signature
Pressure signal generated by a source.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure
Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second ($Pa^2 \cdot s$) (ANSI S1.1-1994 R2004).

sound exposure level (SEL)
A cumulative measure related to the sound energy in one or more pulses. Unit: dB re 1 $\mu Pa^2 \cdot s$. SEL is expressed over the summation period (e.g., per-pulse SEL [for airguns], single-strike SEL [for pile drivers], 24-hour SEL).

sound field
Region containing sound waves (ANSI S1.1-1994 R2004).

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 µPa) and the unit for SPL is dB re 1 µPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2 / p_0^2\right) = 20\log_{10}\left(p / p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source. Unit: dB re 1 $\mu Pa^2 m^2$ or dB 1 $\mu Pa^2 m^2 s$.

spectrum
An acoustic signal represented in terms of its power (or energy) distribution versus frequency.

temporary threshold shift (TTS)
Temporary loss of hearing sensitivity caused by excessive noise exposure.

transmission loss (TL)
Also called propagation loss, this refers to the decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment.

wavelength
Distance over which a wave completes one oscillation cycle. Unit: meter (m). Symbol: λ.

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Appendix A. Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 µPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak sound pressure level (PK; L_{pk}; $L_{p,\text{pk}}$; dB re 1 µPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,pk} = 20\log_{10}\left[\frac{\max(|p(t)|)}{p_0}\right] \quad \text{(A-1)}$$

PK is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The peak-to-peak sound pressure level (PK-PK; $L_{\text{pk-pk}}$; $L_{p,\text{pk-pk}}$; dB re 1 µPa) is the difference between the maximum and minimum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound, $p(t)$:

$$L_{p,pk-pk} = 10\log_{10}\left\{\frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2}\right\} \quad \text{(A-2)}$$

The sound pressure level (SPL; L_p; dB re 1 µPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \quad \text{(A-3)}$$

where $g(t)$ is an optional time weighting function. The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalisation, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL.

In studies of impulsive noise, the time window function $g(t)$ is often a decaying exponential that emphasizes more recent pressure signals to mimic the leaky integration of the mammalian hearing system. For example, human-based fast time weighting applies an exponential function with time constant 125 ms. Another approach for evaluating L_p of impulsive signals is to set T to the “90% time window” (T_{90}): the period over which cumulative square pressure function passes between 5% and 95% of its full per-pulse value. The SPL computed over this T_{90} interval is commonly called the 90% SPL (SPL(T_{90}); L_{p90}; dB re 1 µPa):

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} p^2(t)dt \Big/ p_0^2\right) \quad \text{(A-4)}$$

The sound exposure level (SEL; L_E; $L_{E,p}$; dB re 1 µPa²·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \tag{A-5}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right). \tag{A-6}$$

To compute the SPL(T_{90}) and SEL of acoustic events in the presence of high levels of background noise, equations A-4 and A-5 are modified to subtract the background noise contribution:

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} (p^2(t) - \overline{n^2})dt \Big/ p_0^2\right) \tag{A-7}$$

$$L_E = 10\log_{10}\left(\int_T (p^2(t) - \overline{n^2})dt \Big/ T_0 p_0^2\right) \tag{A-8}$$

where $\overline{n^2}$ is the mean square pressure of the background noise, generally computed by averaging the squared pressure of a temporally-proximal segment of the acoustic recording during which acoustic events are absent (e.g., between pulses).

Because the SPL(T_{90}) and SEL are both computed from the integral of square pressure, these metrics are related by the following expression, which depends only on the duration of the time window T:

$$L_p = L_E - 10\log_{10}(T) \tag{A-9}$$

$$L_{p90} = L_E - 10\log_{10}(T_{90}) - 0.458 \tag{A-10}$$

where the 0.458 dB factor accounts for the 10% of SEL missing from the SPL(T_{90}) integration time window.

If applied, the frequency weighting of an acoustic event should be specified, as in the case of LF-weighted SEL (e.g., $L_{E,LF,24h}$; Appendix A.2). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should else be specified.

A.1. Marine Mammal Impact Criteria

Marine mammals can be adversely affected by underwater anthropogenic noise. Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR

1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for both injury) and disturbance (Section 2.1.2). The following sections summarise the recent development of thresholds; however, this field remains an active research topic.

A.1.1. Injury

In recognition of shortcomings of the SPL-only based injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: Low-, Mid- and High-Frequency cetaceans (LF, MF, and HF respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for human; Appendix A.2). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 $\mu Pa^2 \cdot s$. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF on results obtained from MF studies. In particular they referenced Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 $\mu Pa^2 \cdot s$.

As of 2017, an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2018). The guidance describes injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). Table A-1 lists the recommended thresholds. The criteria defined in NMFS (2018) are applied in this report.

Table A-1. Marine mammal injury (PTS onset) thresholds based on NMFS (2018).

Hearing group	Impulsive source		Non-impulsive source
	PK	Weighted SEL (24 h)	Weighted SEL (24 h)
Low-frequency cetaceans	219	183	199
Mid-frequency cetaceans	230	185	198
High-frequency cetaceans	202	155	173
Phocid pinnipeds in water	218	185	201
Otariid pinnipeds in water	232	203	219

A.2. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.2.1. Marine Mammal Frequency Weighting Functions

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \tag{A-11}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2018). Table A-2 lists the frequency-weighting parameters for each hearing group; Figure A-1 shows the resulting frequency-weighting curves.

Table A-2. Parameters for the auditory weighting functions recommended by NMFS (2018).

Hearing group	*a*	*b*	f_{lo} (Hz)	f_{hi} (kHz)	*K* (dB)
Low-frequency cetaceans	1.0	2	200	19,000	0.13
Mid-frequency cetaceans	1.6	2	8,800	110,000	1.20
High-frequency cetaceans	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water	1.0	2	1,900	30,000	0.75
Otariid pinnipeds in water	2.0	2	940	25,000	0.64

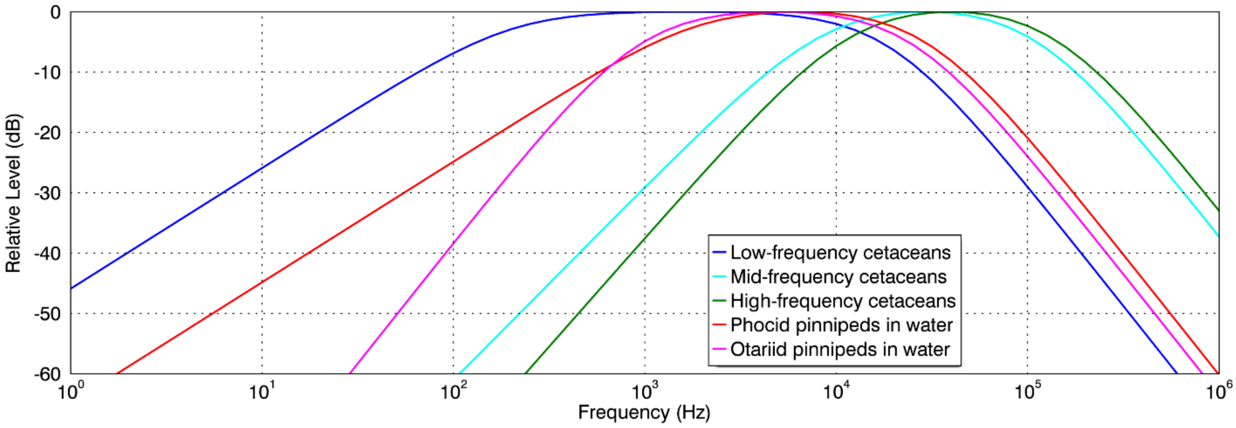

Figure A-1. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix B. Acoustic Source Model

B.1. Methods

The source levels and directivity of the airgun array were predicted with JASCO's Airgun Array Source Model (AASM). AASM includes low- and high-frequency modules for predicting different components of the airgun array spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. Physical effects accounted for in the simulation include pressure interactions between airguns, port throttling, bubble damping, and generator-injector (GI) gun behaviour discussed by Dragoset (1984), Laws et al. (1990), and Landro (1992). A global optimisation algorithm tunes free parameters in the model to a large library of airgun source signatures.

Whilst airgun signatures are highly repeatable at the low frequencies, which are used for seismic imaging, their sound emissions have a large random component at higher frequencies that cannot be predicted deterministically. Therefore, the high-frequency module of AASM uses a stochastic simulation to predict the sound emissions of individual airguns above 800 Hz, using a multivariate statistical model. The current version of AASM has been tuned to fit a large library of high quality seismic source signature data obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008). The stochastic model uses a Monte-Carlo simulation of the random component of the high-frequency spectrum of each airgun in an array. The mean high-frequency spectra from the stochastic model augment the low-frequency signatures from the physical model, allowing AASM to predict airgun source levels at frequencies up to 25,000 Hz.

AASM produces a set of "notional" signatures for each array element based on:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

These notional signatures are the pressure waveforms of the individual airguns at a standard reference distance of 1 m; they account for the interactions with the other airguns in the array. The signatures are summed with the appropriate phase delays to obtain the far-field source signature of the entire array in all directions. This far-field array signature is filtered into 1/3-octave-bands to compute the source levels of the array as a function of frequency band and azimuthal angle in the horizontal plane (at the source depth), after which it is considered to be a directional point source in the far field.

A seismic array consists of many sources and the point-source assumption is invalid in the near field where the array elements add incoherently. The maximum extent of the near field of an array (R_{nf}) is:

$$R_{\mathrm{nf}} < \frac{l^2}{4\lambda} \tag{B-1}$$

where λ is the sound wavelength and l is the longest dimension of the array (Lurton 2002, §5.2.4). For example, an airgun array length of $l = 21$ m yields a near-field range of 147 m at 2 kHz and 7 m at 100 Hz. Beyond this R_{nf} range, the array is assumed to radiate like a directional point source and is treated as such for propagation modelling.

The interactions between individual elements of the array create directionality in the overall acoustic emission. Generally, this directionality is prominent mainly at frequencies in the mid-range between tens of hertz to several hundred hertz. At lower frequencies, with acoustic wavelengths much larger than the inter-airgun separation distances, the directionality is small. At higher frequencies, the pattern of lobes is too finely spaced to be resolved and the effective directivity is less.

B.2. Acoustic Source Levels and Directivity Results

Figure B-1 shows the broadside (perpendicular to the tow direction), endfire (parallel to the tow direction), and vertical overpressure signatures and corresponding power spectrum levels for the 3260 in^3 array. The signatures consist of a strong primary peak, related to the initial release of high-pressure air, followed by a series of pulses associated with bubble oscillations. Most energy is produced at frequencies below 600 Hz. Frequency-dependent peaks and nulls in the spectrum result from interference among airguns in the array and correspond with the volumes and relative locations of the airguns to each other.

Horizontal 1/3-octave-band source levels are shown as a function of band centre frequency and azimuth (Figure B-2); directivity in the sound field is most noticeable at mid-frequencies as described in the model detail in Appendix B.1.

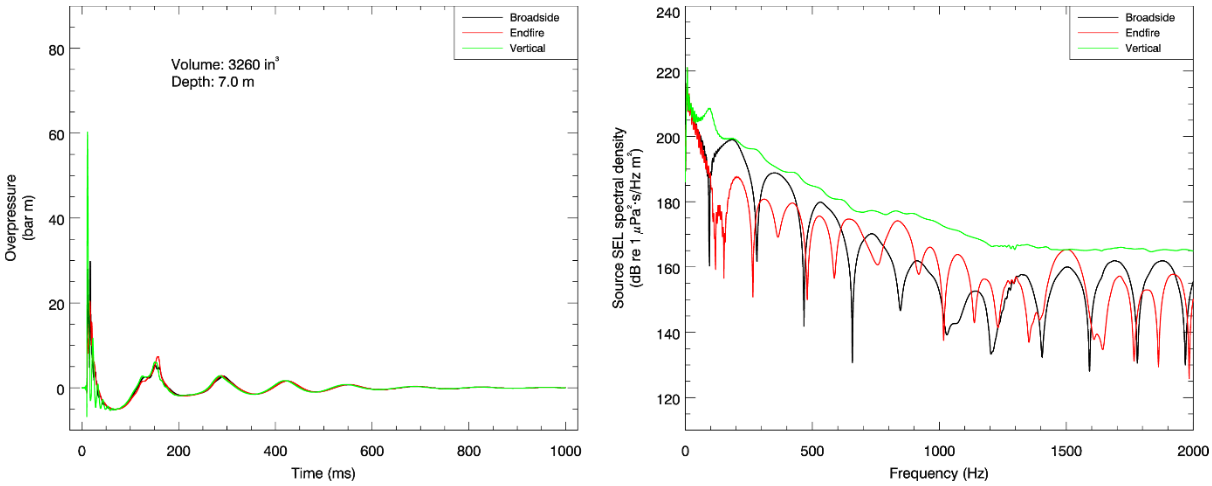

Figure B-1. Predicted source level details for the 3260 in^3 array towed at a depth of 7 m. (Left) the overpressure signature and (right) the power spectrum for broadside (perpendicular to tow direction) and endfire (directly aft of the array) directions, and for vertically down.

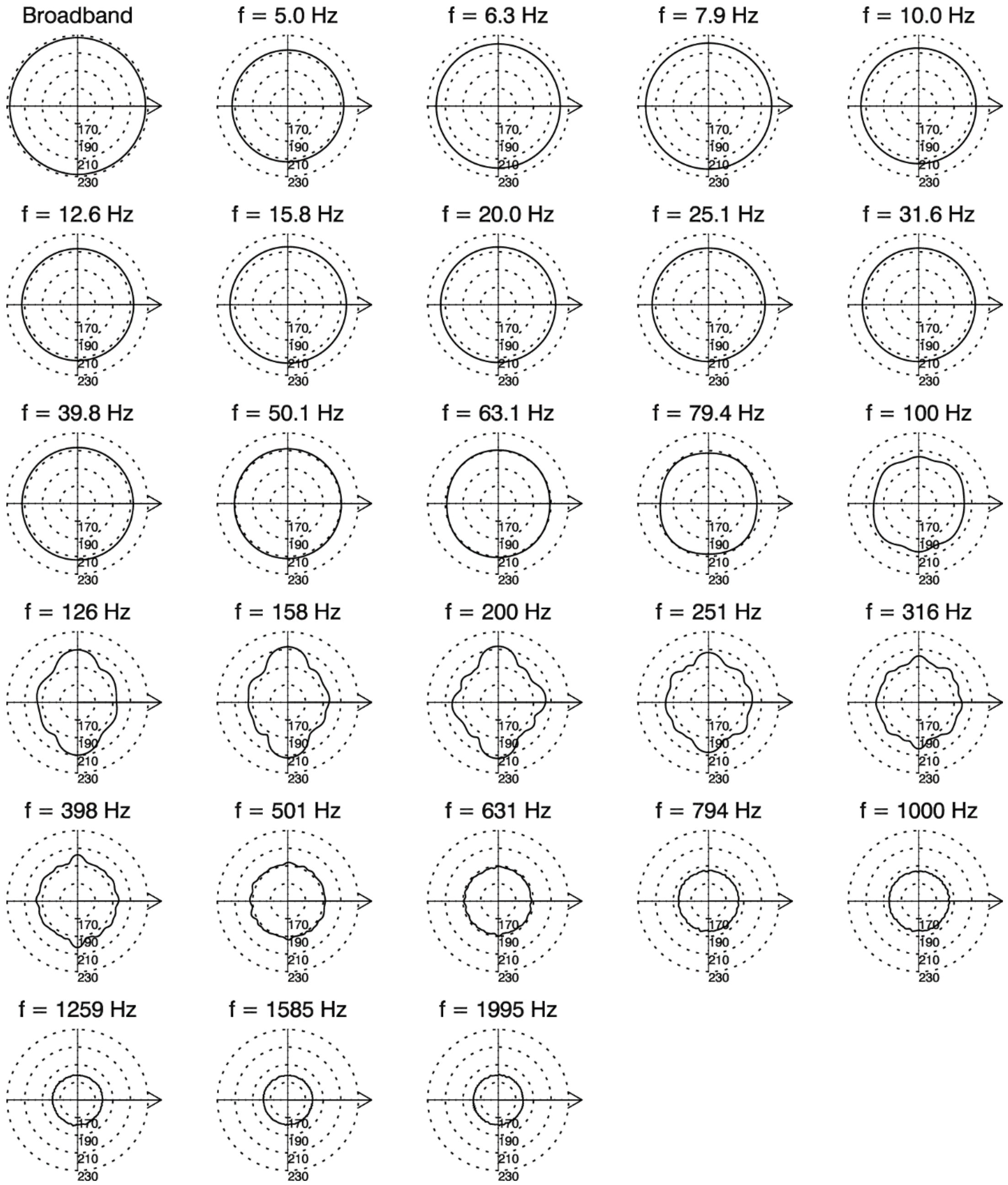

Figure B-2. Directionality of the predicted horizontal source levels for the 3260 in^3 array, 5–2000 Hz. Source levels (in dB re 1 µPa^2·s) are shown as a function of azimuth for the centre frequencies of the 1/3-octave-bands modelled; frequencies are shown above the plots. Tow direction is to the right. Tow depth is 7 m (see Table D-2)

Appendix C. Sound Propagation Models

C.1. MONM-BELLHOP

Underwater sound propagation (i.e., transmission loss) was predicted with JASCO's Marine Operations Noise Model (MONM). This model computes sound propagation at frequencies of 5 Hz to 1.25 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 1.25 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

This version of MONM accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons 1977). The former type of sound attenuation is significant for frequencies higher than 5 kHz and cannot be neglected without noticeably affecting the model results.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure C-1).

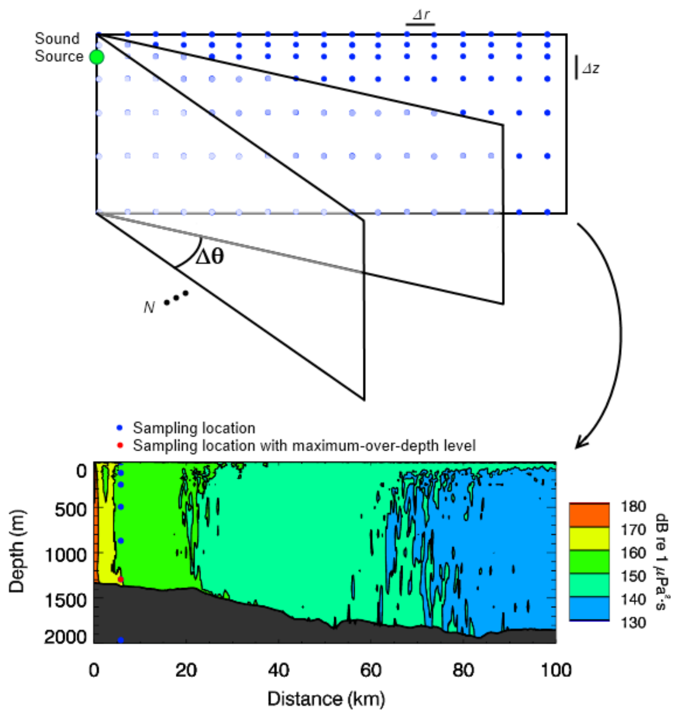

Figure C-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic transmission loss at the centre frequencies of 1/3-octave-bands. Range-dependent smoothing is applied according to the method of Harrison and Harrison (1995) to simulate the average transmission loss over the frequencies of each 1/3-octave-band (a Gaussian window with standard deviation of one quarter of the bandwidth was used). Sufficiently many 1/3-octave-bands, starting at 10 Hz, are modelled to include most acoustic energy emitted by the source. At each centre frequency, the transmission loss is modelled within each of the N vertical planes as a function of depth and range from the source. The 1/3-octave-band received per-pulse SELs are computed by subtracting the band transmission loss values from the directional source level in that frequency band. Composite broadband received SELs are then computed by summing the received 1/3-octave-band levels.

The received per-pulse SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-pulse SEL at a surface sampling receiver location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-pulse SELs are presented as colour contours around the source.

MONM's predictions have been validated against experimental data from several underwater acoustic measurement programs conducted by JASCO (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Martin et al. 2015).

C.2. FWRAM

For impulsive sounds from the seismic array, time-domain representations of the pressure waves generated in the water are required to calculate SPL and peak pressure level. Furthermore, the airgun array must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

Besides providing direct calculations of the peak pressure level and SPL, the synthetic waveforms from FWRAM can also be used to convert the SEL values from MONM to SPL.

C.3. Wavenumber Integration Model

Sound pressure levels near the airgun array were modelled using JASCO's VSTACK wavenumber integration model. VSTACK computes synthetic pressure waveforms versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solving the exact (range-independent) acoustic wave equation. This model is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom. Wavenumber integration methods are extensively used in the field of underwater acoustics and seismology where they are often referred to as reflectivity methods or discrete wavenumber methods. VSTACK computes sound propagation in arbitrarily stratified water and seabed layers by decomposing the outgoing field into a continuum of outward-propagating plane cylindrical waves. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. The output of the model can be post-processed to yield estimates of the SEL, SPL, and PK.

VSTACK accurately predicts steep-angle propagation in the proximity of the source but is computationally slow at predicting sound pressures at large distances due to the need for smaller wavenumber steps with increasing distance. Additionally, VSTACK assumes range-invariant bathymetry with a horizontally stratified medium (i.e., a range-independent environment), which is azimuthally symmetric about the source. VSTACK is thus best suited to modelling the sound field near the source.

Appendix D. Methods and Parameters

This section describes the specifications of the airgun array source that was used at all sites and the environmental parameters used in the propagation models.

D.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure D-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure D-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure D-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

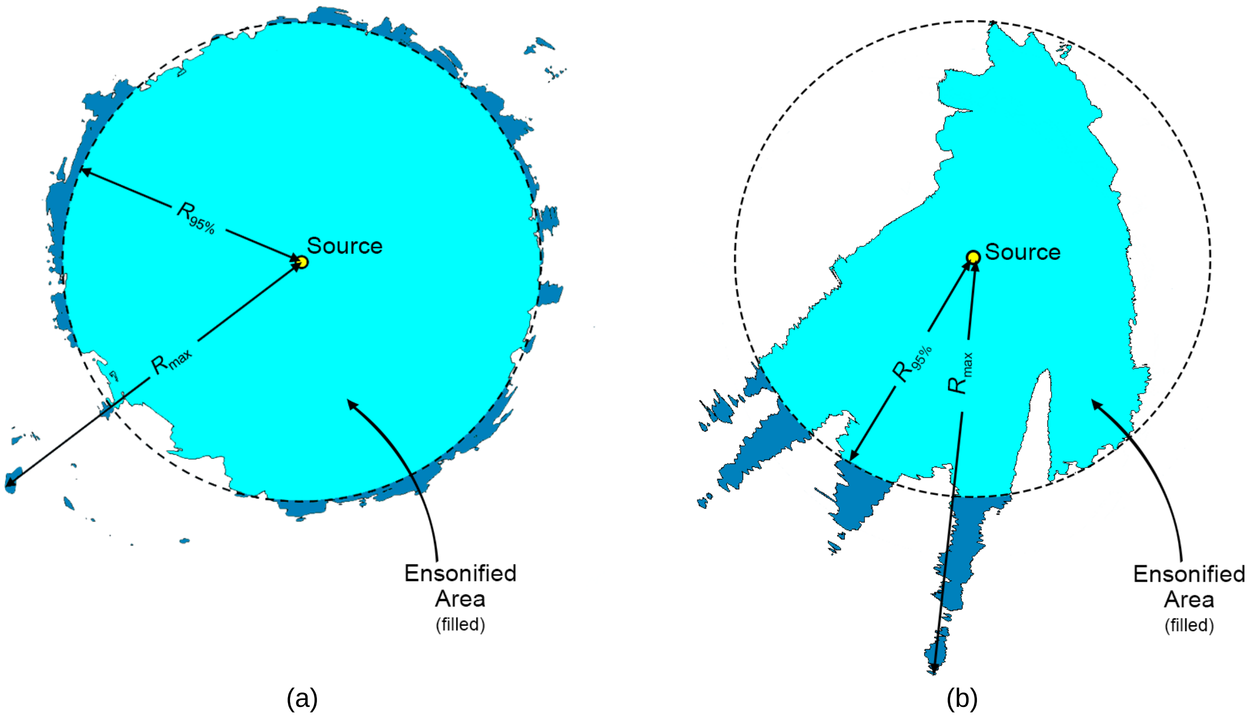

Figure D-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

D.2. Estimating SPL from Modelled SEL Results

The SEL of individual sound pulses is an energy-like metric related to the dose of sound received over the pulse's duration. The SPL on the other hand is related to the pulses intensity over a specified time interval (Appendix A). The time interval applied in this report is fixed at 125 ms.

Seismic pulses typically lengthen in duration as they propagate away from their source due to seafloor and surface reflections and other waveguide dispersion effects. The changes in pulse length affect the numeric relationship between SPL and SEL because the amount of pulse energy within the specified time interval changes. Full-waveform modelling is necessary to estimate SPL, but this type of modelling is computationally intensive and can be prohibitively time consuming when run at high spatial resolution over large areas.

The current study modelled synthetic seismic pulses from 5–1024 Hz with FWRAM (Appendix C.2). This was performed along broadside and endfire radials towards the Australian sea lion BIAs, at three Sites (1, 3, and 4) along the modelled survey line (Line 2; Figure 1). These sites were chosen to represent all water depth regimes along the modelled survey lines, and because they were closest to the sea lion BIAs.

FWRAM uses Fourier synthesis to recreate the signal in the time domain so that both the SEL and SPL can be calculated from the propagated signal. SPL was calculated using a 125 ms fixed time window positioned to maximise the SPL over the pulse duration. The difference between the SEL and SPL was extracted for all ranges and depths corresponded to those generated in the high spatial-resolution MONM results. The resulting SEL-to-SPL offsets were then averaged in 0.5 km range bins. The final range-dependent conversion function for each site correspond to the 90th percentile curve derived from the SEL-to-SPL offsets along all radials at that site. These range-dependent conversion functions were applied to predicted per-pulse SEL results from MONM and BELLHOP to model SPLs. The range-dependent conversion function for Site 1, Line 2, is shown in Figure D-2; the range-dependent conversion functions across all sites are presented in Appendix E.

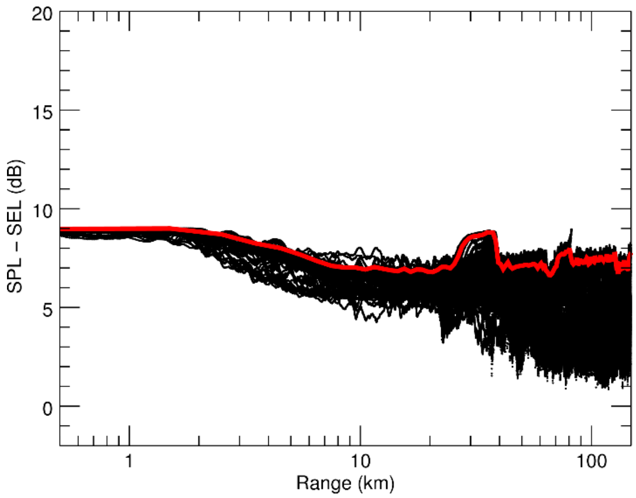

Figure D-2. Range-dependent conversion function (red) for converting SEL to SPL for seismic pulses at Site 1, Line 2. Black dots represent the SEL-to-SPL offsets along all radials at Site 1, Line 2.

D.3. Environmental Parameters

D.3.1. Bathymetry

Water depths throughout the modelled area were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid (approximately 250 × 280 m to 270 × 280 m at the studied latitudes) rendered for Australian waters (Whiteway 2009) (Figure 1). Bathymetry data were extracted and re-gridded onto a Universal Transverse Mercator (UTM) coordinate projections appropriate for all sites with a regular grid spacing of 100 × 100 m, which describes all sites in this study.

D.3.2. Sound speed profile

The sound speed profiles for the modelled sites were derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The temperature and salinity profiles were converted to sound speed profiles according to the equations of Coppens (1981).

The sound speed profiles for March, April, May, September, October, and November were calculated at five locations within the operation area and at one location farther offshore to examine the most conservative profile during the possible survey time period. The mean profiles of the five locations for each month were compared to determine which produced the most conservative scenario (Figure D-3). Since the profiles did not extend to the maximum water depth in the modelling area, they were supplemented with a deeper nearby offshore profile.

The sound speed profile for May provided the greatest propagation; the profile typically features a well-mixed layer with a slight upward-refracting gradient at 0-40 m. The sound speed profile between 50 and ~1200 m depth is downward refracting, but upward refracting at greater depths. The resulting profile was input to the sound propagation modelling (Figure D-3).

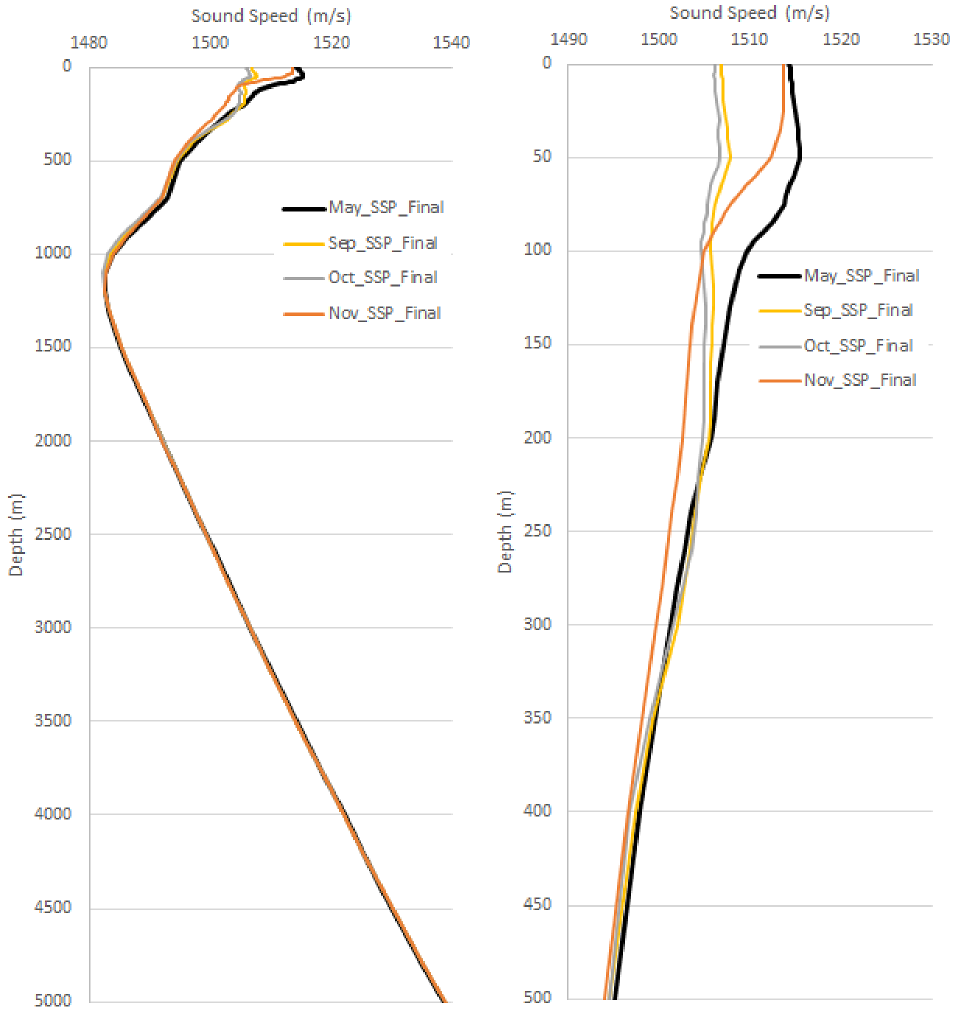

Figure D-3. The mean sound speed profiles for May, September, October, and November: full water depth (left), <500 m (right) at all sites. The profiles were calculated from temperature and salinity profiles from GDEM V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

D.3.3. Geoacoustics

Geoacoustic parameters used in acoustic transmission loss modelling were derived from sedimentary grain size measurements from the Australian Government's Marine Sediments (MARS) database (Heap 2009). Most of these samples were taken on or near the seafloor, although some are from sediment at greater depths. On average, the surficial grain size indicates silty sand is present throughout the modelled area. Geotechnical data along the southern Australian shelf typically show sand overlaying calcarenite layers (Bradshaw 2002, Duncan et al. 2013). Representative grain sizes and porosity were used in the grain-shearing model proposed by Buckingham (2005) to estimate the geoacoustic parameters required by the sound propagation models. Table D-1 lists the geoacoustic parameters used for numeric modelling.

Table D-1. Geoacoustic profile used as the input to the models at all sites.

Depth below seafloor (m)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–10	Silty sand to semi-cemented limestone	1.88	1605–1700	0.35–0.70	255	3.65
10–20		1.88–1.89	1700–1755	0.70–0.85		
20–50		1.89–1.90	1755–1850	0.85–1.15		
50–100		1.90–1.92	1850–1950	1.15–1.35		
100–200		1.92–1.96	1950–2100	1.35–1.60		
200–500		1.96–2.05	2100–2355	1.60–1.95		
>500		2.05	2355	1.95		

D.4. Acoustic Source

The model considered the following specifications:

- A 3260 in³ firing volume seismic airgun array.
- Bolt 1900 LLXT airguns operated at a firing pressure of 2000 psi.
- An 8.8 × 16.8 m array layout consisting of three strings towed at a 7.0 m depth (Figure D-4, Table D-2).

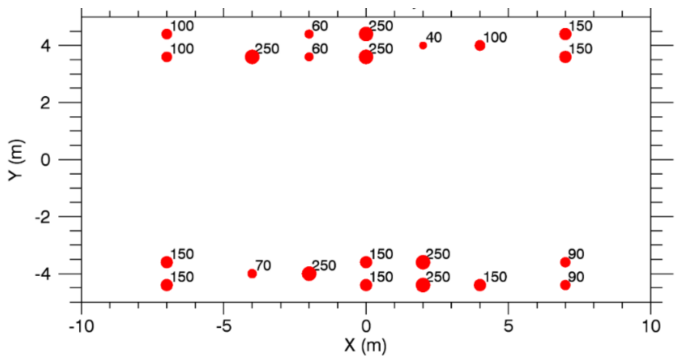

Figure D-4. Layout of the modelled 3260 in^3 airgun array. Tow depth is 7 m. The labels indicate the firing volume (in cubic inches) for each airgun. The convention is that the array is towed in the positive x direction. Also see Table D-2.

Table D-2. Layout of the modelled 3260 in^3 airgun array. Tow depth is 7 m. Firing pressure for all guns is 2000 psi. The tow direction is assumed to be in the positive *x* direction. Also see Figure D-4.

Gun	x (m)	y (m)	Volume (in^3)	Gun	x (m)	y (m)	Volume (in^3)
1	7	−4.4	90	13	7	3.6	150
2	7	−3.6	90	14	7	4.4	150
3	4	−4.4	150	15	4	4	100
4	4	−3.6	150 (spare)	16	2	4	40
5	2	−4.4	250	17	0	3.6	250
6	2	−3.6	250	18	0	4.4	250
7	0	−4.4	150	19	−2	3.6	60
8	0	−3.6	150	20	−2	4.4	60
9	−2	−4	250	21	−4	3.6	250
10	−4	−4	70	22	−4	4.4	250 (spare)
11	−7	−4.4	150	23	−7	3.6	100
12	−7	−3.6	150	24	−7	4.4	100

Appendix E. FWRAM Results

To generate SEL to SPL conversion factors and model distances to PK thresholds, FWRAM was run along three transects: endfire and the two broadside transects. FWRAM computes synthetic pressure waveforms versus range and depth using the PE approach. It computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. Because of the intensity of the computation, this model was run up to a frequency of 1024 Hz, and at three sites along survey line 2, closest to the Australian sea lion Biological Important Areas (BIAs). The conversion factors were applied at the nine modelled sites based on similarity in water depth.

The conversion factors were the same values calculated in the previous modelling (McPherson et al. 2017) since the array sizes are similar and the locations are the same. Each conversion factor was calculated from the generated SEL and SPL values for the 3090 in^3 array along three transects. The conversion factors as a function of range are shown in Figures D-1 to D-3. The black dots indicate the spread of the difference between the two metrics. The red lines represent the 90th percentile of the range-dependent difference that was used in the modelling results presented.

Modelling results for the synthetic pressure waveforms can be viewed as time domain traces, in which multipath arrivals for each impulse can be seen. Figures E-6 to E-8 show example traces for Site 3, Line 2. The 125 ms fixed time window is positioned to maximise the SPL over the pulse duration. If the actual environment is less homogenous than that used as the modelling input, the multipath arrivals could be more distributed in time, thus reducing the SPL within the fixed time window.

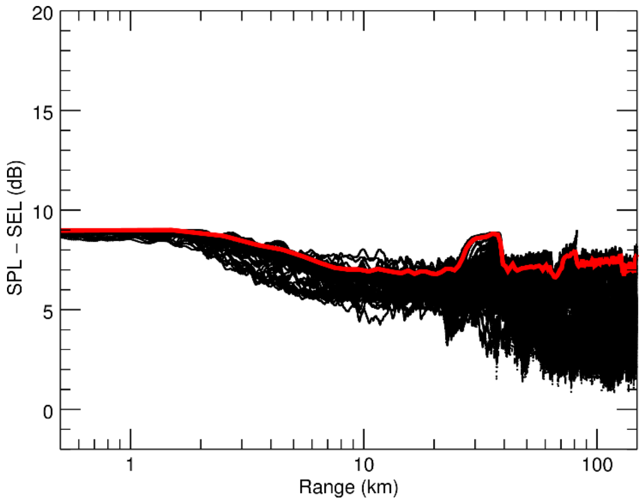

Figure E-1. Conversion Factor 1, applied to sites with water depths of 127–250 m: Range-dependent conversion function for converting single-pulse SEL to SPL for the 3090 in^3 airgun array.

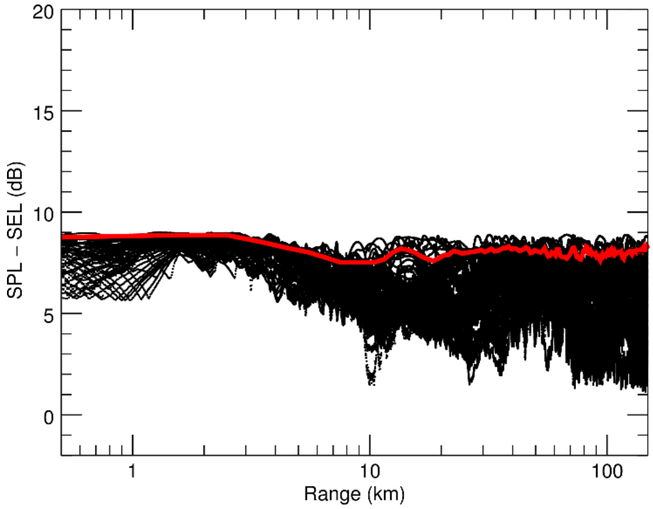

Figure E-2. Conversion Factor 2, applied to sites with water depths of 250–550 m: Range-dependent conversion function for converting single-pulse SEL to SPL for the 3090 in^3 airgun array.

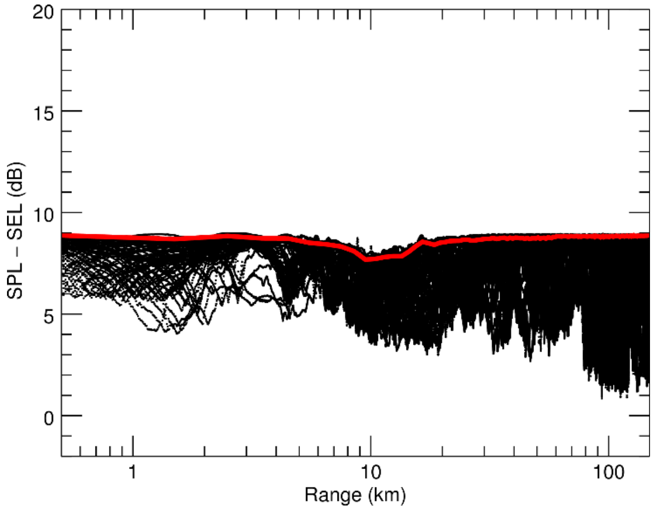

Figure E-3. Conversion Factor 3, applied to sites with water depths >550 m: Range-dependent conversion function for converting single-pulse SEL to SPL for the 3090 in³ airgun array.

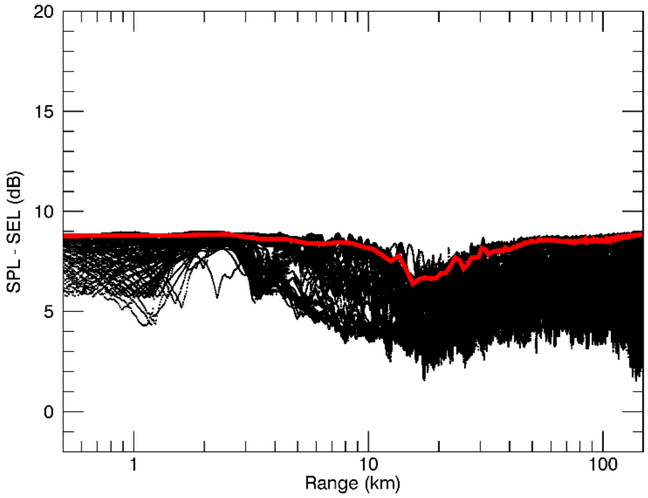

Figure E-4. Conversion Factor for Site A: Range-dependent conversion function for converting single-pulse SEL to SPL for the 3090 in³ airgun array.

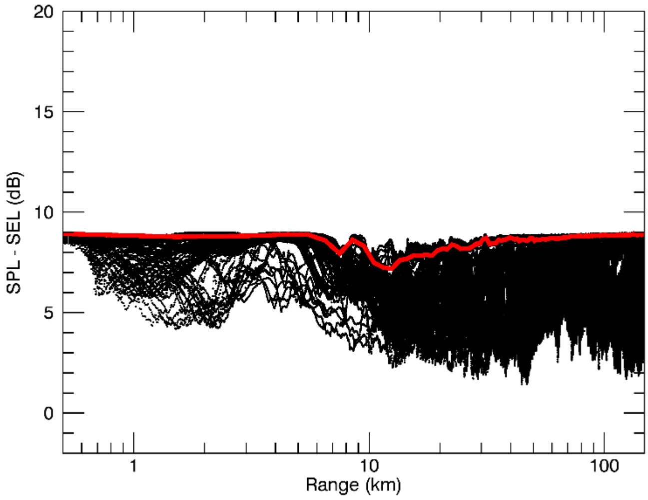

Figure E-5. Conversion Factor for Site B: Range-dependent conversion function for converting single-pulse SEL to SPL for the 3090 in³ airgun array.

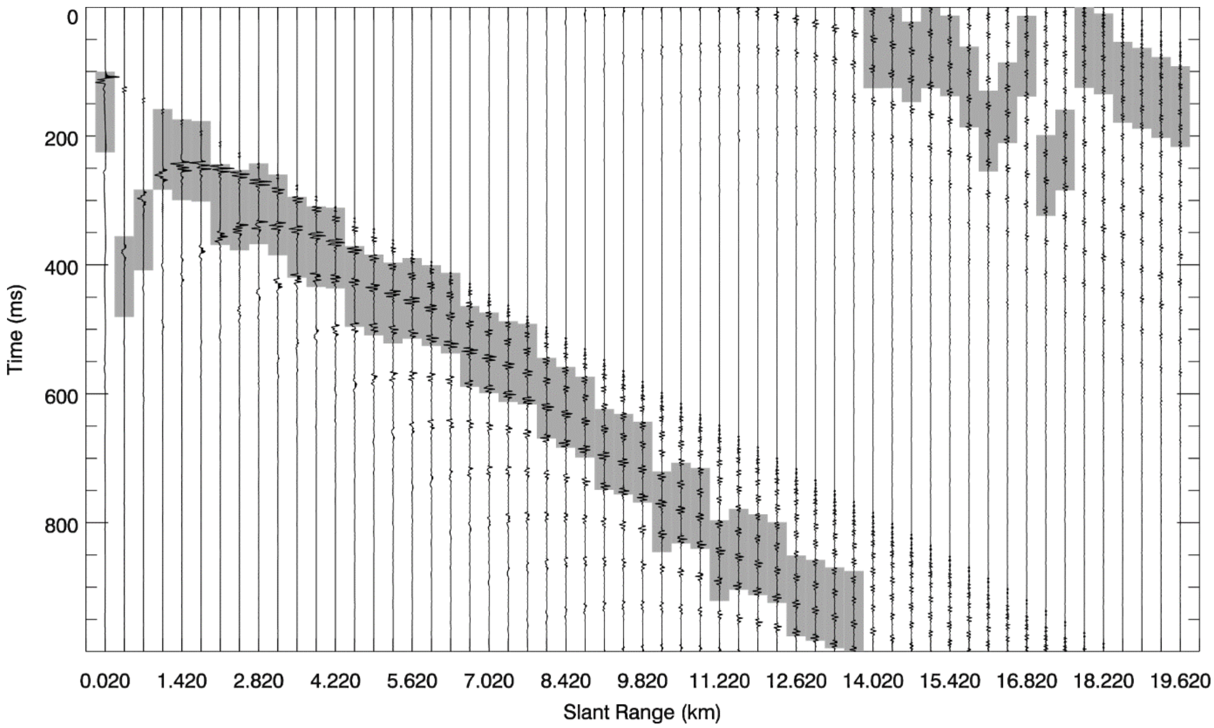

Figure E-6. FWRAM modelled pressure traces in the northern broadside direction for Site 3, Line 2. Results are for the 3260 in^3 airgun array, 0 s time represents the time of airgun array firing. The grey shading highlights the location of the 125 ms fixed time window.

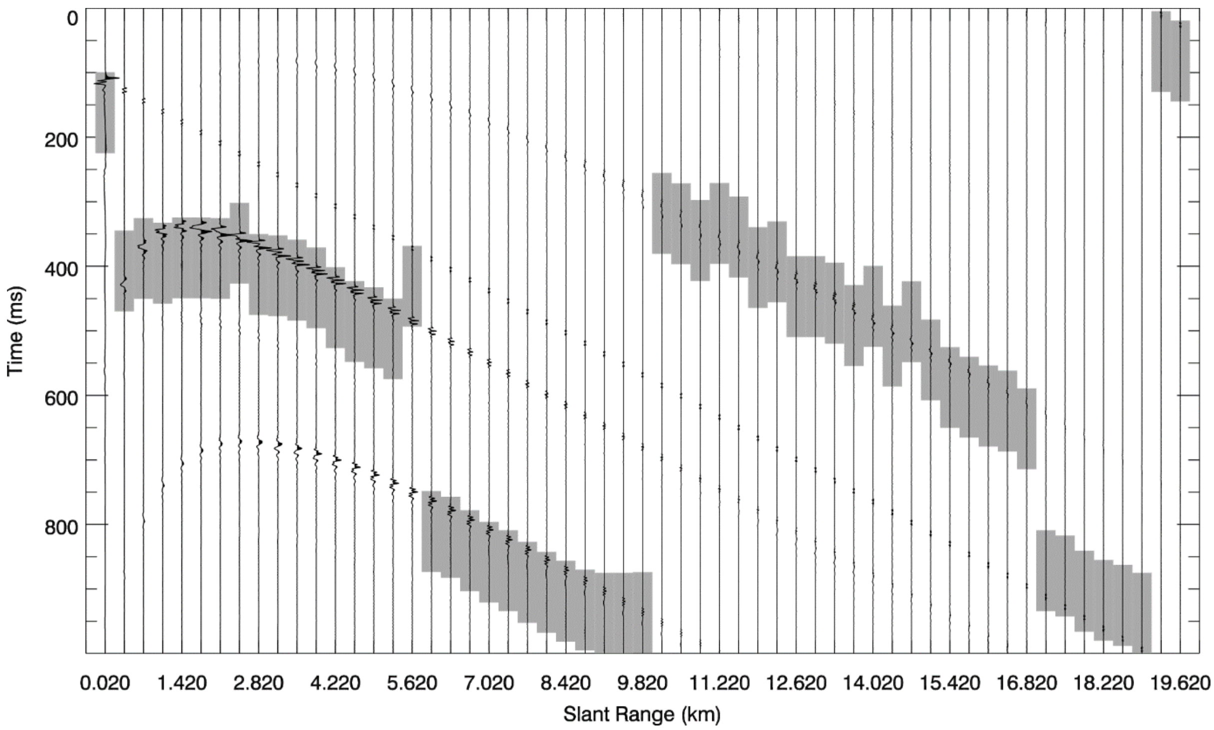

Figure E-7. FWRAM modelled pressure traces in the southern broadside direction for Site 3, Line 2. Results are for the 3260 in^3 airgun array, 0 s time represents the time of airgun array firing. The grey shading highlights the location of the 125 ms fixed time window.

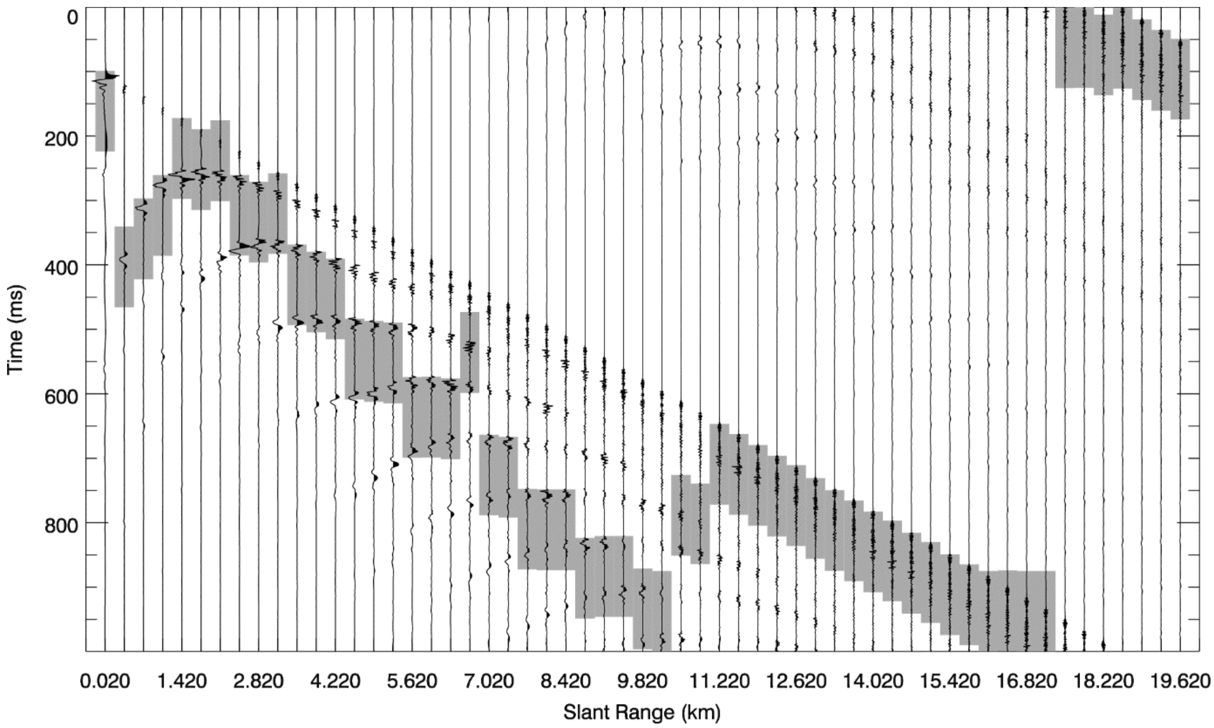

Figure E-8. FWRAM modelled pressure traces in the eastern endfire direction for Site 3, Line 2. Results are for the 3260 in^3 airgun array, 0 s time represents the time of airgun array firing. The grey shading highlights the location of the 125 ms fixed time window.

Duntroon Marine Seismic Survey

Animal Movement Modelling for Assessing Marine Fauna Sound Exposures for a 3260 in³ array

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Executive Summary

Sound propagation models were used to assess underwater noise levels during the proposed Duntroon Multi-Client Marine Seismic Survey (MSS) by PGS Australia. The modelling approach accounted for the acoustic emission characteristics of a 3260 in^3 seismic airgun array that is likely to be operated during the survey and considered source directivity and the area's range-dependent environmental properties relevant for the sound propagation. The results from the propagation modelling are presented in Wladichuk et al. (2018), and includes consideration of a range of noise effect criteria, and metrics including Sound Pressure Level (SPL), Sound Exposure Level (SEL) and Peak Pressure Level (PK).

To supplement the acoustic modelling study, this study was conducted to estimate the number of Southern Right Whales (SRW) potentially exposed to sound levels which could elicit behavioural responses or be potentially injurious during a 24 h period of the survey. The exposure modelling was conducted using JASCO's Animal Simulation Model Including Noise Exposure (JASMINE), linked to the acoustic modelling results for 24 h of survey operation as presented in Wladichuk et al. (2018). The relevant criteria from the acoustic modelling study that were assessed within this study are as follows:

- Wood et al. (2012) probabilistic disturbance thresholds for migrating mysticetes, modified to apply the NMFS (2018) low-frequency (LF) weighting. The thresholds for migrating mysticetes (expanded to included resting / calving animals) are a 10% response likelihood at a weighted SPL of 120 dB re 1 µPa, 50% at a weighted SPL of 140 dB re 1 µPa, and a 90% response likelihood at a weighted SPL of 160 dB re 1 µPa.
- United States National Marine Fisheries Service (NMFS; 2013) acoustic threshold for behavioural effects in marine mammals from impulsive sound, 160 dB re 1 µPa (SPL).
- NMFS (2018) marine mammal injury criteria for Permanent and Temporary Threshold Shift (SEL and PK metrics)

Simulating the behaviour of virtual marine mammals ('animats') makes it possible to estimate the levels to which these animats might be exposed to underwater sound under realistic conditions. An estimate of the three-dimensional (3-D) sound field as a function of time is generated based on predicted locations of acoustic sources and previously-modelled acoustic sound fields, and animats are moved through the field based on probabilistic decision-making models and species-specific parameters for motion. The model did not take aversive reactions by the animats to noise from the seismic survey or mitigation into account.

Two animat scenarios were modelled, the first considered SRW females with calves, and the second juvenile and male SRW, accounting for the distinct behavioural differences between them. The number of animats exposed to levels exceeding the noise exposure thresholds are subsequently scaled to the best estimates available for the Australian SRW population present in or potentially migrating through the survey area and adjacent waters.

The results of the animat exposure modelling for the 24 h period considered, which included the closest acquisition line to the coast, was as follows:

- Wood et al. (2012) probabilistic disturbance thresholds:
    - Between 1.07 and 5.39 SRW are likely exposed to levels exceeding a LF-weighted SPL of 120 dB re 1 µPa.
    - Between 0.24 and 1.15 SRW are likely exposed to levels exceeding a LF-weighted SPL of 140 dB re 1 µPa.
    - Between 0 and 0.34 SRW are likely exposed to levels exceeding a LF-weighted SPL of 160 dB re 1 µPa.
- NMFS (2013) threshold: Between 0 and 0.52 SRW are likely exposed to levels exceeding 160 dB re 1 µPa (SPL).
- NMFS (2018) marine mammal injury criteria:

- No SRW are likely exposed to sound levels (either SEL or PK) which could induce Permanent Threshold Shift at distances beyond 500 m from the airgun array.
- Between 0 and 0.41 SRW are likely exposed to an accumulated sound exposure level (SEL_{24h}) which could induce Temporary Threshold Shift.

These results, however, are conservative estimates, inflated by the model assumption of an even distribution of SRW along the coastline as compared to the true aggregation of SRW in key coastal areas outside the modelled area. Animal behaviour is inherently uncertain, and animat modelling accounts for this complexity by including a large number of virtual animats in the model. Nevertheless, uncertainty about SRW movements remains as scientific information on their behaviour in the calving and offshore areas is scarce.

The modelling results indicate that the proposed seismic operation will likely cause behavioural reactions in a small number of SRW. With increasing severity of effects, the number of SRW predicted to be affected decreases to/below a single animal and is close to zero for injurious effects. These numbers, however, are most likely an overestimation due to model assumption about the distribution of SRW along the coastline as compared to the aggregation of SRW in key areas outside the modelled area.

Animal behaviour is difficult to predict and animat modelling accounts for this complexity by running a Monte Carlo simulation including a large number of virtual animats in the model. Nevertheless, uncertainty about SRW movements remains as scientific information on their behaviour in the calving and offshore areas is scarce.

1. Introduction

JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the Duntroon Multi-Client (MC) Marine Seismic Survey (MSS) proposed by Petroleum Geo-Services (PGS) Australia in the Great Australian Bight (GAB) (Wladichuk et al. 2018).

The acoustic modelling considered seismic lines that were based on an acquisition pattern being considered for the proposed 3-D survey component. These survey lines were selected because they best represent the range of bathymetry within the operational area closest to the two Southern Right Whale (SRW) Biologically Important Areas (BIAs), the calving BIA, and the calving buffer BIA. A 3260 in^3 seismic airgun was considered as the sound source. The source levels, directivity pattern calculations and results of the source and propagation model for this array volume are presented in detail in Wladichuk et al. (2018). Survey area and lines are shown in Figure 1.

To supplement the acoustic modelling study, this study was conducted to estimate the number of Southern Right Whales (SRW) potentially exposed to sound levels which could elicit behavioural responses or be potentially injurious during a 24 h period of the survey. The exposure modelling was conducted using JASCO's Animal Simulation Model Including Noise Exposure (JASMINE), linked to the acoustic modelling results for 24 h of survey operation as presented in Wladichuk et al. (2018).

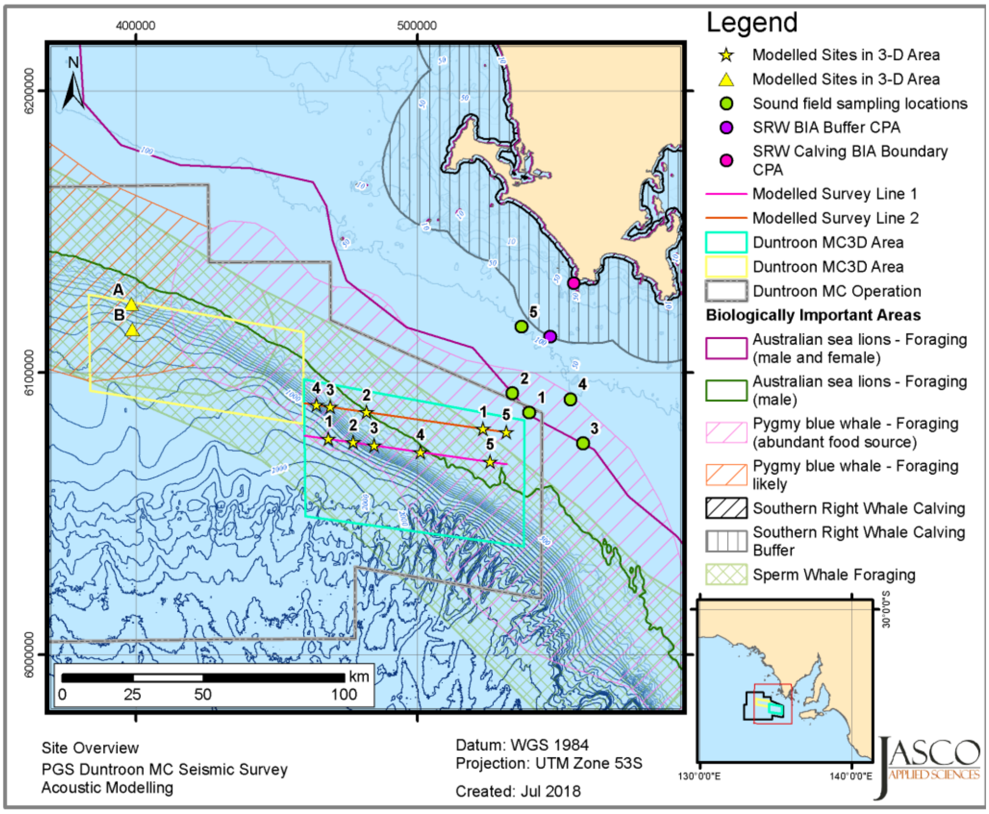

Figure 1. Site locations and relevant features for the Duntroon MSS 3-D Survey Area 1 (Figure 1; Wladichuk et al. 2018).

2. Southern Right Whale Occurrence, Density and Behaviour

Southern right whales, *Eubalaena australis* (SRW) have a circumpolar distribution on the southern hemisphere between 16°S and 65°S (Mackay et al. 2015). A portion of the Australasian population aggregates at calving grounds in coastal Australian waters to calve, mate and rest before migrating to offshore feeding grounds.

SRW seasonal trends in distribution and abundance, timing of arrival/departure and peak abundance periods were assessed in the Great Australian Bight (GAB) using survey data collected between June and October from 1992 to 2016 (Charlton 2017, 2018). SRW arrive in the GAB in June/July, with peak abundance in July/August, and depart the site in late September/October. Unaccompanied whales (juveniles or adults not accompanied by a calf) are more transient into and out of aggregation areas than females accompanied by a calf. Female and calf pairs display residency of up to 3.5 months.

The Australian population of SRW is estimated at 2,500 animals, with approximately 2,200 individuals in the 'western' sub-population and approximately 257 individuals in the 'eastern' sub-population (Bannister 2018). The 'western' sub-population occurs off southern Western Australia (WA) and South Australia (SA) between Albany and Ceduna, and the 'eastern' sub-population occurs off Victoria, New South Wales (NSW) and Tasmania. SRW in Australia are distributed across thirteen identified aggregation areas along the southern coast of Australia (DSEWPaC 2012, Bannister 2018). The connectivity between the eastern and western populations is poorly understood (DSEWPaC 2012). Whilst long term annual monitoring studies have been conducted in southwestern Australia (Bannister 2018) and at the major aggregation ground at Head of Bight, SA (Charlton 2017), little is understood about SRW in small and emerging calving grounds in SA including Sleaford Bay, Kangaroo Island and Encounter Bay.

Abundance of SRW is highly variable due to the cohort structured breeding cycles based on the three to four year mean calving intervals. This results in an estimated 847 SRW occurring each year in the western sub-population (Bannister 2018) and an estimated maximum of 100 SRW in the eastern sub-population.

SRW density is variable across Australia with most animals aggregating at key sites. Female SRW show strong fidelity to calving grounds (e.g. Burnell 2001, Patenaude et al. 2007). Within coastal calving grounds, SRW are primarily distributed within 1 km of shore in water depths less than 20 m. Juvenile and adult SRW not accompanied by a calf are more transient. During the breeding season, they migrate between the breeding grounds and venture also in deeper waters. Their movement in offshore waters is likely associated with the occurrence of the Subtropical Front (STF) (Mackay et al. 2015), which is an oceanographic front characterised by an area of elevated primary production (Moore and Abbott 2000). South of Australia, the STF is a relatively weak oceanographic feature where areas of primary production are patchy. Historical whaling data indicate that the STFs in the Southern Ocean are important feeding areas for SRW. Based on visual observation it can be assumed that 70% of the animals are female SRW with their calves and 30% unaccompanied whales (Charlton 2017).

The primary behaviour observed in calving grounds includes resting, milling, travelling, nursing young and socialising. At times mother and calf pairs remained in lengthy stationary periods, up to 7.5 hrs, that included rest, nursing and play. These mother and calf interactions have implications for communication, learning and survival (Hain et al. 2013). Mean recorded swim speeds of SRW are between 3 - 3.3 km/hr (Mate et al. 2011, Mackay et al. 2015). Median swim speeds for north Atlantic right whales (NRW), in contrast, was 1.3 km/hr with swim speeds varying between behavioural states such as resting and migrating (Hain et al. 2013). There is no published literature on SRW dive profiles (such as descent and ascent rate or reversals) in Australia; this information was adapted from studies on NRW.

3. Animal Movement and Exposure Modelling

To assess the risk of impacts from exposure, an estimate of received sound levels for the animals in the area during operation of the Project is required. Sound sources move as do animals. The sound fields may be complex, and the sound received by an animal is a function of where the animal is at any given time. To a reasonable approximation, the location of the sound source(s) is known, and acoustic modeling can be used to predict the 3-D sound field. The location and movement of animals within the sound field, however, is unknown. Realistic animal movement within the sound field can be simulated. Repeated random sampling (Monte Carlo method simulating many animals within the operations area) is used to estimate the sound exposure history of the population of simulated animals during the operation.

Monte Carlo methods provide a heuristic approach for determining the probability distribution function (PDF) of complex situations, such as animals moving in a sound field. The probability of an event's occurrence is determined by the frequency with which it occurs in the simulation. The greater the number of random samples, in this case the more simulated animals (animats), the better the approximation of the PDF. Animats are randomly placed, or seeded, within the simulation boundary at a specified density (animats/km^2). Higher densities provide a finer PDF estimate resolution but require more computational resources. To ensure good representation of the PDF, the animat density is set as high as practical allowing for computation time. The animat density is much higher than the real-world density to ensure good representation of the PDF. The resulting PDF is scaled using the real-world density.

Several models for marine mammal movement have been developed (Ellison et al. 1987, Frankel et al. 2002, Houser 2006). These models use an underlying Markov chain to transition from one state to another based on probabilities determined from measured swimming behavior. The parameters may represent simple states, such as the speed or heading of the animal, or complex states, such as likelihood of participating in foraging, play, rest, or travel.

The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was based on the open-source marine mammal movement and behavior model, 3MB (Houser 2006) and used to predict the exposure of animats (virtual marine mammals) to sound arising from sound sources in simulated representative surveys. Inside JASMINE, the sound source location mimics the movement of the source vessel through the proposed survey pattern (as described in the MSS report). Animats are programmed to behave like the marine animals likely to be present in the survey area (Figure 2). The parameters used for forecasting realistic behaviors (e.g., diving, foraging, surface times, etc.) are determined and interpreted from marine species studies (e.g., tagging studies) where available, or reasonably extrapolated from related species (see Appendix B for a more detailed explanation of JASMINE and Appendix C for the parameters used in modelling marine mammal movement). An individual animat's modeled sound exposure levels are summed over the total simulation duration, such as 24 hours or the entire simulation, to determine its total received energy. The maximum PK and SPL exposure during the time period is also determined from the exposure history, and both total energy received and maximum PK or SPL are compared to the relevant criteria (Section 4).

JASMINE uses the same animal movement algorithms as the Marine Mammal Movement and Behavior (3MB) model (Houser 2006) but has been extended to be directly compatible with MONM and FWRAM acoustic field predictions, for inclusion of source tracks, and importantly for animats to change behavioral states based on time and space dependent modeled variables such as received levels for aversion behaviour.

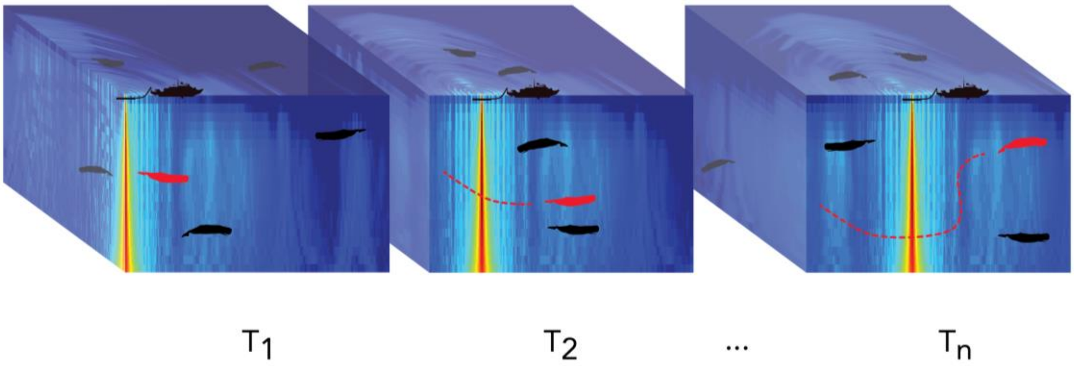

Figure 2. Cartoon of animats in a moving sound field. The acoustic exposure of each animat is determined by where it is in the sound field, and its exposure history is accumulated as the simulation steps through time. In this cartoon the vessel and sound source with its acoustic footprint (highest sound energy levels shown in red/yellow) are moving from right to left, as is the deepest animat. The two upper animats move from left to right. Because the upper and lower animats are far from the source, low levels of sound exposure are expected. The middle animat is nearer the sound source, so its acoustic exposure is expected to be higher than the other two animats, and its highest exposure occurs closest to the sound source at the second time step (t_2).

3.1. Behavioural groups

Female SRWs stay with their offspring close to shore in waters not deeper than 20 m. Unaccompanied SRW (juveniles and adults without accompanying calves) are seen in the breeding areas as well as in deeper waters (Figure 3). To account for this distinction in occurrence and habitat use during the breeding season, two separate behavioural groups were modelled:

- A nearshore group representing mother and calf SRW; and
- An offshore group representing the remaining animals.

As the animat modelling can only consider depth contours, and not features such as BIA boundaries, the 20 m contour has been applied as a reasonable approximate for the boundary of the SRW calving BIA. The area modelled for the offshore group was bound by the 20 m depth contour as a minimum and the 5,000 m depth contour to also account for the southward migration of animals in late September and October.

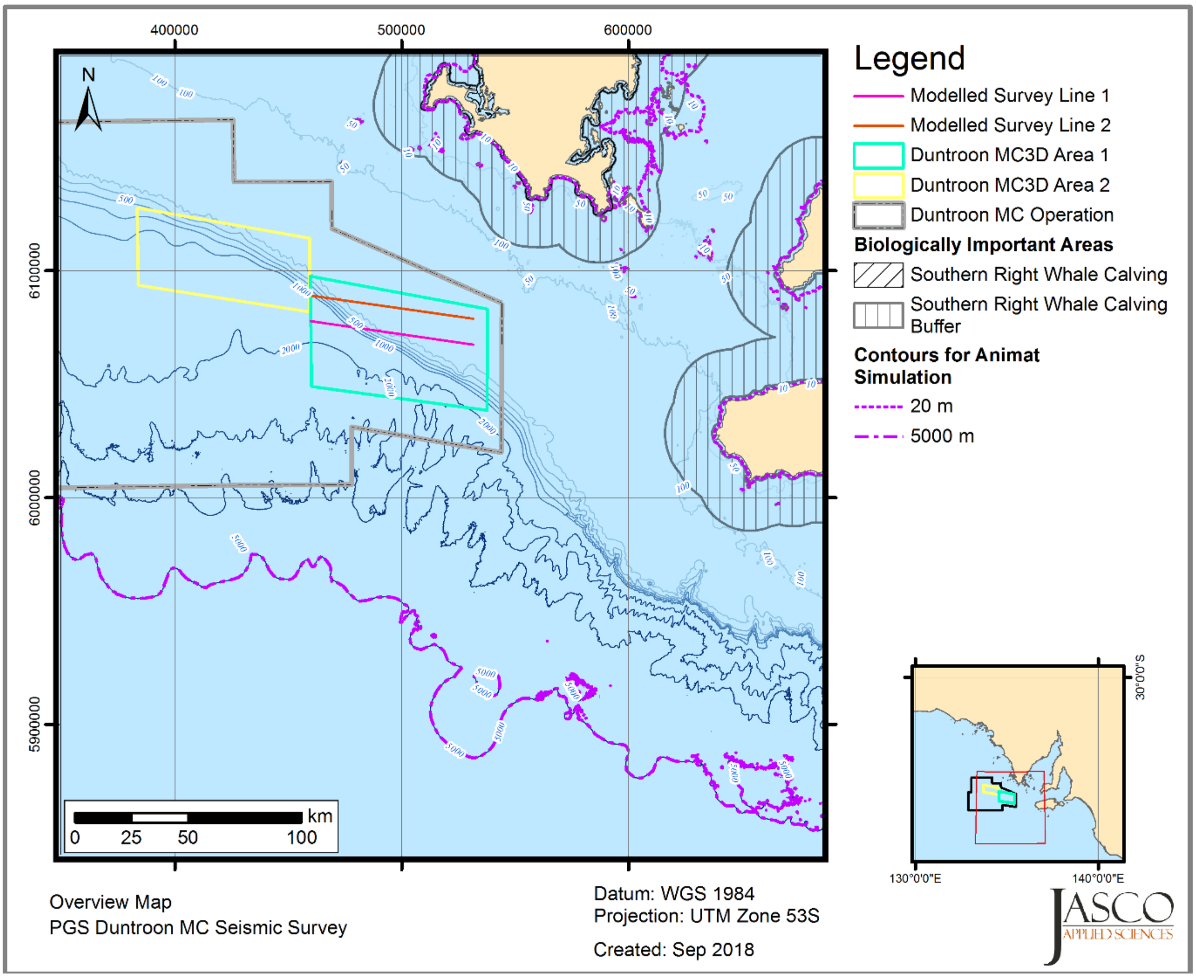

Figure 3. Map showing the operations area and the animat seeding boundaries. Nearshore SRW animats were seeded between the 20m contour and the coast. Offshore SRW were seeded between the 5000 m contour and the 20 m contour.

3.2. Simulation scenarios

Model simulations were run with animat densities of 0.5 animats/km^2 to generate a statistically reliable probability density function for each behavioural group (see Appendix B). This resulted in a total number of animats modelled for the two behavioural groups (nearshore and offshore) of 211,781 and 148,650, respectively. As mother-calf pairs rarely enter either the Spencer Gulf or St. Vincent Gulf, these areas were excluded from seeding. All animats were randomly distributed throughout their respective seeding areas which are defined by their depth ranges (min/max); the aggregation of females and calves in their key calving areas was not taken into account.

The precise geographic delineation between the two Australian SRW sub-populations remains unclear (Mackay et al. 2015). Based on existing survey data, the home range for the eastern subpopulation was considered to stretch from Albany to Ceduna, the western sub-population from Ceduna to the east. The coastline between Albany (WA) to Ceduna (SA) stretches over 1979 km, from Ceduna to Otway (VIC) over 2839 km coastline; excluding the coastline of Spencer Gulf and St. Vincent Gulf reduces this range to 1630 km. Kangaroo Island, with a coastline of 427 km, was included as SRW are reported for this area; this resulted in a combined coastline for the eastern subpopulation of 2057 km. Due to the uncertainly about the delineation between subpopulations, the entire Australian population was considered which inhabits a coastline of 4036 km during the calving season. The coastline considered in the simulation for the offshore scenario covered a coastline segment of 532 km.

3.3. Exposure estimation method

The predicted number of SRW exposed to sound levels exceeding the criteria is derived by scaling the modelled number of exposed animals from a ‘population’ of virtual SRW (animats) to the real-world situation; the total number of animats (>100,000 replicates per scenario) is put in relation to the estimated number of SRW occurring south of Australia each year (see Appendix C) and subsequently correcting the animat results for the difference in spatial extent between the entire home range of SRW and the coastline covered in this study.

4. Noise Effect Criteria

Several sound level metrics are commonly used to evaluate noise and its effects on marine life (Appendix A). The period of accumulation associated with SEL is defined, with this report referencing either a "per pulse" assessment or over 24 h. Appropriate subscripts indicate any applied frequency weighting; unweighted SEL is defined as required. The acoustic metrics in this report reflect the updated ANSI and ISO standards for acoustic terminology, ANSI-ASA S1.1 (R2013) and ISO/DIS 18405.2:2017 (2016). The criteria considered in this study are as follows:

1. The noise criteria relevant to the SRW exposure assessment, applied in the modelling study Wladichuk et al. (2018), are as follows: Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from the U.S. National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals.
2. Marine mammal behavioural threshold based on the current interim U.S. National Marine Fisheries Service (NMFS) criterion (NMFS 2013) for marine mammals of 160 dB re 1 µPa SPL (L_p) for impulsive sound sources.
3. Low-frequency (LF) weighted SPL for comparison to the Wood et al. (2012) probabilistic disturbance thresholds for migrating mysticetes (relevant for calving mysticetes), assessed using the NMFS (2018) frequency weighting function. The relevant thresholds are LF-weighted SPLs of 120, 140 and 160 dB re 1 µPa, relating to response likelihoods of 10, 50 and 90%, respectively.

4.1. Marine mammal weighting functions

The potential for anthropogenic sounds to impact marine mammals is largely dependent on whether the sound occurs at frequencies that an animal can hear well, unless the sound pressure is so high that it can cause physical tissue damage regardless of frequency. For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting the sound relative to an animal's sensitivity to those frequencies. Auditory (frequency) weighting functions reflect an animal's ability to hear a sound (Nedwell and Turnpenny 1998, Nedwell et al. 2007). Auditory weighting functions have been proposed for marine mammals, specifically associated with PTS thresholds expressed in metrics that consider what is known about marine mammal hearing (e.g., SEL) (Southall et al. 2007, Erbe et al. 2016, Finneran 2016). Marine mammal auditory weighting functions published by Finneran (2016) are included in the NMFS 2018 Technical Guidance for use in conjunction with corresponding PTS (injury) onset acoustic criteria (Appendix A.2).

4.2. Behavioural response

Despite numerous studies on marine mammal behavioural responses to sound exposure there is not yet consensus within the scientific community regarding the appropriate metric or sound levels useful for assessing behavioural reactions. It is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016). Because of the complexity and variability of marine mammal behavioural responses to acoustic exposure, NMFS has not yet released updated technical guidance providing criteria or thresholds for evaluating behavioural disruption (NMFS 2018). The NMFS currently uses a step function to assess behavioural impact. Initially, the probability of inducing behavioural responses at a SPL of 160 dB re 1 µPa was derived from the HESS (1999) report which, in turn, was based on the responses of migrating mysticete whales to airgun sounds (Malme et al. 1983, Malme et al. 1984). The HESS team recognized that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above a SPL of 140 dB re 1 µPa. An extensive review of behavioural responses to sound was undertaken by Southall et al. (2007, their Appendix B). Southall et al. (2007) found varying responses for most marine mammals between a SPL of 140 and 180 dB re 1 µPa, consistent with the HESS (1999) report, but lack of convergence in the data prevented them from suggesting explicit step functions. Absence of controls, precise measurements, appropriate metrics, and context dependency of responses (including the activity state of the animal) all contribute to variability. For impulsive sounds, this threshold is 160 dB re 1 µPa SPL for cetaceans (NMFS 2013).

Wood et al. (2012) proposed a step function of the probability of response for impulsive sounds using a frequency weighted SPL metric. They defined behavioural response categories for sensitive species (including harbor porpoise and beaked whales) and for migrating mysticetes. The migrating mysticete category has been applied in this analysis to Southern Right Whales, in particular within the calving and calving buffer BIAs, but also during migration, to assess behavioural response to impulsive sounds (Table 1). The Wood et al. (2012) approach has been updated to consider the frequency weighting from NMFS (2018).

Table 1. Behavioural exposure criteria used in this analysis for calving and migrating southern right whales Probability of behavioural response to LF-weighted sound pressure level (SPL dB re 1 µPa) (NMFS (2018). Probabilities are not additive. Adapted from Wood et al. (2012).

Probability of response to frequency-weighted SPL (dB re 1 µPa)		
120	140	160
10%	50%	90%

4.3. Injury and hearing sensitivity changes

Exposure to sufficiently intense sound may lead to an increased hearing threshold in any living animal capable of perceiving acoustic stimuli by some means of a sensory receptor. Such an increase in hearing threshold due to noise exposure is called a threshold shift (TS). If this shift is reversed and the hearing threshold returns to normal, the NITS is called a temporary threshold shift (TTS). If the threshold shift does not return to normal, the residual TS is called a permanent threshold shift (PTS).

To assist in assessing the potential for injuries to marine mammals this report applies the criteria recommended by NMFS (2018); both PTS and TTS are considered to help assess the potential for injuries to marine mammals, Table 2. Appendix A provides more information about the NMFS (2018) criteria.

Table 2. The SEL_{24h} ($L_{E,24h}$) and PK (L_{pk}) thresholds for acoustic effects on southern right whales. Injury is defined as permanent threshold shift (PTS).

Hearing group	NMFS (2018)			
	PTS onset thresholds* (received level)		TTS onset thresholds* (received level)	
	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	183	219	168	213

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

L_{pk}, flat–peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa

L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa^{2}s

Subscript LF indicates the marine mammal auditory weighting function for low-frequency cetaceans.

5. Results

This section presents the estimated number of SRW expected to receive sound levels exceeding behavioural and injurious thresholds in a 24 h period.

5.1. Real world exposure estimates

The numbers of modelled animats (Appendix D) exposed to acoustic levels exceeding thresholds must be scaled to relate to the number of SRW in the survey area. Two scaling factors are calculated:

1. A correction factor accounting for the difference in animats compared to the number of SRW in the (sub-)population; and
2. A spatial factor setting the survey area (km coastline) in proportion to the overall home range of SRW during the survey period.

The real-world number of SRW potentially exposed to sound levels exceeding the noise exposure thresholds are given for the two scenarios (nearshore vs offshore) based on numbers of SRW for the entire Australian population (Table 3) and the eastern sub-population (Table 4). The exposures for the eastern population, nearshore SRW, are approximately equivalent to the exposures within the SRW calving BIA.

Table 3. Spatial scaling of animat modelling results for entire SRW population. Scaling number of animat exposed to sound levels exceeding the noise exposure criteria based on coastline including in the animat modelling as compared to home range of SRW for the entire Australian population.

Sub-population	Spatial correction [%]	120 dB ($L_{p,LF}$)	140 dB ($L_{p,LF}$)	160 dB ($L_{p,LF}$)	160 dB (L_p)	TTS 168 dB ($L_{E,LF,24h}$)	PTS† 183 dB ($L_{E,LF,24h}$)
Offshore SRW (males/juveniles)	0.13	5.39	1.15	0.34	0.52	0.41	0.01
Nearshore SRW (females/calves)	0.13	5.15	0	0	0	0	0

$L_{p,LF}$ – denotes low-frequency weighted sound pressure level and has a reference value of 1 μPa
L_p - denotes sound pressure level and has a reference value of 1 μPa
L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 μPa²s
†The model does not account for shutdowns.

Table 4. Spatial scaling of animat modelling results for eastern SRW population. Scaling number of animat exposed to sound levels exceeding the noise exposure criteria based on coastline including in the animat modelling as compared to home range of SRW for the eastern Australian population.

Sub-population	Spatial correction [%]	120 dB ($L_{p,LF}$)	140 dB ($L_{p,LF}$)	160 dB ($L_{p,LF}$)	160 dB (L_p)	TTS 168 dB ($L_{E,LF,24h}$)	PTS† 183dB ($L_{E,LF,24h}$)
Offshore SRW (males/juveniles)	0.26	1.12	0.24	0.07	0.11	0.09	0.001
Nearshore SRW (females/calves)	0.26	1.07	0	0	0	0	0

$L_{p,LF}$ – denotes low-frequency weighted sound pressure level and has a reference value of 1 μPa
L_p - denotes sound pressure level and has a reference value of 1 μPa
L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 μPa²s
†The model does not account for shutdowns.

6. Discussion and Conclusion

The extreme site-fidelity of female SRW during the calving season restricts their movements to areas at large distances (>50 km) from the operational survey area. In addition, female SRW and their calves exhibit a dive behaviour which prevents them from exposure to intense levels of sound due to physical acoustic effects that reduce the sound levels received near the surface. One supposition implicit to animat modelling is that the virtual animals are distributed randomly (i.e., more or less evenly) over areas restricted by bathymetry due to their depth preference.

This is contrary to the aggregated distribution of nearshore SRW in their calving grounds (Bannister 2017). Given that none of the known key calving grounds of SRW along the coastline of South Australia, especially their main grounds at Head of Bight and Fowler's Bay, is in this area considered in this model, this even distribution of animats results in an overestimation of SRW exposed to the seismic airgun impulses.

The dive parameters chosen in this model had to be partially derived from northern right whales. The chosen parameters result in a variation of types of dive behaviour which resemble the behaviour described from visual observations of SRW in their calving grounds. Changes to the dive depth, duration and profile are individually different, highly complex and depend on behavioural context, gender, motivation and numerous other biological parameters. Updated information on SRW behaviour will allow improving the precision of the modelling results in the future, but substantial changes to the results are unlikely unless completely unexpected dive behaviour is discovered.

Scaling the modelling results to the real-world situation based on the entire Australian population size represents an overestimation of the number of affected SRW as the survey area is closest to areas inhabited by the eastern SRW sub-population which occurs at lower densities and represents approximately only 1/9th of the entire SRW population. This ratio can change depending on the number of animals 'seeded' in each of the sub-populations.

The proportion – in relation to the overall population of Australian SRW – of animals returning to south Australian waters each year can only be estimated and is variable. A count for the western sub-population resulted in 847 SRW (Bannister 2018) while the eastern can only be stimated; a ratio of 1:3 to 1:4 relative to the overall population size can be assumed (C.Charlton, pers. Comm; (Charlton 2017). In this analysis, a ratio of 3 was used as a conservative approach, resulting in an estimated 100 SRW for the eastern area. Based on an estimate of 300 SRW for the eastern sub-population and by applying a ratio of, e.g., 3.94 (Bannister 2017)[1], the resulting eastern number of animals belonging to the eastern sub-population would be 76 animals instead of 100. Accordingly, the modelling results for this sub-population most likely represent an overestimation by 33%.

Offshore SRW (unaccompanied adults and juveniles) have a higher predicted likelihood of exposure to sound levels above the threshold criteria than SRW in the nearshore areas (females and calves). In this model, a 70/30 ratio has been used, but this may underestimate the number of animals in the offshore region; assuming a higher number of SRW occurring in offshore waters south of Australia (e.g., choosing a 50/50 ratio) would increase the number of animals exposed to levels beyond the threshold for a 10% response likelihood slightly (resulting in an increase by 3 SRW for the entire population, <1 SRW for the eastern population); the other effect categories would change only marginally (e.g. increase <0.2 SRW).

The animat model assumes a uniformly (random) distribution of animats along the coastline. SRW, however, occur in the BIA in aggregations in their calving grounds which are distant (>50 km) from the survey area. Apart from animals migrating between calving grounds, nearshore SRW are not likely to be present in the BIA between those calving grounds. The area exposed to LF-weighted sound levels >120 dB re 1 µPa (SPL) covers a zone within the BIA that does not contain one of known calving SRW grounds including the emerging Sleaford Bay area. Accordingly, the number of SRW predicted to be exposed to sound levels exceeding the threshold for a 10% response likelihood is most likely an overestimation. In an example from the closest single impulse to the coast (Figure 4), also shown focused on the coastline (Figure 5), this zone stretches over 24.9 km and 1,307 animats were seeded

[1] The current population size of SRW is is estimated using a model, whereby the cow/calf count over three years (to allow for the 3-year periodicity in calving) is multiplied by a factor of 3.94.

in this area. By scaling this number down to the real-world situation, a total of four (3.89) SRW would be predicted to be exposed – as compared to up to five (5.39) SRW predicted to be exposed by looking at the entire population and one (1.12) SRW if only considering the eastern population. In this context it is important to note that none of the known key aggregation areas is located within this zone which reduces the risk of SRW of being exposed to LF-weighted sound levels >120 dB re 1 µPa (SPL) substantially.

It is evident that SRW will start migrating south at the end of the calving season, but it remains unclear if there are migratory corridors or if animals are moving south from wherever they roamed prior to the start of the migration. A relatively large proportion of SRW is present in aggregation areas in SA (Fowler Bay and Head of Bight) north of the operational area. A southward movement from there would take animals close to the operational area with an increased the risk of exposure to higher sound levels. Due to compete lack of information on this aspect, it is impossible to assess if the modelling results are biased toward an under- or overestimation of numbers.

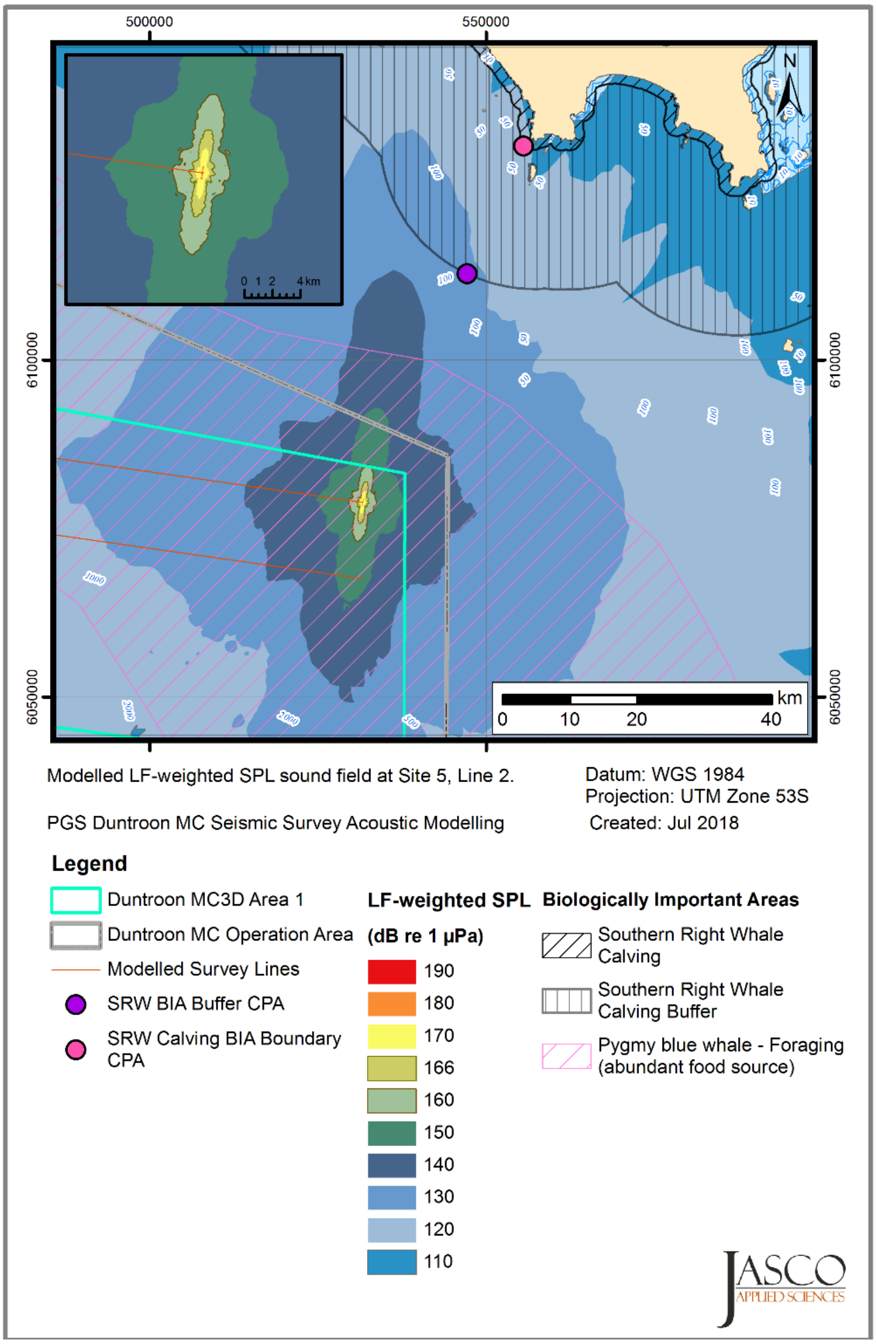

Figure 4. Sound level contour map showing maximum-over-depth LF-weighted SPL results for the 3260 in³ array towed at 7 m depth, operating at Line 2, Shot 5, on a heading of 278° at the closest point to the SRW BIAs, receiver locations for sound levels at the boundaries are shown as circles. Insert shows a close-up of the contours around the source.

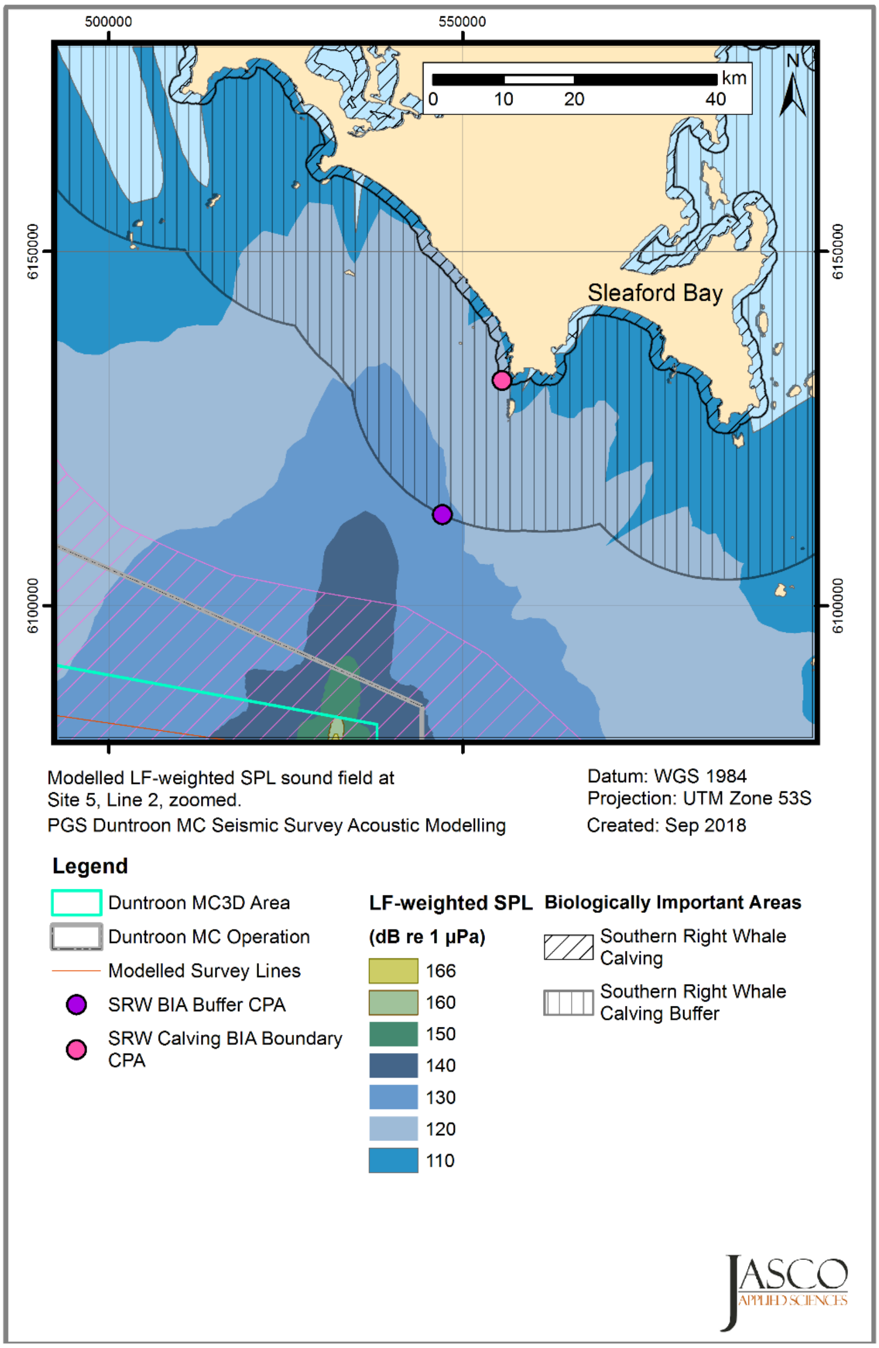

Figure 5. Sound level contour map focused on the footprint closer to the coast, showing maximum-over-depth LF-weighted SPL results for the 3260 in³ array towed at 7 m depth, operating at Line 2, Shot 5, on a heading of 278° at the closest point to the SRW BIAs, receiver locations for sound levels at the boundaries are shown as circles.

6.1. Summary

Based on the modelled sound field created by the seismic operation and available information on the occurrence and behaviour of SRW, the number of animals likely to be exposed to sound levels sufficient to exceed underwater noise criteria for injury and behaviour has been predicted using an animat modelling approach. Numerous biological parameters were derived from scientific literature or from expert judgement. A high number of replicates were used to virtually populate and move through the survey area and adjacent waters. In combination with the predetermined sound field generated by the seismic operation, a exposure scenario was created and the likelihood for exposures exceeding noise exposure criteria calculated.

The modelling results indicate that the proposed seismic operation will likely have behavioural effects (i.e. 10% response likelihood) on a small number of SRW (1 of the eastern sub-population or 5 relative to the entire SRW population present per year, Table 5). The likelihood of causing an increased behavioural response or injurious effects is increasingly smaller (>1 SRW, Table 6) and erroneously inflated by the model assumption of an even distribution of SRW along the coastline.

Table 5. Predicted, scaled number of animat exposed to sound pressure levels exceeding behavioural disturbance criteria for eastern and entire SRW (sub-)population during the 24 h simulation.

(Sub-) Population	Eastern				Entire			
	Adapted from Wood et al. (2012)			NMFS (2013)	Adapted from Wood et al. (2012)			NMFS (2013)
	120 dB ($L_{p,LF}$)	140 dB ($L_{p,LF}$)	160 dB ($L_{p,LF}$)	160 dB (L_p)	120 dB ($L_{p,LF}$)	140 dB ($L_{p,LF}$)	160 dB ($L_{p,LF}$)	160 dB (L_p)
Offshore SRW (males/juveniles)	1.12	0.24	0.07	0.11	5.39	1.15	0.34	0.52
Nearshore SRW (females/calves)	1.07	0	0	0		0	0	0

$L_{p,LF}$ – denotes low-frequency weighted sound pressure level and has a reference value of 1 μPa
L_p - denotes sound pressure level and has a reference value of 1 μPa

Table 6. Predicted, scaled number of animat exposed to sound exposure levels exceeding the TTS and PTS criteria from NMFS (2018) for entire and eastern SRW (sub-)population during the 24 h simulation.

(Sub-) Population	Eastern		Entire	
	TTS 168 dB re 1 μPa²·s ($L_{E,LF,24h}$)	PTS† 183 dB re 1 μPa²·s ($L_{E,LF,24h}$)	TTS 168 dB re 1 μPa²·s ($L_{E,LF,24h}$)	PTS† 183 dB re 1 μPa²·s ($L_{E,LF,24h}$)
Offshore SRW (males/juveniles)	0.09	0.001	0.41	0.01
Nearshore SRW (females/calves)	0	0	0	0

†The model does not account for shutdowns.

Glossary

3-D
Three-dimensional

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise a one octave-band. One-third-octave-bands become wider with increasing frequency. Also see octave.

audiogram
A graph of hearing threshold level (sound pressure levels) as a function of frequency, which describes the hearing sensitivity of an animal over its hearing range.

auditory weighting function (frequency-weighting function)
Auditory weighting functions account for marine mammal hearing sensitivity. They are applied to sound measurements to emphasise frequencies that an animal hears well and de-emphasise frequencies they hear less well or not at all (Southall et al. 2007, Finneran and Jenkins 2012, NOAA 2013).

bandwidth
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI/ASA S1.13-2005 R2010).

BIA
Biologically Important Area (http://www.environment.gov.au/marine/marine-species/bias)

cetacean
Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

ensonified area
The total area ensonified in conjunction with a specified isopleth.

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

functional hearing group
Grouping of marine mammal species with similar estimated hearing ranges. Southall et al. (2007) proposed the following functional hearing groups: low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

GAB
Great Australian Bight

hearing threshold
The sound pressure level that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hertz (Hz)
A unit of frequency defined as one cycle per second.

impulsive sound
Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 R2006). For example, seismic airguns and impact pile driving.

low-frequency cetacean
The functional hearing group that represents mysticetes (baleen whales).

MC
Multi-Client

MSS
Marine Seismic Survey

mysticete
Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate but use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and the grey whale (*Eschrichtius robustus*).

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

peak pressure level (PK)
The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak pressure level. Unit: decibel (dB).

peak-to-peak pressure level (PK-PK)
The difference between the maximum and minimum instantaneous pressure levels. Unit: decibel (dB).

permanent threshold shift (PTS)
A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: p.

pulsed sound
Discrete sounds with durations less than a few seconds. Sounds with longer durations are called continuous sounds.

received level
The sound level measured at a receiver.

signature
Pressure signal generated by a source.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure
Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second ($Pa^2 \cdot s$) (ANSI S1.1-1994 R2004).

sound exposure level (SEL)
A cumulative measure related to the sound energy in one or more pulses. Unit: dB re 1 µPa^2·s. SEL is expressed over the summation period (e.g., per-pulse SEL [for airguns], single-strike SEL [for pile drivers], 24-hour SEL).

sound field
Region containing sound waves (ANSI S1.1-1994 R2004).

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 µPa) and the unit for SPL is dB re 1 µPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2 / p_0^2\right) = 20\log_{10}\left(p / p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source. Unit: dB re 1 µPa^{2}m^2 or dB 1 µPa^{2}m^{2}s.

spectrum
An acoustic signal represented in terms of its power (or energy) distribution versus frequency.

temporary threshold shift (TTS)
Temporary loss of hearing sensitivity caused by excessive noise exposure.

transmission loss (TL)
Also called propagation loss, this refers to the decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment.

wavelength
Distance over which a wave completes one oscillation cycle. Unit: meter (m). Symbol: λ.

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Appendix A. Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 µPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak sound pressure level (PK; L_{pk}; $L_{p,pk}$; dB re 1 µPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,pk} = 20\log_{10}\left[\frac{\max(|p(t)|)}{p_0}\right] \tag{A-1}$$

PK is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The peak-to-peak sound pressure level (PK-PK; $L_{pk\text{-}pk}$; $L_{p,pk\text{-}pk}$; dB re 1 µPa) is the difference between the maximum and minimum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound, $p(t)$:

$$L_{p,pk-pk} = 10\log_{10}\left\{\frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2}\right\} \tag{A-2}$$

The sound pressure level (SPL; L_p; dB re 1 µPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \tag{A-3}$$

where $g(t)$ is an optional time weighting function. The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalisation, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL.

In studies of impulsive noise, the time window function $g(t)$ is often a decaying exponential that emphasizes more recent pressure signals to mimic the leaky integration of the mammalian hearing system. For example, human-based fast time weighting applies an exponential function with time constant 125 ms. Another approach for evaluating L_p of impulsive signals is to set T to the “90% time window” (T_{90}): the period over which cumulative square pressure function passes between 5% and 95% of its full per-pulse value. The SPL computed over this T_{90} interval is commonly called the 90% SPL (SPL(T_{90}); L_{p90}; dB re 1 µPa):

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} p^2(t)dt \Big/ p_0^2\right) \tag{A-4}$$

The sound exposure level (SEL; L_E; $L_{E,p}$; dB re 1 µPa²·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \quad \text{(A-5)}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right). \quad \text{(A-6)}$$

To compute the SPL(T_{90}) and SEL of acoustic events in the presence of high levels of background noise, equations A-4 and A-5 are modified to subtract the background noise contribution:

$$L_{p90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} (p^2(t) - \overline{n^2})dt \Big/ p_0^2\right) \quad \text{(A-7)}$$

$$L_E = 10\log_{10}\left(\int_T (p^2(t) - \overline{n^2})dt \Big/ T_0 p_0^2\right) \quad \text{(A-8)}$$

where $\overline{n^2}$ is the mean square pressure of the background noise, generally computed by averaging the squared pressure of a temporally-proximal segment of the acoustic recording during which acoustic events are absent (e.g., between pulses).

Because the SPL(T_{90}) and SEL are both computed from the integral of square pressure, these metrics are related by the following expression, which depends only on the duration of the time window T:

$$L_p = L_E - 10\log_{10}(T) \quad \text{(A-9)}$$

$$L_{p90} = L_E - 10\log_{10}(T_{90}) - 0.458 \quad \text{(A-10)}$$

where the 0.458 dB factor accounts for the 10% of SEL missing from the SPL(T_{90}) integration time window.

If applied, the frequency weighting of an acoustic event should be specified, as in the case of LF-weighted SEL (e.g., $L_{E,LF,24h}$; Appendix A.2). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should else be specified.

A.1. Marine Mammal Impact Criteria

Marine mammals can be adversely affected by underwater anthropogenic noise. Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR

1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for both injury) and disturbance (Section 4.2). The following sections summarise the recent development of thresholds; however, this field remains an active research topic.

A.1.1. Injury

In recognition of shortcomings of the SPL-only based injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: Low-, Mid- and High-Frequency cetaceans (LF, MF, and HF respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for human; Appendix A.2). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 $\mu Pa^2 \cdot s$. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF on results obtained from MF studies. In particular they referenced Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 $\mu Pa^2 \cdot s$.

As of 2017, an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2018). The guidance describes injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). Table A-1 lists the recommended thresholds. The criteria defined in NMFS (2018) are applied in this report.

Table A-1. Marine mammal injury (PTS onset) thresholds based on NMFS (2018).

Hearing group	Impulsive source		Non-impulsive source
	PK	Weighted SEL (24 h)	Weighted SEL (24 h)
Low-frequency cetaceans	219	183	199
Mid-frequency cetaceans	230	185	198
High-frequency cetaceans	202	155	173
Phocid pinnipeds in water	218	185	201
Otariid pinnipeds in water	232	203	219

A.2. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.2.1. Marine Mammal Frequency Weighting Functions

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \quad \text{(A-11)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2018). Table A-2 lists the frequency-weighting parameters for each hearing group; Figure A-1 shows the resulting frequency-weighting curves.

Table A-2. Parameters for the auditory weighting functions recommended by NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans	1.0	2	200	19,000	0.13
Mid-frequency cetaceans	1.6	2	8,800	110,000	1.20
High-frequency cetaceans	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water	1.0	2	1,900	30,000	0.75
Otariid pinnipeds in water	2.0	2	940	25,000	0.64

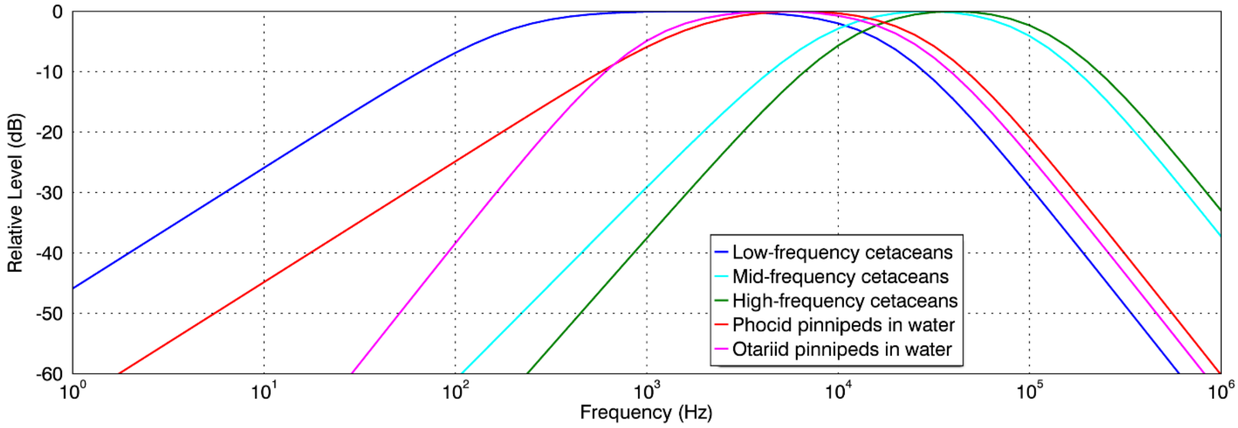


Figure A-1. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix B. Animal Simulation and Acoustic Exposure Model

To assess the risk of impacts from exposure, an estimate of received sound levels for the animals in the area during operations is required. Sound sources move and so do animals. The sound fields may be complex, and the sound received by an animal is a function of where the animal is at any given time. To a reasonable approximation, the location of the sound source(s) is known, and acoustic modelling can be used to predict the 3-D sound field (Figure 2). The location and movement of animals within the sound field, however, is unknown. Realistic animal movement within the sound field can be simulated, and repeated random sampling (Monte Carlo)—achieved by simulating many animals within the operations area—used to estimate the sound exposure history of animals during the operation. Monte Carlo methods provide a heuristic approach for determining the probability distribution function (PDF) of complex situations, such as animals moving in a sound field. The probability of an event's occurrence is determined by the frequency with which it occurs in the simulation. The greater the number of random samples, in this case the more simulated animals (animats), the better the approximation of the PDF. Animats are randomly placed, or seeded, within the simulation boundary at a specified density (animats/km^2). The animat density is much higher than the real-world density to ensure good representation of the PDF. The resulting PDF is scaled using the real-world density.

Several models for marine mammal movement have been developed (Ellison et al. 1987, Frankel et al. 2002, Houser 2006). These models use an underlying Markov chain to transition from one state to another based on probabilities determined from measured swimming behaviour. The parameters may represent simple states, such as the speed or heading of the animal, or complex states, such as likelihood of participating in foraging, play, rest, or travel. Attractions and aversions to variables like anthropogenic sounds and different depth ranges can be included in the models.

Analysis in this report uses the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) 2017. JASMINE uses the same animal movement algorithms as the 'Marine Mammal Movement and Behavior' (3MB) model (Houser 2006) but has been extended for use with JASCO-formatted acoustic fields, inclusion of source tracks, and for animats to change behavioural states based on modelled variables such as received level. JASMINE also includes aversion in response to realistic received levels.

B.1. Animal Movement Parameters

JASMINE uses previously measured behaviour to forecast behaviour in new situations and locations. The parameters used for forecasting realistic behaviour are determined (and interpreted) from marine species studies (e.g., tagging studies). Each parameter in the model is described as a probability distribution. When limited or no information is available for a species parameter, a Gaussian or uniform distribution may be chosen for that parameter. For the Gaussian distribution, the user determines the mean and standard deviation of the distribution from which parameter values are drawn. For the uniform distribution, the user determines the maximum and minimum distribution from which parameter values are drawn. When detailed information about the movement and behaviour of a species are available, a user-created distribution vector, including cumulative transition probabilities, may be used (referred to here as a vector model; Houser 2006). Different sets of parameters can be defined for different behaviour states. The probability of an animat starting out in or transitioning into a given behavioural state can in turn be defined in terms of the animat's current behavioural state, depth, and the time of day. In addition, each travel parameter and behavioural state has a termination function that governs how long the parameter value or overall behavioural state persists in simulation.

The parameters used in JASMINE describe animal movement in both the vertical and horizontal planes. The parameters relating to travel in these two planes are briefly described below.

B.1.1.1. Travel sub-models

Direction–determines the animat's choice of direction in the horizontal plane. Sub-models are available for determining the bearing of animats, allowing for movement to range from strongly biased to undirected. A random walk model can be used for behaviours with no directional preference, such as feeding and playing. In a random walk, all bearings are equally likely at each parameter transition time step. A correlated random walk can be used to smooth the changes in bearing by using the current bearing as the mean of the distribution from which to draw the next heading. An additional variant of the correlated random walk is available that includes a directional bias for use in situations where animals have a preferred absolute direction, such as migration. A user-defined vector of directional probabilities can also be defined to control animat bearing. For more detailed discussion of these parameters, see (Houser 2006) and (Houser and Cross 1999).

Travel rate–defines the rate of travel of an animat in the horizontal plane. When combined with vertical speed and dive depth, the dive profile of the animat is produced.

B.1.1.2. Dive sub-models

Ascent Rate–defines the rate of travel of an animat in the vertical plane during the ascent portion of a dive.

Descent Rate–defines the rate of travel of an animat in the vertical plane during the descent portion of a dive.

Depth–defines the maximum depth to which an animat will dive.

Bottom Following–determines whether an animat returns to the surface once reaching the ocean floor, or whether it follows the contours of the bathymetry.

Reversals–determines whether multiple vertical excursions occur once reaching the maximum dive depth. This behaviour is used to emulate the foraging behaviour of some marine mammal species at depth. Reversal-specific ascent and descent rates may be specified.

Surface Interval–determines the amount of time spent at the surface prior to performing another dive.

Appendix C. Animat Behavioural Parameters

C.1. Nearshore SRW

Table C-1. Animat behavioural parameters for nearshore SRW (females and calves) (number values represent Means (SD) unless otherwise indicated). The parameters are derived from published data on SRW migratory and swim/dive behaviour (Mate et al. 2011, Hain et al. 2013, Mackay et al. 2015) and complemented by data published on northern right whales (Winn et al. 1986, Baumgartner and Mate 2003, Baumgartner and Mate 2005, Mellinger et al. 2007, Kenney 2009).

Behavior	Variable	Value
Foraging	Travel Direction	Correlated Random Walk
	Perturbation value	10
	Termination coefficient	0.2
	Travel rate (m/s)	Gaussian 0.44 (0.16)
	Ascent rate (m/s)	Gaussian 1.47 (0.26)
	Descent rate (m/s)	Gaussian 1.4 (0.3)
	Average depth (m)	Gaussian 8.0 (5.0)
	Bottom following	No
	Reversals	Gaussian 0.7 (0.2)
	Probability of reversal	0.7
	Reversal Ascent Dive Rate (m/s)	0.01 (0.01)
	Reversal Descent Dive Rate (m/s)	0.01 (0.01)
	Time in Reversal (s)	Gaussian 420 (60)
	Surface interval (s)	Gaussian 187.8 (59.4)
	Bout duration (s)	Gaussian 3600 (600)
V-shaped	Travel Direction	Correlated Random Walk
	Perturbation value	10
	Termination coefficient	0.2
	Travel rate (m/s)	Gaussian 0.44 (0.16)
	Ascent rate (m/s)	Gaussian 1.47 (0.26)
	Descent rate (m/s)	Gaussian 1.4 (0.3)
	Average depth (m)	Gaussian 8.0 (5.0)
	Bottom following	No
	Reversals	No
	Surface interval (s)	Gaussian 440 (120)
	Bout duration (s)	Gaussian 1800 (600)
Other	Travel Direction	Correlated Random Walk
	Perturbation value	10
	Termination coefficient	0.2
	Travel rate (m/s)	Gaussian 0.44 (0.16)
	Ascent rate (m/s)	Gaussian 1.47 (0.26)
	Descent rate (m/s)	Gaussian 1.4 (0.3)
	Average depth (m)	Gaussian 8.0 (5.0)
	Bottom following	No

Behavior	Variable	Value
	Reversals	Random 1.0-10.0
	Probability of reversal	0.3
	Reversal Ascent Dive Rate (m/s)	0.08 (0.05)
	Reversal Descent Dive Rate (m/s)	0.01 (0.01)
	Time in Reversal (s)	Gaussian 200 (60)
	Surface interval (s)	Gaussian 440 (120)
	Bout duration (s)	Gaussian 1200 (600)
General	Shore following (m)	5
	Depth limit on seeding (m)	5 (minimum), 20 (maximum)

C.2. Offshore SRW

Table C-2. Animat behavioural parameters for offshore SRW (juveniles and males) (number values represent Means (SD) unless otherwise indicated). Behavioural parameters are derived from published data on SRW migratory and swim/dive behaviour (Mate et al. 2011, Hain et al. 2013, Mackay et al. 2015) and complemented by data published on northern right whales (Winn et al. 1986, Baumgartner and Mate 2003, Baumgartner and Mate 2005, Mellinger et al. 2007, Kenney 2009).

Behaviour	Variable	Value
Foraging	Travel Direction	Correlated Random Walk
	Perturbation value	10
	Termination coefficient	0.2
	Travel rate (m/s)	Gaussian 0.92 (0.1)
	Ascent rate (m/s)	Gaussian 1.47 (0.26)
	Descent rate (m/s)	Gaussian 1.4 (0.3)
	Average depth (m)	Gaussian 121.2 (24.2)
	Bottom following	No
	Reversals	Gaussian 1.0 (0)
	Probability of reversal	1.0
	Reversal Ascent Dive Rate (m/s)	0.01 (0.01)
	Reversal Descent Dive Rate (m/s)	0.01 (0.01)
	Time in Reversal (s)	Gaussian 420 (60)
	Surface interval (s)	Gaussian 187.8 (59.4)
	Bout duration (s)	Gaussian 3600 (600)
V-shaped	Travel Direction	Correlated Random Walk
	Perturbation value	10
	Termination coefficient	0.2
	Travel rate (m/s)	Gaussian 0.92 (0.1)
	Ascent rate (m/s)	Gaussian 1.47 (0.26)
	Descent rate (m/s)	Gaussian 1.4 (0.3)
	Average depth (m)	Gaussian 121.2 (24.2)
	Bottom following	No
	Reversals	No
	Surface interval (s)	Gaussian 440 (120)
	Bout duration (s)	Gaussian 1800 (600)
Other	Travel Direction	Correlated Random Walk
	Perturbation value	10
	Termination coefficient	0.2
	Travel rate (m/s)	Gaussian 0.92 (0.1)
	Ascent rate (m/s)	Gaussian 1.47 (0.26)
	Descent rate (m/s)	Gaussian 1.4 (0.3)
	Average depth (m)	Gaussian 121.2 (24.2)
	Bottom following	No
	Reversals	Random 1.0-10.0
	Probability of reversal	0.3
	Reversal Ascent Dive Rate (m/s)	0.08 (0.05)

Behaviour	Variable	Value
	Reversal Descent Dive Rate (m/s)	0.01 (0.01)
	Time in Reversal (s)	Gaussian 200 (60)
	Surface interval (s)	Gaussian 440 (120)
	Bout duration (s)	Gaussian 1200 (600)
General	Shore following (m)	5
	Depth limit on seeding (m)	5 (minimum), 20 (maximum)

Appendix D. Modelled Animal Exposures

The numbers of modelled animats exposed to acoustic levels exceeding different behaviour thresholds are presented in Table D-1. These results are based upon 0.5 animats/km^2.

Table D-1. Counts of modelled animats exposed to acoustic levels exceeding thresholds specified by (Wood et al. 2012, [NMFS] National Marine Fisheries Service 2013).

Sub-population	Counts of modelled animats exposed to specific sound levels			
	120 dB ($L_{P,LF}$)	140 dB ($L_{P,LF}$)	160 dB ($L_{P,LF}$)	160 dB (L_P)
Offshore SRW	21402	4573	1366	2078
Nearshore SRW	12480	0	0	0

$L_{p,LF}$ – denotes low-frequency weighted sound pressure level and has a reference value of 1 µPa
L_p - denotes sound pressure level and has a reference value of 1 µPa
L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa^{2}s

The exposures as a proportion of the modelled sub-populations of 211,781 (offshore SRW) and 148,650 animats (nearshore SRW), are given in Table D-2.

Table D-2. Modelled animats that were exposed to sound pressure levels exceeding behavioural thresholds as a percentage of the number of animats modelled.

Sub-population	Counts of modelled animats exposed to specific sound levels			
	120 dB ($L_{P,LF}$)	140 dB ($L_{P,LF}$)	160 dB ($L_{P,LF}$)	160 dB (L_P)
Offshore SRW	13.79%	2.95%	0.88%	1.34%
Nearshore SRW	5.89%	0.00%	0.00%	0.00%

$L_{p,LF}$ – denotes low-frequency weighted sound pressure level and has a reference value of 1 µPa
L_p - denotes sound pressure level and has a reference value of 1 µPa

In the nearshore behavioural simulations, no animats were exposed to levels exceeding the threshold for injurious effects (PTS). The following discussion should be considered in terms of the seeding density of the animats, which was 0.5 animats/km^2,which is greater than the real-world density of SRW. For the offshore sub-population, the simulation predicts that 21 animats, representing 0.01% of the modelled population, would be exposed to a weighted, SEL_{24h} greater than 183 dB and thus experience PTS when applying the NMFS (2018) criteria. All animats which received this sound level were within 500 m of the airgun source, which is less than the predicted maximum distance for the PTS isopleth in the modelling study, which was 760 m. The simulation resulted in 1636 animats (1.03%) exposed to a weighted, SEL_{24h} greater than 168 dB 1 µPa^{2}s, and thus experience TTS when applying the NMFS (2018) criteria. For both PTS and TTS, the few animats (5 and 21) that were exposed to peak pressure levels (PK) exceeding thresholds were also exposed to levels above the SEL_{24h} threshold. However, it is important to note that the model does not account for shutdowns, and all animats which received PTS are within the 2 km low-power and 500 m shutdown range required by the Australian Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 2.1, Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008).

Table 7. Population-scaling of animat modelling results for entire SRW population (uncorrected for spatial correlation). Scaling number of animat exposed to sound pressure levels exceeding the noise exposure criteria based on number of SRW for entire Australian population.

Sub-population	Correction factor [%]	120 dB ($L_{p,LF}$)	140 dB ($L_{p,LF}$)	160 dB ($L_{p,LF}$)	160 dB (L_p)	TTS† 168 dB ($L_{E,LF}$)	PTS† 183 dB ($L_{E,24h}$)
Offshore SRW (males/juveniles)	0.19	40.90	8.74	2.61	3.97	3.13	0.04
Nearshore SRW (females/calves)	0.31	39.06	0	0	0	0	0

$L_{p,LF}$ – denotes low-frequency weighted sound pressure level and has a reference value of 1 µPa
L_p - denotes sound pressure level and has a reference value of 1 µPa
L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa²s
†The model does not account for shutdowns.

Table 8. Population-scaling of animat modelling results for eastern SRW population (uncorrected for spatial correlation). Scaling number of animat exposed to sound pressure levels exceeding the noise exposure criteria based on number of SRW for eastern Australian population.

	Correction factor [%]	120 dB($L_{P,LF}$)	140 dB($L_{P,LF}$)	160 dB($L_{P,LF}$)	160 dB(L_P)	TTS† 168 dB ($L_{E,LF}$)	PTS† 183 ($L_{E,LF,24h}$)
Offshore SRW (males/juveniles)	0.02	4.32	0.92	0.28	0.42	0.33	0
Nearshore SRW (females/calves)	0.03	4.13	0	0	0	0	0

$L_{p,LF}$ – denotes low-frequency weighted sound pressure level and has a reference value of 1 µPa
L_p - denotes sound pressure level and has a reference value of 1 µPa
L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa²s
†The model does not account for shutdowns.

Appendix C: PGS Ramform Sovererign Specifications

RAMFORM SOVEREIGN MARITIME AND SEISMIC SPECIFICATIONS

The M/V Ramform Sovereign was launched in 2008 and upgraded to GeoStreamer(R) in 2014.

The S-class design builds on the proven industry leading capabilities of the V-class Ramform vessels, while introducing GeoStreamer technology and is capable of towing up to 22 streamers (with narrow separation). The vessel's widest spreads recently towed are 12 x 8km @ 150m and 16 x 7km @ 100m separation.

The S-class vessels are also defined by features such as ~100 day endurance, steerable streamers and sources, in-line acoustics, dual workboat capacity and unique gear handling ability.

Proven in terms of productivity, efficiency, safety and data quality.

Maritime Specification Summary

Name	: **Ramform Sovereign**
Owner	: PGS Falcon AS
Maritime Operator	: PGS Geophysical AS
Flag	: Bahamas
Port of registry	: Nassau
Builder and date built	: Aker Yards AS, Langsten, Norway 2008. Upgraded to GeoStreamer in 2014
Vessel classification	: DNV+1A1, ICE-C, Heldk, E0, RP, Clean, Tmon
Call sign	: 9VBN9
IMO number	: 9390460
Official number	: 393693
Length	: 102.2 m
Breadth	: 40 m
Draft	: 7.4 m (7.9 m max)
Gross tonnage	: 13688 tonnes
Net tonnage	: 4107 tonnes
Fuel capacity	: 6184 m³ HFO + 454 m³ MGO
Endurance (production/transit)	: 95 days
Vessel cruising speed	: 15 knots
Main propulsion system	: Diesel electric
Propulsion type	: Diesel electric / 2 Twin screw, 14,000 kW
Power Plant	: 4 x Bergen Diesel 4165 kw 2 x Bergen Diesel 2765 kw
Fresh water maker capacity	: Alfa Laval 2 x 30m³
Accommodation (single berths)	: 70 (36 single cabins, 17 double cabins)
Helideck	: 26m 15 t (Super Puma/EH-101)

RAMFORM SOVEREIGN MARITIME AND SEISMIC SPECIFICATIONS

Electrical installations and Power Supplies

Power plant	: 4 x Bergen Diesel B32:40L9A
	: 2 x Bergen Diesel B32:40L6A
	: 4 x 4165 kW (ABB)
	: 2 x 2765 kW (ABB)
	: Total of 22160 kW

Vessel Fire Fighting Equipment, Safety and Survival

Fire detection system	: Eltek
Pumps	: Allweiler x 3 / 132m³
Hydrants and hoses	: Stoltz "C"
Inert gas and other fixed systems	: HIFOG, CO2, foam, FM200
Foam deluge system	: Marioff
Portable fire extinguishers	: Brude Safety
Fireman's outfits	: 6 x FireBuddy
Breathing apparatus spares	: 6 x Dräger
Life boats	: 2 x Harding, 70 pax each
Life rafts	: 6 x 25 pax
MOB craft	: Norsafe Magnum 750
Life jackets	: 146 adult size, 8 child size
Survival suits	: 74
Lifebuoys	: 13 x Hygrapha

Communication System and Navigational Aids

Inmarsat B number	: +870 764 832 053
Norsat number (bridge)	: +47 6751 5500
Email	: sovpc@pgs.com
Radar	: 2 x Furuno X-Band – PM31
	: 1 x Furuno S-Band – PM51
	: 1 x Sea-Hawk X-Band
Autopilot	: Kongsberg K-pos
Heading sensor	: 2 x SGB Meridian Surveyor
Echo sounder	: Furuno FE-700 – 200kHz
AIS	: Furuno FA-150
Water speed log	: Skipper

HSE

Hospital and medical facilities	: 2 beds with trauma equipment and NMD/WHO medicine chest

RAMFORM SOVEREIGN MARITIME AND SEISMIC SPECIFICATIONS

Streamer Systems

Manufacturer, type	: PGS GeoStreamer(R) Solid
Skin material	: Polyurethane
Outside diameter	: 62 mm
Length of each group	: 12.5 m (12 hydrophones per group)
Streamer set-up	: Typical 14 x 8100 m
Hydrophones, manufacture, type	: Hydrophones: Teledyne T-2BX
	: Velocity Sensors: PGS Confidential
Type of array	: Linear
Coupling phones and pre-amp	: Capacitive
Sensitivity at 1/P to recorder	: 20 V/bar at 100Hz
Lateral controlling devices	: Kongsberg e-Bird
Type of depth controller devices	: Kongsberg e-Bird
Manufacture, type of compass	: ION 5011 DigiBird

Recording System

Data Acquisition System	: PGS GeoStreamer 24bit
Recording System	: PGS gAS
Number of seis and aux channels	: Typical 14 x (648 x 2) + 48
Format(s) available	: SEG-D 8036
Tape drives	: 4 x IBM 3592
Sample rates	: 2 ms (standard)
High cut filters available	: 428Hz, 214Hz, 107Hz @ 341dB/oct
Low cut filter	: 3.04Hz @ 7.5dB/oct, 4.4Hz @ 12dB/oct
Auxiliary channels allocation	: Flexible, append/overlay
Telemetry systems pre amp gain	: 12 dB

Energy Source

Manufacturer and type	: BOLT 1900 LLXT
Volume of standard array(s)	: 2 x 3090 in^3 or 2 x 4130 in^3
Maximum number of sub-arrays	: 6
Standard array depth(s)	: 5 - 9 m
Position of depth transducers	: Front and tail of subarray
Working pressure	: 2000 - 2500 psi
Type of firing sensors	: Pressure activated
Position of firing sensors	: Each gun
Type of firing synchroniser unit	: PGS SourceLink
Timing accuracy	: +/- 1.5 ms
Position of near field phones	: Each cluster, all positions, 7 each array
Number of air compressors	: 3 x LMF 48/138-207 – E60

RAMFORM SOVEREIGN MARITIME AND SEISMIC SPECIFICATIONS

Integrated Navigation Computer System

Type	: ORCA
Supplier	: Concept Systems Ltd (ION)
Hardware description	: IBM 3650 M4 Servers
Tape drives	: IBM 3592

Navigation Post prcessing System

Type	: NRT (near real time) navigation processing, IRIS
Supplier	: Concept Systems Ltd (ION)
Hardware description	: IBM 3650 M4 Servers

Binning System

Type	: Reflex
Supplier	: Concept Systems Ltd (ION)
Hardware description	: IBM 3650 M4 Servers

Differential GPS

Standard system	: Skyfix.XP2, Starfix.HP and Skyfix.G2
Subcontractor	: Fugro Survey AS
Processing software	: Multifix-6 / Starpack v7

Relative GPS

Standard system	: Starfix-RGPS
Processing software	: Starfix Suite RGPS

Acoustic Ranging System

Model	: GeoStreamer Inline Acoustics (GIA)
Frequency	: 21-25 kHz
Type of units	: Inline adaptors

Vessel Heading Sensors

GPS heading reference	: Seapath 330
Survey gyrocompasses	: 2x SG Brown Meridian

Echo sounder

Manufacturer/model	: Kongsberg Simrad EA 600
Frequencies	: 200 +38 +12kHz
Maximum sounding depth	: 5000m

Onboard Seismic Data Processing

Application Software: SPArk 1.0

Server Hardware:

- 16 x SuperMicro X10 (4 x 2496C GK210GL [Tesla K80] GPUs, 64GB RAM, 2 x 1TB in RAID10 configuration)
- 17 x Dell R630 (2 x 10C Intel(R) Xeon(R) CPU E5-2660 v3 @ 2.60GHz, 192GB RAM, 6 x 600GB in RAID10 configuration).
- 19 x Dell R620 (2 x 8C Intel(R) Xeon(R) CPU E5-2670 0 @ 2.60GHz, 128GB RAM, 6 x 600GB in RAID10 configuration).
- 14 x Dell R610 (2 x 6C Intel(R) Xeon(R) CPU X5660 @ 2.80GHz, 96GB RAM, 6 x 300GB in RAID0 configuration).
- 2 x HP Z820 Workstations (2 x 6C Intel(R) Xeon(R) CPU E5-2620 0 @ 2.00GHz, 32GB RAM, 2 x 900GB HDD in RAID1 configuration with 2 hot spares, nVIDIA Quadro 2000)

Storage Hardware:

- 5 x Panasas PAS 11 (60TB Shelves) NAS

Archiving Hardware:

- 6 x IBM TS1120 3592-E05
- 2 x IBM TS1140 3592-E07

Compute Capability:

- 150572 processing cores total
- 190.1 TFLOPS
- 205TB storage capacity

RAMFORM SOVEREIGN MARITIME AND SEISMIC SPECIFICATIONS

Real Time Acquisition System (gAS)

Application Software: gAS

Server Hardware:

- 2 x IBM SystemX 3750M4 (4 x 8C Intel(R) Xeon(R) CPU E5-4650 0 @ 2.70GHz, 64GB RAM, 2 x 146GB in RAID1 configuration with 1 hot spare + 2 x 1.1TB in RAID1 configuration with 1 hot spare).
- 2 x IBM SystemX 3650M4 (2 x 8C Intel(R) Xeon(R) CPU E5-2650 v2 @ 2.60GHz, 32GB RAM, 2 x 146GB in RAID1 configuration with 1 hot spare + 2 x 1.1TB in RAID1 configuration with 1 hot spare), nVIDIA GK107 [NVS 510])

Storage Hardware:

- 2 x Infortrend DS S24F-G2840-4 Storage arrays
- 2 x 20TB in RAID10 configuration with 4 hot spares

QC system (Viper)

Application Software: Viper

Server Hardware:

- 3 x IBM SystemX 3650M4 (2 x Intel(R) Xeon(R) CPU E5-2670 0 @ 2.60GHz, 32GB RAM, 2 x 146GB in RAID1 configuration with 1 hot spare).
- 3 x HP Z820 Workstations (2 x 6C Intel(R) Xeon(R) CPU E5-2620 0 @ 2.00GHz, 32GB RAM, 2 x 900GB HDD in RAID1 configuration with 2 hot spares, nVIDIA GF106GL [Quadro 2000])

Storage Hardware:

- 4 x Infortrend DS S24F-G2840-4 Storage arrays
- 4 x 20TB in RAID10 configuration with 4 hot spares

Appendix D: PGS Ramform Sovereign SOPEP

Shipboard Oil Pollution Emergency Plan (SOPEP)

APPROVED
MARPOL, Annex I, Reg. 37, in compliance with amended IMO Res. MEPC.86(44).
18 64 DNV·GL SAFEGUARDING LIFE, PROPERTY AND THE ENVIRONMENT
SEE LETTER
Date: 2016-04-19

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

In accordance with Regulation 37 of Annex I of MARPOL 73/ 78

SHIP´S IDENTIFICATION

DNV-GL Register-Number	27233
Name of Ship	Ramform Sovereign
Distinctive Number or Letters (Call Sign)	9VBN9
IMO-Number	9390460
Type of Ship	Seismic Research Vessel
Port of Registry	Singapore
Gross Tonnage	13688
Flag	Singapore

Owner/ Managers: see „Ship Interest Contacts“

TABLE OF CONTENT/ INDEX OF SECTIONS

RECORD OF CHANGE

DATE	DETAILS	Approved by

INTRODUCTION

1. This Shipboard Oil Pollution Emergency Plan (hereafter referred to as the "Plan") is written in accordance with the requirements of regulation 37 of Annex I of the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 relating there to.

2. The purpose of the Plan is to provide guidance to the Master and officers on board the ship with respect to the steps to be taken when an oil pollution incident has occurred or is likely to occur. The appendices contain communication data of all contacts referenced in the Plan, as well as other reference material.

3. The Plan contains all information and operational instructions as required by the "Guidelines for the development of the Shipboard Oil Pollution Emergency Plan" as developed by the Organization (IMO), published under MEPC.54(32) and amended by MEPC.86(44).

4. The Plan has been approved by the Administration or on their behalf and, except as provided below, no alteration or revision shall be made to any part of it without the prior approval by or on behalf of the Administration.

5. Changes to Section 5 and the appendices are not required to be approved. The appendices should be maintained up to date by the owners, operators and managers in intervals not exceeding 12 months.

SECTION 1: PREAMBLE

1.1 This Plan is available to assist the ship's personnel in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge of oil and to mitigate its effects.

1.2 Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner.

1.3 The primary objectives of this Plan are to

- prevent oil pollution
- stop or minimize oil outflow when a damage to the ship or its requirements occurs
- stop or minimize oil outflow when a operational spill occurs in excess of the quantity or instantaneous rate permitted under the present Convention

1.4 Further, the purpose of the Plan is to provide the Master, officers and certain crew members with a practical guide to the prevention of oil spills and in carrying out the responsibilities associated with regulation 37 of Annex I to MARPOL 73/ 78

- procedures to report an oil pollution incident
- Coastal State contacts (Focal Points) and Port Contact Lists to be contacted in the event of an oil pollution incident
- response actions to reduce or control the discharge of oil following an incident
- co-ordination with national and local Authorities in combating oil pollution

1.5 In summary, the Plan will serve to promote a practised response when the ship's personnel are faced with an oil spill. It is important to be prepared at all times.

1.6 SOPEP Drills

The Master is responsible to ensure regular drills according to Safety Management System are carried out. All drills shall be documented and evaluated. The effectiveness of these drills shall be formally reviewed in debriefs with involved crew and any suggested improvements arising from these debriefs shall be addressed accordingly.

1.7 Although the Plan is designed as a ship-specific tool it must also be considered as an additional instrument and as a link to shore-based plans. With this the Plans allow an efficient co-ordination between the ship and shore-based Authorities/ Organizations in mitigating the effects of an oil pollution incident.

1.8 The Plan includes a summary flowchart to guide the Master through reporting and acting procedures required during an oil pollution incident response.

1.9 The Plan will be a document used on board by the Master and officers of the ship and must therefore be available in the working language used by them.

SHIPBOARD OIL POLLUTION EMERGENCY PLAN – SUMMARY FLOWCHART

This flow diagram is an outline of the course of action that shipboard personnel should follow in responding to an oil pollution emergency based on the guidelines published by the Organization. This diagram is not exhaustive and should not be used as a sole reference in response. Consideration should be given for inclusion of specific reference to the Plan. The steps are designed to assist ship personnel in action(s) to stop or minimize the discharge of oil and mitigate its effects. These steps fall into two main categories – reporting and action

Discharge of Oil
Probable or Actual

Assessment of the Nature of Incident

Actions
Alert crew members
Identify and monitor spill source
Personnel protection
Spill assessment
Vapour monitoring
Evacuation

REPORTING

By Master and/ or designated crew member

When to report
- All probable and actual spills

How to report
- By quickest means to coastal radio station
- Designated ship movement reporting station (VTS) or
- Rescue Co-ordination Centre (at sea)
- By quickest available means to local authorities

Who to report
Refer to contact lists
- Nearest Coastal State Harbour and terminal operators (in port)
- Shipowner´s manager; P & I insurer
- Head Charterer if applicable

What to report
- Initial report (Res. A.851(20)) as amended by IMO resolution MEPC138(53)
- Follow-up reports
- Characteristics of oil spilled
- Cargo/ ballast/ bunker dispositions
- Weather and sea conditions
- Slick movement
- Assistance required for
    - Salvage
    - Lightening capacity
    - Mechanical equipment
    - External strike team
    - Chemical dispersant/ degreasing

ACTION TO CONTROL DISCHARGE

Measures to minimize the escape of oil and threat to the marine environment

NAVIGATION MEASURES
To be considered:
- Alter course/ position and/or speed
- Change of list and/or trim
- Anchoring
- Setting aground
- Initiate towage
- Assess safe haven requirements
- Weather/ tide/ swell fore-casting
- Spill slick monitoring

Record of events and communications shall be taken

SEAMANSHIP MEASURES
- Safety assessment and precaution
- Advice on priority countermeasures/ preventive measures
- Damage stability and stress consideration
- Ballasting/ de-ballasting
- Internal cargo transfer operations
- Emergency ship-to-ship transfers of cargo and/ or bunker
- Set up shipboard response for:
    - Leak sealing
    - Fire fighting
    - Handling of shipboard response equipment
    - Etc.

STEPS TO INITIATE EXTERNAL RESPONSE
- Refer to Coastal State Contact List for local assistance
- Refer to ship interest contact list
- External clean-up resources required
- Continued monitoring of activities

SECTION 2: REPORTING REQUIREMENTS

2.1 General

The reporting requirement of this section complies with those of regulation 37 of MARPOL 73/ 78, Annex I.

When the ship is involved in an incident which results in the discharge or probable discharge of oil, the Master is obliged under the terms of MARPOL 73/ 78 to report details of the incident, without delay, to the nearest Coastal State by means of the fastest telecommunication channels available.

The intent of these requirements are to ensure that Coastal States are informed, without delay, of any incident giving rise to oil pollution, or threat of oil pollution, of the marine environment, as well as of assistance and salvage measures, so that appropriate action may be taken.

Without interfering with ship owners' liability, some coastal states consider that it is their responsibility to define techniques and means to be taken against an oil pollution incident and approve such operations which might cause further pollution, i.e. lightening. States are in general entitled to do so under the International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969.

2.2 Reporting Procedures

For easy reference the reporting requirements in the context of this Plan are divided in the following information blocks:

2.2.1 When to report

Taking the summary flowchart as a basic guide into consideration reports are necessary in the following cases:

2.2.1.1 Actual Discharge

The Master is obliged to report to the nearest Coastal State whenever there is a discharge of oil resulting

- from damage to the ship
- from damage to the ship's equipment
- for the purpose of securing the safety of a ship or saving life at sea
- during the operation of the Ship in excess of the quantity or instantaneous rate permitted under the present Convention

2.2.1.2 Probable Discharge

The Master is obliged to report even when no actual discharge of oil has occurred but there is a probability that one could.

As it is not practicable to lay down precise definitions of all types of situations involving probable discharge of oil which would warrant an obligation to report the Master is obliged to judge by himself whether there is such a probability and whether a report should be made.

It is recommended that, at least, the following events

- damage, failure or breakdown which affects the safety of the ship (e.g. collision, grounding, fire, explosion, structural failure, flooding, cargo, cargo shifting etc.)

  or

- failure or breakdown of machinery or equipment which results in impairment of the safety of navigation (e.g. failure or breakdown of steering gear, propulsion, electrical generating system, essential shipborne navigation aids etc.)

are carefully considered by the Master – taking into account the nature of the damage failure or break-down of the ship, machinery or equipment as well as the ship's location, proximity to land, weather, state of the sea and traffic density – as cases in which a probable discharge of oil is most likely.

If in doubt, the Master should always make a report in cases abovementioned.

In all cases the Authorities should be kept informed by the Master as how the situation progress and be advised when all threat of pollution has passed.

2.2.2 Information Required

As required in article 8 and Protocol I of MARPOL 73/ 78 Convention the Master or other persons having charge of the ship should report the particulars of any pollution incident. In this context the International Maritime Organization (IMO), in 1997, adopted Resolution A. 851 (20) "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents involving Dangerous Goods, Harmful Substances and/ or Marine Pollutants".

The intent of the Resolution aforementioned is to enable Coastal States and other interested parties to be informed, without delay, of any incident giving rise to oil pollution, or threat of oil pollution, of the marine environment, as well as of assistance and salvage measures, so that appropriate action may be taken.

Nothing in this chapter relieves the Master in using sound judgement to make sure that any incident or probable discharge of oil is reported as quickly as possible in the prevailing situation.

When transmitting initial reports to the authorities of the nearest Coastal State the Master or other persons dealing with such a transmission should take note of Resolution A. 851(20) as amended by IMO resolution MEPC.138 (53)

Especially, the format of the initial report as well as supplementary of follow-up reports should be conform to the guidance contained in Res. A. 851 (20). All reporting whether initial or follow-up, should follow IMO's reporting format as outlined below and should contain the following information:

LABEL	FUNCTION	EXPLANATION
A	Ship	Name, call sign and nationality
B	Date and time (UTC) of event	A 6-digit group giving day of month (first two digits), hours & minutes (last four digits)
C	Position	A 4-digit group giving latitude in degrees and minutes suffixed with N or S, and a 5-digit group giving longitude in degrees and minutes suffixed with E or W
D	Position	True bearing (first 3 digits) and distance (state distance) in nautical miles from clearly identified landmark (state landmark)
E	True course	A 3-digit group
F	Speed at time of incident	In knots and tenths of knots as a 3-digit group
L	Route information	Details of intended track
M	Radio communications	Full details of radio stations (names) and frequencies being guarded
N	Time (UTC) of next report	A 6-digit group as under BB above
P	Cargo on board: can be included in „RR„ as relevant	Type(s) and quantity(/ies) of cargo/ bunker on board and brief details of any dangerous cargoes as well as harmful substances and gases that could endanger persons or the environment
Q	Defects or damage or deficiencies or other limitations	Brief details of conditions of the ship as relevant; ability to transfer cargo/ ballast/ bunker fuel
R	Description of pollution or possible overboard discharge	Brief details of type of pollution (oil, chemicals, etc.) or dangerous goods lost overboard; position expressed as in (C) or (D) (See detailed reporting requirements)
S	Weather conditions	Brief details of weather and sea conditions prevailing including wind force and direction and relevant swell details
T	Ship's representative and/ or owner	Name, address, telex and telephone number of the ship's owner and representative (charterer, manager or operator of the ship or their agents)
U	Ship's size and type	Details of length, breadth and type of ship as well as draught
X	Miscellaneous and additional information	Any other information including relevant details such as brief details of incident, need for outside assistance, action being taken to limit further discharge; details of any personnel injuries sustained, details of P & I Club and local correspondent.

A sample format for initial notification and a detailed example of an initial report is shown within the appendices.

All follow-up reports by the Master should include information relevant to the Coastal State Authorities to keep them informed as the incident develops.

Follow-up reports should include information on any significant changes in the ship's condition, the rate of release and spread of oil, weather and sea conditions and clean-up activities underway.

In this context details of bunker disposition, condition of any empty tanks and nature of any ballast carried are information needed by those involved in order to assess the threat posed by an actual or probable discharge of oil from the damaged ship.

2.2.3 Who to Contact

The Master is responsible for reporting any incident involving an actual or probable discharge of oil.

Taking into consideration the summary flowchart in Section 1 the Master of the ship involved in any kind of an actual or probable discharge, cases of which are defined under SECTION 2 (sub-paragraph 2.2.1.1 and 2.2.1.2) of this Plan should report details on the incident immediately (see Report Format in App. 1)

Nothing in this chapter relieves the Master from using sound judgement to make sure that any incident is reported as quickly as possible in the prevailing situation.

2.2.3.1 Coastal State Contacts

For the ship at sea

In order to expedite response and minimize damage from an oil pollution incident at sea, it is essential that appropriate Coastal States are notified without delay.

In this context the use of the list of agencies or officials of Administrations responsible for receiving and processing reports (so called "Focal Points") as developed by the Organization (IMO) in conformity with article 8 of the Convention is recommended.

Such a list is shown under App. 2.

An updated list of existing "Focal Points" is available from the Internet pages of IMO under address:

http://www.imo.org/ >> National Contacts >>> MEPC.6/Circ. xx

In the absence of such a list or listed focal point for a single country/ Coastal State, the Master should contact by the quickest available means

- the nearest coastal radio station or
- the designated ship movement reporting station or
- the nearest Rescue Co-Ordination Centre (RCC).

2.2.3.2 Port Contacts

For the ship in port,

Notification of local agencies, combating teams or clean-up companies will speed up response. If an oil spill occurs during the ship's stay in port, whether operational or as a result of an incident, the

Master should inform the appropriate local agencies (e.g. National Response Centre, Terminal/ Port Authorities etc.) without undue delay.

If the ship is engaged in a regular service between ports/ terminals the Master or any other person aboard delegated by the Master should provide a list with the relevant Port Contact addresses for each port served regularly of Authorities/ persons and/ or terminals dealing with an oil spill. This list must be regularly updated.

The "Port Contact List" is shown in the App. 3.

If a change in the ship's range of trade or a change in the addresses of persons/ Authorities of the ports/ terminals served regularly takes place the Master or any other person aboard delegated by the Master is required to issue a new list.

Where ship's service makes it not feasible to prepare such a list the Master should seek guidance concerning such local Port Contacts and local reporting procedures upon arrival in port.

Addresses obtained in this way should be documented aboard in the form that the Master considers most effective and should be attached to the Plan.

2.2.3.3 Ship Interest Contacts

For Ship Interest Contacts it is necessary to have information at the Master's disposal in case of an oil spill for informing the home office of the ship's operator, the local agent of the company, the appropriate P & I Club and correspondents, clean-up contractors etc.

This information shall be provided in the form of a "Ship Interest Contact List".
Minimum requirement is to have Operator and Owner listed with full contact details.

The "Ship Interest Contact List" is shown in the App. 4.

To avoid duplication of reports and to co-ordinate the Plan and the company's shoreside plan(s) responsible for informing the various Ship Interested Contacts is

- ☐ Master
- ☐ Owner
- ☒ Operator

SECTION 3: STEPS TO CONTROL DISCHARGE

Ship personnel will most probably be in the best position to take quick action to mitigate or control the discharge of oil from their ship.

Therefore, this Plan provides the Master with clear guidance on how to accomplish this mitigation for a variety of situations.

It is the Master's responsibility to initiate a response in the event of a discharge of oil or substantial threat of discharge of oil – actual or probable – into the waters.

In no case action should be taken that in any way could jeopardize the safety of personnel either onboard or ashore.

Company emergency response procedures shall be followed as per Safety Management System

The following enumeration specifies different kinds of possible operational oil spills with regard to reactions to be taken.

3.1 Operational Spills

3.1.1 Operational Spill Prevention

Crew members shall maintain a close watch for the escape of oil during bunker operations.

Prior to bunker transfer crew members should mobilize the oil spill equipment, as far as available on board, and place it close to the planned operation, e.g. along the railing on the side at which bunker operation takes place.

Before bunker handling commences, all concerned deck scuppers and open drains must be effectively plugged. Accumulations of water should be drained periodically and scupper plugs replaced immediately after the water has run off. Any free floating oil or oil droplets should be removed prior to draining.

Bunker tanks which have been topped up should be checked frequently during the remaining bunker operations to avoid an overflow.

Unless there are permanent means for retention of any slight leakage at ship/ shore connections for bunker transfer, it is essential that a drip tray is in place to catch any leaking oil.

The removed bunker oil and the used clean-up material should be retained on board in proper containment units until it can be discharged to a reception facility.

3.1.2 Pipeline Leakage

If a leakage occurs from a pipeline, valve, hose, cylinder, etc. operations through that connection should be stopped immediately until the cause has been ascertained and the defect remedied.

Defective pipe sections should be isolated. Affected sections should be drained down to an available empty or slack tank.

If a leakage occurs from a hydraulic pipeline, operations should be stopped immediately.

Initiate clean-up procedures.

The removed bunker oil and the used clean-up material should be retained on board in proper containment units until it can be discharged to a reception facility.

Inform in line with Section 2 all parties interested about Pipeline Leakage and the actions taken so far.

3.1.3 Tank Overflow

If there is a tank overflow all bunker operations should be stopped immediately and should not be restarted until the fault has been rectified and all hazards from the released oil have been eliminated.

If there is any possibility of the released oil or oil vapours entering an engine room intake or accommodation intake, appropriate preventive steps must be taken quickly.

Promptly shift bunker oil from the tank overflowed to an available empty or slack tank or prepare pump(s) or transfer the excess ashore.

Initiate clean-up procedures.

The removed bunker oil and the used clean-up material should be retained on board in proper containment units until it can be discharged to a reception facility.

Inform in line with Section 2 all parties interested about Tank Overflow and actions taken so far.

3.1.4 Hull Leakage

Identify leaking tank; consider diver if necessary and possible.

Reduce level in tank in question well below sea level.

If it is not possible to identify the leaking tank, reduce level in all tanks in vicinity. In this case give careful consideration to hull stress and stability.

If there is a spillage due to suspected hull leakage reduce the head of bunker and promptly transfer the bunker oil to an available empty or slack tank or, if berthed, discharge ashore in suitable barges/ tanks.

Inform in line with SECTION 2 all parties interested about Hull Leakage and the actions taken so far.

3.1.5 Spills caused by Equipment in Machinery Spaces

If operational oil spills are caused by a failure of equipment in machinery spaces any further operations of this equipment should be stopped immediately or measures are to be taken to avoid an oil spill.

Such equipment may be:

- Oily-water separating equipment or oil filtering equipment to de-oil bilge water from the engine room bilges
- Valves in pipes connecting ballast/ bilge systems
- Cooling pipes in oil cooler systems
- Gearing of bow thrusters
- Stern tubes

The removed bunker oil and the used clean-up material should be retained on board in proper containment units until it can be discharged to a reception facility.

3.2 Spills Resulting From Casualties

In the event of a casualty the Master's first priority is to ensure the safety of the ship's personnel, and to initiate actions which may prevent escalation of the incident and marine pollution.

3.2.1 Ship grounded / stranded

The Master's priority should be to ensure that he as soon as possible receives detailed information about the damage that the ship has been sustained, in order to determine remedial action to be taken for ensuring the safety of the ship and its crew.

Furthermore, the Master should also consider

- Danger to the ship's complement if the ship should slide off grounding site
- Danger of ship being shattered by heavy seas or swell
- Health hazards to the ship's crew and surrounding population due to release of oil or other hazardous substances in dangerous concentrations
- That fires may start due to released flammable substances and uncontrolled ignition sources
- Should the damage which the ship has sustained be of such an extent that the stability cannot be computed on board, the Master should seek assistance according to subparagraph 3.6

Also, the ship's Master shall take into account the following considerations:

- Is the vessel constantly being struck in the seaway?
- Is the vessel exposed to torsion?
- Is there a large difference in the tidal rangers at the grounding site?
- Are there strong tidal currents in the grounding area?
- May the vessel drift further up on the shore, due to high tides, wind and waves?

3.2.1.1 Prevention of Fire and Explosion

If the ship is aground and therefore cannot manoeuvre, all possible sources of ignition should be eliminated and action should be taken to prevent flammable vapours from entering the machinery spaces or the accommodation.

3.2.1.2 Extension of Hull Damage / Containment System Failure

First, a visual inspection should be carried out.

Check for visible oil along hull or in wake of the ship during day time. At night a stick with white cloth (or sheet of sorbent) around it may be lowered into the water alongside the ship to check for oil leakages.

All ballast/ bunker tanks to be sounded (ullage),
All other compartments which may have contact with the sea should be sounded to ensure that they are intact.

Soundings of ballast tanks/ bunkers tanks are to be compared with last soundings to check for possible leaks.

Sounding to be taken around the ship establish the ship's position on the grounding area.

When the ship is aground, due regards should be given to the indiscriminate opening of ullage plugs, sighting ports etc. as loss of buoyancy could be the result of such actions.

Any list of the ship shall be noted and included in the report for assistance.

3.2.1.3 Procedures to Reduce or Stop Outflow of Oil

The Master should assess the possibility of damage to the environment and whatever action can be taken to reduce further damage from an oil release, such as:

- Transfer of bunkers internally, provided shipboard piping system is in an operational condition
- If the damage is fairly limited and restricted, i.e. to one or two tanks, consideration should be given to transfer of bunkers internally from the damaged tank(s) to intact tanks, taking into account the impact on the ship's overall stress and stability
- Isolate damaged/ penetrated bunker tank(s) hermetically to ensure that hydrostatic pressure in tanks remains intact during tidal changes
- Evaluate possibility of pumping water into a damaged tank in order to form a water bottom stopping the outflow of oil
- Evaluate the necessity of transferring bunkers to barges or other ships and request such assistance accordingly
- Evaluate the possibility of additional release of oil.

In case of large differences between the tide levels, the Master should try to isolate the damaged tank(s) to reduce additional loss of oil.

3.2.1.4 Refloating by own Means

The Master should also evaluate the question of refloating the vessel by own means. Before such an attempt is made, it must be determined:

- whether the ship is damaged in such a way that it may sink, break up or capsize after getting off
- whether the ship after getting off may have manoeuvring problems upon leaving the dangerous area by own means
- whether machinery, rudder or propeller are damaged due to grounding or may be damaged by trying to get off ground by own means
- whether the ship may be trimmed or lightened sufficiently to avoid damage to other tanks in order to reduce additional pollution from oil/ bunker spillage
- weather evaluation: whether there is time/ reason to await improvements in weather or tide.

3.2.1.5 Securing the Ship

If the risk of further damage to the ship is greater in an attempt to refloat the ship by own means, than in remaining aground until professional assistance has been obtained, the ship's Master should try to secure the ship as much as possible by:

- Trying to prevent the ship from moving from its present position
- By dropping anchors (adequate water depth and anchor ground provided)
- By taking ballast into empty tanks, if possible
- Trying to reduce longitudinal strain on hull by transferring ballast or bunkers internally
- Reducing fire risk by removing all sources of ignition.

Inform in line with Section 2 all parties interested about the Grounding and the actions taken so far.

3.2.2 Fire/ Explosion

Should an explosion and a fire occur on board, sound the GENERAL ALARM immediately.
Further actions should be initiated in accordance with the ship's Muster List.
In case of fire and explosion the following priorities exist:

- Rescuing lives
- Limiting the damage/ danger to the ship and cargo
- Preventing environmental pollution

Steps to control the discharge of oil will depend largely on the damage to ship and cargo.
Special information thereto is contained in subparagraphs 3.2.4, 3.2.5 and 3.2.6.
Inform in line with Section 2 all parties interested about the Fire/ Explosion and the actions taken so far.

3.2.3 Collision (with fixed or moving object)

Should the ship be involved in a collision with another ship, fixed or moving object, the Master should as soon as possible identify the extent of damage to his own vessel.

When a collision occurs, the GENERAL ALARM should be sounded immediately for the personnel to muster at their designated Muster Stations.

The following check list should assist the Master in assessing the situation:

- Are any tanks penetrated above or below the waterline?
- If ships are dead in the water and interlocked, what is most prudent, to stay interlocked or separate?
- Is there any oil spill at present – small or large? Will a separation of the interlocked ships create a larger oil spill than if the ships stay interlocked?
- If there is an oil spill, will the separation of the ships cause sparks that can ignite the spilled oil or other flammable substances leaked out from the ships?
- Are the ships creating a greater danger to other traffic in the area if they are interlocked than if separated?
- Is there a danger to either ship of sinking after being separated?
- If the ships are separated, how is the manoeuvrability of the own ship?

If separation of the ships takes place, alter course to bring the own ship windward of any oil slick, if possible.

Shut down all none essential air intakes.

Isolate damaged/ penetrated tank(s) by hermetically closing the tank(s), if possible.

When it is possible to manoeuvre, the Master, in conjunction with the appropriate shore authorities, should consider moving his ship to a more suitable location in order to facilitate emergency repair work or lightening operations, or to reduce the threat posed to any sensitive shoreline areas.

Inform in line with Section 2 all parties interested about the collision and the actions taken so far.

3.2.4 Hull Failure

Should the ship lose one or more shellplatings, develop major cracks, or suffer severe damage to the hull, the Master should immediately sound the GENERAL ALARM to call the crew members to their Muster Stations, and inform them of the situation, and prepare lifeboats for launching if necessary.

The Master should then assess the situation, and confer with his senior officers.
The Master should obtain the latest weather forecast, and asses its impact on the present situation.

Furthermore, the following questions should be considered and should be asked:

- Is the ship in any immediate danger of sinking or capsizing?

If YES:

- Send distress message
- Immediately abandon the ship

If NO, initiate damage control measures as found necessary by considering the following points:

- Can the vessel manoeuvre on its own?
- Has the ship lost buoyancy?
- If the ship has a list due to loss of ballast, cargo/ bunker or buoyancy, is it necessary and possible to rearrange the bunker or ballast by internal transfer operation in order to bring the ship to an even keel?
- Is it necessary to dump cargo in order to maintain stability without changing the stress situation?
- Can this operation wait till another ship/ barge can receive that cargo?
- Is there any abnormal change in the ship's stability and stress situation?
- Can the change in the ship's stability and stress situation be monitored and calculated on board? If not, the Master should seek assistance according to subparagraph 3.6.
- Does the ship need assistance or escort to nearest port of refuge or repair port?
- Might it be prudent to salve part of the crew members in case the situation should worsen, or is it necessary to abandon the ship totally?

Inform in line with Section 2 all parties interested about the Hull Failure and the actions taken so far.

3.2.5 Excessive List

Should the ship for some reasons suddenly start to list excessively during discharging/ loading operations, or bunkering, all ongoing operations should be stopped immediately until the cause has been determined.

The Officer on Duty should inform the Master and/ or Chief Officer without delay.

The Master should try to determine the reason for the excessive list, and take steps to rectify the situation and to stabilize the ship's condition:

- Check reason(s) for list
- Soundings/ ullage to be taken in all tanks
- Bunker/ ballast pumps to be made ready
- Consider measures to minimize list in transferring liquid from one compartment to another
- Ensure water tightness of empty spaces
- Close all openings
- Secure vent pipes to avoid ingress of water
- If bunkering: Change to corrective tanks for rectifying the situation
- If ballasting/ deballasting: Change to corrective tanks to rectify the situation
- If there is reason to believe that the list may cause an oil spill, notify as per Section2
- If the ship's crew is in jeopardy, prepare lifeboats for launching, and notify as per Section 2

If the situation is brought under control, inform all parties interested.

3.2.6 Ship submerged/foundered/wrecked

If the ship is wrecked to the extent that it or parts of it are submerged take all measures to prepare for evacuation of all persons on board. The Master will have the final decision to evacuate, if necessary. Avoid contact with any spilled oil. Alert other ships and/or the nearest coastal state for assistance in rescuing lives and the ship as far as possible.

3.2.7 Hazardous Vapour release

In case of any vapour release out of the containment system precautions have to taken to protect the persons onboard against contamination. The ship should be brought with the accommodation upwind of the spill area as far as possible. The crew should be evacuated from any area of risk. All possible sources of ignition should be eliminated and non-essential air intakes shut down to prevent intake of vapour into accommodation and engine spaces.
If unavoidable work has to be carried out within risk areas, the involved persons have to wear protective closing and breathing apparatus.

3.3 Priority Actions

Top priority shall in all cases of casualty be put on the safety of the persons onboard and to take actions to prevent escalation of the incident.
Immediate consideration should be given to protective measures against fire, explosions and personnel exposure to toxic vapour.
Detailed information about the damage sustained to the ship and its containment system has to be

obtained. On the basis of the information the Master can decide next actions for the protection of lives, the ship, the cargo and the environment.
The Master should take into account the following when he is determining whether salvage assistance will be needed or not:

- Nearest land or hazard to navigation
- Vessel's set and drift
- Estimated time of casualty repair
- Determination of nearest capable assistance and its response time.

In case of necessary movement of cargo within the ship careful consideration is to be given to hull strength and stability.
Plans/tables about the location and specification of the current cargo as well as bunkers and ballast have to be readily available.

3.4 Mitigating Activities

If safety of both the ship and the personnel has been addressed the Master shall care for following issues:

- Assessment of the situation and monitoring of all activities as documented evidence
- Care for further protection of the personnel, use of protection gear, assessment of further risk for health and safety
- Containment of the spilled material by absorption and safe disposal within leak proof containers of all used material onboard until proper delivery ashore, with due consideration to possible fire risk.
- Decontamination of personnel after finishing the cleanup process

3.5 Transfer of fuel

If the ship has sustained extensive structural damage, it may be necessary to transfer all or part of the fuel to another ship; however, this section refers to bunker transfer procedures only.
In Ship-to-Ship-transfer operations involving a specialized service ship, the Master of that ship will normally be in overall charge.
In the case of non-specialized ships the Master or other person in overall charge of the operation should be mutually agreed and clearly established by the Masters concerned prior to the start of operations.
The actual bunker transfer should be carried out in accordance with the requirements of the receiving ship.
In all cases each Master remains responsible for the safety of his own ship, its crew, cargo/ bunker and equipment and should not permit their safety to be jeopardized by the action of the other Master, his owner, regulatory officials or others.

The Ship-to-Ship-transfer operations should be coordinated with the appropriate responsible local Authority.

When selecting the area of operation the Master(s) should consider the following points

- The need to notify and obtain the agreement of any responsible authority
- The destinations of the ships concerned
- The shelter provided, particularly from sea and swell

- The sea area and depth of water, which should be sufficient for manoeuvring during mooring, unmooring and transfer operations and allow a safe anchorage if operations have to be undertaken at anchor
- The traffic density
- The weather conditions and the weather forecasts

Further, before commencing Ship-to-Ship transfer operations each ship should carry out, as far as possible, appropriate preparations like

- Pre-mooring preparations of the ships
- Positioning of fenders if such equipment is available on board
- Mooring equipment arrangements
- Checking the communication channels between the two ships

In additions to the general principles of Ship-to-Ship operations as said the Master should take note of supplemented instructions issued by the company.

Those supplemented information is located in:

☐ The Master's Office/ Cabin

☐ Chief Officers Office/ Cabin

☐ Navigation Bridge

☒ In Safety Management System

3.6 Damage Stability and Hull Stress Calculation

Vessels managed by PGS are entered into an Emergency Response Service scheme with DNV-GL. Under this scheme, DNV-GL provides a 24-hour response service to assist with calculations on strength, stability and buoyancy. A ring binder with more detailed instructions on the scheme and reporting procedures is available on each vessel, with a copy located in the contingency room in PGS head office in Oslo.

3.6.1 General Description of Shipboard Facilities

- Bunker information is available at ECR or Bridge on Hoglund IAS
- Ballast information is available at Bridge or ECR on Hoglund IAS
- Vessel Stability Calculation System is available at Bridge on NAPA PC
- Damage Control Plan is available at Bridge in Stability Manual and on NAPA PC

3.7 General Responsibilities of the Master and designated Officers/ Crew Members

Master

2nd in Command
Chief Officer

Containment Team Leader
2nd Engineer

2nd in Command
3rd Engineer

Containment Team
Motorman 1
Motorman 2
Additional but NOT required:
Extra / Other Engine Rating

Meet at the SOPEP Station
Report to the Bridge when ready
Carry out emergency containment procedures to stop or minimize the pollution by operating booms, valves, pumps etc.
Where oil has spilled into the water, all efforts should be made to limit extent of the spill by rigging around the ship, supplied booms, old mooring ropes, air filled hoses etc.

Clean-up Team Leader
2nd Officer

2nd in Command
Bosun

Clean-up Team
AB 1
AB 2
AB 3
Additional but NOT required:
Extra / Other Deck Rating

Meet at the SOPEP Station
Report to the Bridge when ready
Carry out emergency clean up procedures using all available materials on board, such as portable pumps, absorbents and chemicals if and when approved by the local authorities.
Fire precautions should be observed at all times.

Muster Station Leader
3rd Engineer (off duty)

2nd in Command
Electrician

Crew not assigned to Any other Team
(As needed)

Assist as ordered

3.7.1 General Responsibilities

The following crew members are in charge in the event of an oil spill – actual or probable – to bring the accident under control, limit outflows, organize onboard clean-up procedures and determine the additional manpower needed. Arrangements shall be made that in case of sudden unavailability of superior ranks other available ranks are prepared to take over.

Ranking	Duties
Master	Overall in charge of operation on board dealing with an oil spill; responsible for all steps to be taken especially for the two main categories – reporting and action. Keeps log off all events and progress of actions.
Chief Officer	In charge of deck operation, establish communication with Chief Engineer, decide on a course of action to contain and clean up the spill, give clear directives to containment and clean up team leaders. Keep the Master informed and updated on the situation and the results from action taken to stop or minimize an oil outflow.
Chief Engineer	In charge of engine operation, establish communication with Chief Officer, decide on a course of action to contain and clean up the spill, give clear directives to containment and clean up team leaders. Keep the Master informed and updated on the situation and the results from action taken to stop or minimize an oil outflow.
2nd Engineer	Containment team leader, organize containment team and equipment, carry out emergency containment procedures, and follow directives from Chief Officer / Chief Engineer.
2nd Officer	Clean up team leader, organize clean up team and equipment, carry out emergency clean up procedures, and follow directives from Chief Officer / Chief Engineer. Prepare for firefighting if applicable.
3rd Engineer	2nd in command containment team, assist 2nd Engineer, prepare for firefighting if applicable.
Bosun	2nd in command clean up team, assist 2nd Officer, prepare for firefighting if applicable.
3rd Engineer (off duty)	Muster station leader, mobilize off duty crew as necessary. Assist as ordered.
Electrician	2nd in command Muster station. Assist Muster station leader. Assist as ordered.

SECTION 4: NATIONAL AND LOCAL CO-ORDINATION

Quick efficient co-ordination between the ship and Coastal States or other parties involved becomes vital in mitigating the effects of an oil pollution incident.

As the identities and roles of various national and local Authorities involved vary widely from state to state and even from port to port, the Master should take note of these particularities, as far as possible. In this context the Master should call upon the owner's representatives in the state/ port of question to receive the relevant information.

Prior to undertaking mitigation actions – especially in cases of an actual discharge of oil due to casualties in the territorial waters of a Coastal State – the Master should contact the Coastal State for authorization of his action.

The Master should co-ordinate all his activities with the Coastal State.

The Master should call the Coastal State for allowance to use chemical agents for response to oil pollution on the sea. Without authorization of the Authorities of the appropriate Coastal State no chemical agents should be used.

Where no responsibility for discharge response by a Coastal State is noticed the Master should take all the necessary steps as deemed appropriate to minimize the escape of oil.

With respect of the accident happened the Master should take measures as stated in Section 2 and Section 3 of this Plan.

Appendices:

- Initial Notification (app. 1)
- Coastal State Contacts (Focal Points) (app. 2)
- Port contacts (app. 3)
- Ship interest contacts (app. 4)
- Ship's Plans and Drawings (app. 5)
    1. General Arrangement Plan
    2. Tank Plan
    3. Fuel/Lube Oil Piping Diagram
    4. Bilge system
    5. Ballast system
    6. Availability of response equipment (onboard spill equipment) and its location
    7. Drawings of deck drains indicating first overboard points in case of spills

SECTION 5 NON-MANDATORY INFORMATION

In addition to the mandatory provisions required by Reg. 37, Annex I, MARPOL 73/ 78 which are mentioned in Sections 1 to 4 of this Plan, local requirements, insurance company or owner/ operator policies etc. may dictate the provisions of additional guidance.

Such additional information material, including diagrams and/ or drawings, reference material etc., may be of help for the Master when responding to an oil pollution incident or an emergency situation as well as may be required by local Authorities in ports visited by the individual ship.

APPENDICES

List of contacts
and
Additional Information Material

APPENDIX 1 INITIAL NOTIFICATION

The following format provides an example as to how Initial Notification information shall be presented:

A	MV „X„, Call Sign D..., German Flag
B	01 12 36
C	2528N 05740E
E	179
F	186
L	Bound Singapore from Muscat
M	Bahrain Radio 500 KHz, VHF 16, INMARSAT No. 888 888
N	As required
P	650 TEU/ NO IMDG CARGO/ BUNKERS 580 IFO/ 75 MDO
Q	Collision with cargo ship ..., HFO-Service tank starboard breached, no fire and all essential shipboard systems operational
R	Quantity of fuel oil lost from breached tank about 10 tons; tank now empty Slick moving SE away from land and out of Gulf of Oman
S	Weather fine, wind NNW, 3 Bft, sea state slight to moderate, no swell
T	Owner Blue Horizon Co., Vorsetzen 12, 20459 Hamburg, Tel. +40 123 45, Telex 876 54 Fax +40 876 543
U	Length 169 m, breadth 25 m, tonnage 23.000 tdw, type container ship
X	No personnel injuries sustained; no clean-up operations possible from ship; Shipsafe P and I Club advised; local correspondent is Miller on Tel. Dubai 54 444. Proceeding to Dubai for survey/ repairs.

MASTER

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

SAMPLE FORMAT FOR INITIAL NOTIFICATION

A (SHIPS NAME; CALL SIGN; FLAG)

B(DATE AND TIME OF EVENT; UTC)

D	D	H	H	M	M

C (POSITION; LAT; LONG) OR D (BEARING; DISTANCE FROM LANDMARK)

				N	S
d	d	m	m		

				N miles
d	d	d		

					E	W
d	d	d	m	m		

E (COURSE)

d	d	d

kn	kn	1/ 10

L (INTENDED TRACK)

M (RADIO STATION(S) GUARDED)

N (DATE AND TIME OF NEXT REPORT; UTC)

D	D	H	H	M	M

P (TYPE AND QUANTITY OF CARGO/ BUNKERS ON BOARD)

Q (BRIEF DETAILS OF DEFECTS/ DEFICIENCIES/ DAMAGE)

R (BRIEF DETAILS OF POLLUTION; INCLUDING ESTIMATE OF QUANTITY LOST)

S (CONTACT DETAILS OF WEATHER AND SEA CONDITIONS) Wind: Direction, Speed (Beaufort) SWELL: Direction, Height (m)
T (CONTACT DETAILS OF SHIP´S OWNER/ OPERATOR/ AGENT)
U (SHIP SIZE AND TYPE)
X (ADDITIONAL INFORMATION)

Footnote: The alphabetical reference letters in the above format are from „General principles for ship reporting systems and ship reporting requirements, including guidelines for reporting incidents involving dangerous goods, harmful substances and/ or marine pollutants“ adopted by the International Maritime Organization by resolution A. 851 (20) as amended by IMO resolution MEPC.138 (53). The letters do not follow the complete alphabetical sequence as certain letters are used to designate information required for other standard reporting formats, e.g., those used to transmit route information.

APPENDIX 2 COASTAL STATE CONTACTS (FOCAL POINTS)

See separate folder "Appendix 2"

APPENDIX 3 PORT CONTACTS

Note: See 2.2.3.2 Port Contacts

Name of Port Contact	Address	Means of contact	Remarks
			...
			...
			...
			...

APPENDIX 4 SHIP INTEREST CONTACTS

Note: See 2.2.3.3 Ship Interest Contacts

(a) Owner/ operator contacts

Name of institution/ person to be contacted	Address	Means of contact	Remarks
Guard P & I Club, 24hrs telephone		+47 90 52 41 00	
DNV-GL Emergency Response Service		Ref. Safety Management System: "Emergency Phone Numbers"	See Emergency response procedure
National Response Centre - NRC			Only when operating in US waters Assigned QI (Qualified Individual) will establish contact according to NTVRP
Flag state			If applicable
Local Agent			Depending area of operation

(b) Other ship interest contacts

Name of institution/ person to be contacted	Address	Means of contact	Remarks
Vessel Maritime Superintendent	Petroleum Geo-Services AS Lilleaker 0283 Oslo Norway	Ref. Safety Management System: "Maritime Department Contact list"	See Emergency response procedures
PGS 24hrs emergency telephone		+ 47 9945 14 01	See Emergency response procedures
Port Authority/Local agency			Depending area of operation

APPENDIX 5 SHIP´S PLANS AND DRAWINGS

Following plans to be inserted in file:

1. General Arrangement Plan
2. Tank Plan
3. Fuel/Lube Oil Piping Diagram
4. Bilge system
5. Ballast system
6. Availability of response equipment (onboard spill equipment) and its location
7. Drawings deck drains indicating first overboard points in case of spills

See separate folder “Appendix 5”

Appendix E: Scientific Monitoring Plan

Scientific Study Module 1 (SSM1): Water Quality

WATER QUALITY	
Parameter	**Action**
RATIONALE	Monitor hydrocarbons in marine waters at sub-tidal, intertidal (e.g. sand beaches) sensitive locations and reference sites to support assessment of environmental impacts and recovery.
AIM	This module aims to: • Monitor hydrocarbons in marine waters to support assessment of impacts and recovery of environmental sensitivities; • Verify hindcast modelling. **SSM1** aims to: (a) Operational Monitoring Detect and monitor for the presence, quantity and behaviour of surface and in-water hydrocarbons; and verify predictions made in predictive modelling about the extent and presence of hydrocarbon contamination. The information collected in SSM1(a) may also support the assessment of environmental impacts as determined through subsequent SSMs. (b) Scientific monitoring Provides a desktop assessment which collates the results of operational monitoring and will: • Assess and document the extent and severity of hydrocarbon contamination with reference to the obsrvations made during SSM1(a) and/or in-water measurements made during operatinal monitoring; and • Provide information that may be used to interpret potential cause and effect drivers for environmental receptors monitored under other SMPs.
BASELINE	Not required. Assumption is that water quality in the region is pristine (no detectable hydrocarbons).
INITIATION CRITERIA	**SSM1 (a)** will be intiated in a Level 2/3 spill event. **SSM1 (b)** will be initiated in the event of a Level 2/3 spill and implemented when operational monitoring has ceased if SSM2 and SSM3 have been activated.
TERMINATION CRITERIA	**SSM1 (a)** will be terminated when the hydrocarbon release has ceased; no visible sheens are present; and no further sheens are predicted from modelling. **SSM1 (b)** will be terminated when: • Operational monitoring data relating to observations and/or measurements of hydrocarbons on and in-water have been compiled, analysed and reported; and • The report provides details on the extent and severity of hydrocarbons which can be used for the analysis of impacts recorded for sensitive receptors monitored under other SMPs.
DURING SPILL ACTIVITIES	Operational monitoring may include the following types of surveys: • Survey vessels to monitor for surface sheens (initially); • Aerial/vessel-based surveys of impacted area. Study design will incorporate survey methods described in Oil Spill Monitoring Handbook (Hook et al., 2016) and to relevant Australia Standards.
POST SPILL ACTIVITY	Desktop Only
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Study team lead will be an experienced water quality scientist. • Monitoring personnel will be qualified marine scientists with approriate training and experience in water quality sampling. • Laboratories NATA registered.
ANALYSIS AND REPORTING	• Daily reports during field activities; • Final Report with data to inform scientific outcomes 4 weeks after termination.

Scientific Study Module 2 (SSM2): Marine Sediment

MARINE SEDIMENT	
Parameter	Action
RATIONALE	Monitor hydrocarbons in marine sediments at sub-tidal, intertidal (e.g. sand beaches) sensitive locations and reference sites to support assessment of environmental impacts and recovery.
AIM	This module aims to detect the presence , extent, persistence and properties of hydrocarbons in marine sediments following a spill. Objectives: • Determine the extent, severity and persistence of hydrocarbons in marine sediments across selected sites where hydrocarbons were observed, recorded or predicted; • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for senstive receptors monitored under SMPs; • Verify hindcast modelling.
BASELINE	Not required. Assumption is that sediment quality in the region is pristine (no detectable hydrocarbons).
INITIATION CRITERIA	SSM2 (a) will be intiated when a Level 2/3 spill event occurs and implemented as follows: • Response activities have ceased; and • Operational monitoring results indicate that shoreline, inter-tidal or sub-tidal sediments have been exposed to surface or in-water hydrocarbon levels of 0.5 g/m^2 (visible sheen) or 7ppb (entrained phase) respectively (ANZECC, 2000).
TERMINATION CRITERIA	Module will be terminated in consultation with relevant state and Commonwealth authorities (NOPSEMA, DoEE, SA EPA, SA DPTI) when: • Concentrations of hydrocarbons in sediment fall below ANZECC/ARMCANZ (2000) ISQG low trigger values for biological disturbance or hydrocarbon levels in sediment are within natural variability of baseline conditionsand/or no longer pose a risk to environmental receptors; and • The extent, severity and persistence of hydrocarbons from concentrations recorded in sediments have been documented.
DURING SPILL ACTIVITIES	Not Applicable
POST SPILL ACTIVITY	• Undertake scientific surveys of marine sediments at all habitat sites to quantify the level of hydrocarbons in sediments including sampling at routine intervals to obtain temporal data; • Provision of validation dataset for sedimentation impacts to hindcast modellers; • Quantify the level of exposure in marine sediments; and • Assess impact of hydrocarbon release and recovery within sediments.
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Study team lead marine scientist with experience in marine sediment sampling. • Monitoring personnel will include qualified marine scientists with experience in sediment and water quality monitoring; • Laboratory services NATA certified; • Commercially certified/surveyed plan (vessels).
ANALYSIS AND REPORTING	• Sediment survey report within one month of survey completion; • Long-term monitoring report (as required) within one month of final survey completion. • Final Report one month after study termination.

Scientific Study Module 3 (SSM3): Assessment of Impacts and Recovery of Subtidal and Intertidal Benthos

SUBTIDAL AND INTERTIDAL BENTHOS (INCLUDING FISH)	
Parameter	Action
RATIONALE	Hydrocarbon contact with shorelines may lead to contamination of inter-tidal and sub-tidal (coastal) habitats. Hydrocarbon contamination of sand beaches can lead to impacts to inter-tidal invertebrates and subsequent effects to shoreline bird species and affect productivity in sub-tidal areas leading to effects on other trophic levels. Categories of inter-tidal and sub-tidal habitat that may be monitored include rocky reefs, seagrass, macroalgae, filter feeders, demersal and site-attached fish.
AIM	This module aims to assess the impacts and recovery of sub-tidal and inter-tidal benthos following a spill. Objectives: • Characterise the status of intertidal and subtidal benthic habitats including resident fish populations exposed/contacted by hydrocarbons; • Quantify any impacts to functional groups and species (abundance, richness and density) and resident fish population structure; and • Determine the impact and subsequent recovery of the sub-tidal and inter-tidal habitats (including fish) from the spill.
BASELINE	Baseline data available from DEWNR, EPA and EnviroData SA include: • Marine Benthic Habitats (Habitat type and description) DEWNR EGIS Data Set 1224. • Within (some) Marine Parks – Baseline information on fish , invertebrate, seagrass and macroalgal density and abundance (DEWNR); • SA EPA Aquatic ecosystem condition reports (Eyre/Murat Areas; Southern Spencer Gulf).
INITIATION CRITERIA	SSM3 will be intiated in a Level 2/3 spill and implemented when operational monitoring detected or modelling predicted intersection of shoreline inter-tidal/sub-tidal habitats with: • Visible oil sheens (0.5 g/m^2); and/or • In-water total petroleum hydrocarbon (TPH) concentrations > 7 ppb.
TERMINATION CRITERIA	Module will be terminated in consultation with relevant state and Commonwealth authorities (NOPSEMA, DoEE, SA EPA, SA DPTI) when: • Overall impacts to habitats from hydrocarbon exposure have been quantified; • Recovery of impacted sub-tidal and intertidal habitats have been evaluated; • KPIs, objectives and values for Marine Parks and Reserves have been met; and • Agreement with relevant stakeholders and regulators based on the nature and scale of the spill, impacts and/or the observed impacts can to longer be attributed to the spill.
DURING SPILL	Scientific monitoring will incorporate relevant monitoring parameters from baseline studies obtained for existing protected areas (i.e. Marine Parks, Terrestrial Parks) to provide consistent and continuity of any 'habitat health' parameters and agree with Commonwealth/SA State regulators on the scope and location of monitoring sites.
POST SPILL ACTIVITIES	Study design will incorporate survey methods an parameters described in Oil Spill Monitoring Handbook (Appendix P –*Standard Operating Procedure for sampling inter-tidal and sub-tidal areas for community composition*) (Hook et al., 2016) and parameters contained within recovery plan/species conservation advices and marine park monitoring programs.
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Study team lead marine scientist with experience in vessel-based marine benthic habitat monitoring. • Monitoring personnel will include qualified marine scientists with experience in benthic surveys including inter-tidal and sub-tidal benthic monitoring and habitat analysis; • Dive teams with Australian commercial certification; • Commercially certified/surveyed plant (vessels).
ANALYSIS AND REPORTING	• Baseline Report within 2 weeks of spill; • Survey reports within one month of survey completion; • Long-term monitoring report (as required) within one month of final survey completion. • Final Report one month after study termination.

Scientific Study Module 4 (SSM4): Assessment of Impacts and Recovery to Saltmarsh and Mangroves

SALTMARSH & MANGROVES	
Parameter	Action
RATIONALE	Hydrocarbon contact with shorelines may lead to contamination of inter-tidal mangrove or saltmarsh habitats. Hydrocarbon contamination of saltmarsh and mangroves can damage habitat and affect productivity in sub-tidal areas.
AIM	This module aims to: • Characterise the status of mangrove and saltmarch habitat at shorelines exposed/contacted by soiled hydrocarbons; • Quantify any impacts to species (abundance and density) and mangrobe/saltmarch community structure; and • Determine and monitor the impact of the hydrocarbon spill and potential subsequent recovery. SSM4 will be supported by sediment sampling undertaken in SSM2.
BASELINE	Limited baseline data is available for saltmarsh in area (spatial extent only) (DEWNR). Data available on mangroves present at Sir Joseph Banks Marine Park (spatial extent, size, abundance and diversity, mangrove condition) (Wiebkin, 2013).
INITIATION CRITERIA	SSM4 will be intiated in a Level 2/3 spill event when operational monitoring detected or modelling predicted intersection of inter-tidal/sub-tidal habitats with: • Visible oil sheens (0.5 g/m^2); and/or • Total petroleum hydrocarbon (TPH) concentrations > 7 ppb.
TERMINATION CRITERIA	Module will be terminated in consultation with relevant state and Commonwealth authorities (NOPSEMA, DoEE, SA EPA, SA DPTI) when: • Impacts to mangrove and saltmarsh habitat from hydrocarbon exposure have been quantified; • Recovery of impacted saltmarsh/mangrove habitats have been evaluated; • KPIs, objectives and values for Marine/Terrestrial Reserves have been met; and • Agreement with relevant stakeholders and regulators based on the nature and scale of the spill, impacts and/or the observed impacts can to longer be attributed to the spill.
DURING SPILL ACTIVITIES	Scientific monitoring will incorporate relevant monitoring parameters from baseline studies obtained for existing protected areas (i.e. Marine and Terrestrial Reserves) to provide consistent and continuity of any 'habitat health' parameters and agree with Commonwealth/SA State regulators on the scope and location of monitoring sites.
POST SPILL ACTIVITY	Study design will incorporate survey methods an parameters described in Oil Spill Monitoring Handbook (Appendix P –*Standard Operating Procedure for sampling inter-tidal and sub-tidal areas for community composition*) (Hook et al., 2016) and parameters contained within recovery plan/species conservation advices and marine park monitoring programs.
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Study team lead is a qualified marine scientist with experience in inter-tidal habitat monitoring. • Monitoring personnel will include qualified marine scientists with experience in inter-tidal monitoring and habitat analysis; • Commercially certified/surveyed plant (vessels).
ANALYSIS AND REPORTING	• Baseline Report within 2 weeks of spill; • Survey reports within one month of survey completion; • Long-term monitoring report (as required) within one month of final survey completion. • Final Report one month after study termination.

Scientific Study Module 5 (SSM5): Assessment of Impacts and Recovery to Marine Fauna

<table>
<tr><th colspan="2">MARINE FAUNA (Excluding Avifauna)</th></tr>
<tr><th>Parameter</th><th>Action</th></tr>
<tr><td>RATIONALE</td><td>Oil spills have the potential for long-term impacts to marine fauna. Hydrocarbon contact with marine and shoreline fauna due to the presence of surface and in-water concentrations of hydrocarbon may has the potential to impart lethal and sub-lethal impacts to individual and populations of species. This may include behavioural (e.g. deviation from migratory routes, foraging habitats), physiological (e.g. disruption to digestion) and/or physical effects.</td></tr>
<tr><td>AIM</td><td>SSM5 aims to:
(a) Operational Monitoring (all fauna)
Monitor for oiled fauna (mortalities, sub-lethal impacts, number, extent, location) and habitats (mortalies, sub-lethal impacts, type, extent of cover, area, hydrocarbon character, thickness, mass and content) throughout the response at locations contacted by hydrocarbons to inform spill response activities. Fauna includes cetaceans, turtles, pinnipeds and sharks (such as the white shark).
This information collected in SSM5 may also support the assessment of environmental impacts as determined through subsequent SSMs. This includes SSM2 (marine sediment monitoring).
(b) Scientific monitoring (marine megafauna)
Provides a desktop assessment which collates the results of operational monitoring where observations related to mortality, strandings or oiling of mobile marine megafauna species (excluding colony locations) including cetaceans, turtles, sharks and pinnipeds.
This desk-based assessment will include population analysis to infer potential impacts to marine megafauna species populations.
Note scientific monitoring for shorebased pinniped colonies is not included in SSM5(b) – refer to SSM7.</td></tr>
<tr><td>BASELINE</td><td>Baseline data is available from various data custodians including (but not limited to):
Southern Right Whale: GAB Right Whale Study; SARDI, SA Museum;
Blue Whale: Whale ecology group – Deakin University;
Australian Sea Lion/Fur seals: SARDI
Sharks: SARDI (Shark Ecology Group) and CSIRO (White Shark at Neptune Islands);
Turtles: Southern Australian Sea Turtle Project – Deaking University for Integrative Ecology.
SSM5 (b) Assessment Methodology:
Data on mortality and injury reports recorded from operational monitoring will be used to infer potential impacts to marine megafauna species populations (excludes colonies).
Refer to SSM7 for monitoring of shoreline pinniped colonies.</td></tr>
<tr><td>INITIATION CRITERIA</td><td>SSM5 (a) will be intiated in a Level 2/3 spill event.
SSM5 (b) will be initiated in the event of a Level 2/3 spill, and implemented if operational monitoring reports record dead, oiled or injured non-avian megafauna during the spill/response phase.</td></tr>
<tr><td>TERMINATION CRITERIA</td><td>SSM5 (a) will be terminated when:
Hydrocarbon release has ceased; and
Spill response and cleanup activities have ceased; and
No visible sea surface sheens are present; and
Modelling predicts no further surface sheens.
SSM5 (b) will be terminated in consultation with relevant state and Commonwealth authorities (NOPSEMA, DoEE, SA EPA, SA DPTI) when it is deemed that:
KPIs, objectives and values within species recovery plans or conservation advices have been met; and
Impacts to megafauna populations from hydrocarbon exposure has been quantified.</td></tr>
</table>

MARINE FAUNA (Excluding Avifauna)	
Parameter	Action
DURING SPILL ACTIVITIES (Method)	Operational monitoring includes the following types of surveys: • MFO resources on-board survey vessels to monitor for marine megafauna exposure (initially); • Aerial surveys of impacted area. Study design will incorporate survey methods an parameters described in Oil Spill Monitoring Handbook (Appendix R - *Standard Operating Procedure for Surveying impacts of oil spills on (non-avian) marine wildlife*) (Hook et al., 2016) and parameters contained within recovery plan/species conservation plan monitoring programs.
POST SPILL ACTIVITY	Desktop assessment on data on mortality and injury reports recorded from operational monitoring will be used to infer potential impacts to marine mega-fauna populations.
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Experienced personnel – MFOs (initially); • Study Team Lead will be an experienced marine biologist with monitoring personnel qualified and experienced in the study of marine megafauna; • Commercially certified/surveyed plant (vessels & aircraft).
ANALYSIS AND REPORTING	• Daily report during operational surveys; • Baseline Report within 8 weeks of spill for affected species – pinnipeds, etc. • Survey reports within one month of each survey completion; • Final Report summarising all data one month after study termination.

Scientific Study Module 6 (SSM6): Assessment of Impacts and Recovery in Bird Populations

BIRD POPULATIONS	
Parameter	Action
RATIONALE	Oil spills have the potential for long-term impacts to seabird/shorebird populations. Hydrocarbon contact with avifauna may impart lethal and sub-lethal impacts to individual birds and populations of species through direct contact with oiled surfaces; transfer of oil to eggs from contaminated plumage or ingestion during foraging or eating contaminated prey. Impacts may include behavioural (e.g. deviation from migratory rotes), physiological (e.g. disruption to digestion) and/or physical (e.g. matting of feathers, inability to fly).
AIM	This module aims to: SSM6 (a) Operational Monitoring (all birds) Monitor for oiled birds (mortalities, sub-lethal impacts, number, extent, location, proximity to oil, condition, weather conditions and visibility, photograp where possible) throughout the response at locations contacted by hydrocarbons to inform spill response (remedial) activities and scientific monitoring. SSM6 (b) Scientific monitoring 1. Collate and quantify impacts on avian wildlife from results recorded during **SSM5 (a)** (such as mortalities, oiling, sickness, rescue and release counts) and undertake desk-based assessment to infer potential impacts at a species population level; and 2. Undertake monitoring to quantify and assess impacts of hydrocarbon exposure to seabirds and shorebird populations at targetted breeding colonies/staging sites/important coastal wetlands where hydrocarbon contact was recorded.
BASELINE	Baseline data is available from various data custodians including (but not limited to): • Seabirds (Species, colony locations, range of numbers per colony, breeding period) DEWNR EGIS Data Set 1218 • Crested terns, little penguins, short-tailed shearwaters and flesh-footed shearwaters (distribution, breeding) (SARDI Aquatic Sciences); • BirData website (seasonal distribution, breeding) www.birdata.birdlife.org.au (includes Shoreline 2020 data).
INITIATION CRITERIA	**SSM6 (a)** will be intiated in a Level 2/3 spill event. **SSM6 (b)** will be intiated in a Level 2/3 spill event and implemented as follows: 1. Records of dead, oiled or injured bird species are made during the hydrocarbon spill or response. 2. Operational monitoring identified shoreline contact of surface hydrocarbons above 0.5 g/m^2 or in-water concentrations of 7 ppb at important bird colonies/staging areas/important coastal wetland locations.
TERMINATION CRITERIA	**SSM6 (a)** will be terminated when: • Hydrocarbon release has ceased; and • Spill response and cleanup activities have ceased; and • No visible sea surface sheens are present; and • Modelling predicts no further surface sheens.. **SSM6 (b)** will be terminated in consultation with relevant state and Commonwealth authorities (NOPSEMA, DoEE, SA EPA, SA DPTI) when it is deemed that: • KPIs, objectives and values within species recovery plans or conservation advices have been met; • Impacts to seabird and shorebird populations from hydrocarbon exposure have been quantified; • Recovery of impacted seabird and shorebird populations have been evaluated; and • Agreement with relevant stakeholders and regulators based on the nature and scale of the spill, impacts and/or the observed impacts can to longer be attributed to the spill.
DURING SPILL ACTIVITIES	Operational monitoring includes the following types of surveys: • MFO resources on-board survey vessels to monitor for seabird exposure (initially); • Aerial surveys of impacted area. Study design will incorporate survey methods and parameters described in Oil Spill Monitoring Handbook (*Appendix Q – Standard Operating Procedure for Surveying impacts of oil spills on bird populations*) (Hook et al., 2016) and parameters contained within recovery plan/species conservation plan monitoring programs.

BIRD POPULATIONS	
Parameter	Action
POST SPILL ACTIVITY	Data on mortality and injury reports recorded from operational monitoring will be used to infer potential impacts to avifauna populations. Shoreline surveys will incorporate survey methods and parameters described in Oil Spill Monitoring Handbook (*Appendix Q – Standard Operating Procedure for Surveying impacts of oil spills on bird populations*) (Hook et al., 2016) and parameters contained within recovery plan/species conservation plan monitoring programs.
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Principal Investigator and monitoring personnel – Qualified zoologist/ ornithologist with experience in surveys of coastal sea birds; • Commercially certified/surveyed plant (vessels & aircraft).
ANALYSIS AND REPORTING	• Daily report during operational surveys; • Survey reports within one month of each survey completion; • Final Report summarising all data one month after study termination.

Scientific Study Module 7 (SSM7): Assessment of Impacts and Recovery in Pinniped Colonies

PINNIPED COLONIES	
Parameter	Action
RATIONALE	Oil spills have the potential for long-term impacts to marine fauna. Hydrocarbon contact with marine and shoreline fauna due to the presence of surface and in-water concentrations of hydrocarbon may has the potential to impart lethal and sub-lethal impacts to individual and populations of species. This may include behavioural (e.g. deviation from migratory routes, foraging habitats), physiological (e.g. disruption to digestion) and/or physical effects.
AIM	This module aims to: • Quantify impacts on pinniped colonies and haul-out sites as a result of hydrocarbon contact/exposure; • Collate and quantify impacts to pinniped populations.
BASELINE	Baseline data is located with various data custodians including (but not limited to): • Australian Sea Lion/Fur seals: SARDI
INITIATION CRITERIA	**SSM7** will be intiated in a Level 2/3 spill event and implemented if operational monitoring has: • Identified shoreline contact of surface hydrocarbons above 0.5 g/m^2 or in-water concentrations of 7 ppb at known pinniped colonies; and/or • Records of dead, oiled or injured pinniped species have been made during the hydrocarbon spill.
TERMINATION CRITERIA	**SSM7** will be terminated in consultation with relevant state and Commonwealth authorities (NOPSEMA, DoEE, SA EPA, SA DPTI) when it is deemed that: • KPIs, objectives and values within species recovery plans or conservation advices have been met; • Characterisation of impacts to pinniped populations has been established; • Monitoring of recovery is reasonably satisfied for pinniped populations; and • Agreement with relevant stakeholders and regulators based on the nature and scale of the spill, impacts and/or the observed impacts can to longer be attributed to the spill.
DURING SPILL ACTIVITIES (Method)	Refer to **SSM5**. Operational study design will incorporate survey methods and parameters described in Oil Spill Monitoring Handbook (*Appendix R – Standard Operating Procedure for Surveying impacts of oil spills on non-avian marine wildlife*) (Hook et al., 2016) and any requirements contained within recovery plan/species conservation plan monitoring programs.
POST SPILL ACTIVITY (Method)	Data on mortality and injury reports recorded from operational monitoring will be used to infer potential impacts to pinniped populations. Shoreline surveys will incorporate survey methods and parameters described in Oil Spill Monitoring Handbook (*Appendix R – Standard Operating Procedure for Surveying impacts of oil spills on non-avian marine wildlife*) (Hook et al., 2016) and any requirements of 'recovery' monitoring programs for threatened species (i.e. Australian sea lion) and relevant monitoring guidelines (i.e. Guidelines for monitoring abundance of Australian Sea Lions (DoEE).
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Principal Investigator and monitoring personnel – Qualified zoologist/ marine biologist with experience in surveys of marine mammals; • Commercially certified/surveyed plant (vessels & aircraft).
ANALYSIS AND REPORTING	• Survey reports within one month of each survey completion; • Final Report summarising all data one month after study termination.

Scientific Study Module 8 (SSM8): Assessment of Impacts and Recovery in Commercial and Recreational Fishing and Aquaculture (including fish health and fish taint)

COMMERCIAL AND RECREATIONAL FISHING AND AQUACULTURE	
Parameter	Action
RATIONALE	Oil spills have the potential to impacts upon commercial and recreational fisheries beyond the actual spill via a number of pathways such as physical contamination and disturbance, toxic effects and by disrupting business activity. Fish exposed to hydrocarbons may not be killed but may suffer sub-lethal impacts that may impact upon population dynamics of the affected fish as well as having the potential to make any fish caught unsalable for commercial fishers.
AIM	This module aims to assess the physiological impacts to important commercial fish and shellfish species (assessment of fish health); seafood quality/safety and long-term assessment of impact based on catch. Results will be used to make inferences on the health of commercial and recreational fisheries and the potential magnitude of impacts to the fishery.
BASELINE	Baseline data has been through the collation of this EP and current will be obtained from existing knowledge in the region. Information is available for protected areas such as: • Australian Fisheries Management Authority https://data.gov.au/dataset/reported-landed-annual-catch-from-commonwealth-fisheries • SARDI Aquatic Sciences (DATA Request); • Commercial fisheries • ABARES Fishery Data. Baseline data with respect to seafood quality/taint is not required. PGS assumes no taint in commercial fisheries and aquaculture in the region.
INITIATION CRITERIA	**SSM8** will be initiated in a Level 2 or Level 3 spill if operational monitoring indicates the following: • The hydrocarbon spill has intersected with active commercial fisheries or aquaculture activities; • Commercially targeted fish and/or shellfish mortality has been observed/ recorded; or • Commerial fishing or aquaculture has been exposed to visible sheen hydrocarbons (at or above 0.5 µm); or • Taste, odour or appearance of seafood presents a potential risk to human health is observed. Note a reference to fish also includes aquaculture species.
TERMINATION CRITERIA	**SSM8** will be terminated in consultation with relevant state and Commonwealth authorities when the following conditions are satisfied: • The hydrocarbon spill has ceased; • Physiological impacts to important commercial/recreational fish, shellfish and aquaculture from hydrocarbons exposure has been quantified; • Recovery of important commercial/recreational fish, shellfish and aquaculture from hydrocarbon exposure has been evaluated; • Impacts to seafood quality/safety (if applicable) have been assessed* and information provided to the relevant stakeholders and regulators for the management of any impacted fisheries; • Agreement with relevant stakeholders and regulators based on the nature and scale of the spill, impacts and/or observed impacts can no longer be attributed to the spill. *Relevant criteria is fish and shellfish taint observed by olfactory analytical methods (Moller et al, 1999); and chemical analysis identifies that PAH levels in fish and shellfish are at or below control/reference samples; or PAH concentrations are below United States Food and Drug Administration (USFDA) levels of concern or the United States Environmental Protection Agency (USEPA) screening value for each contaminant. PAHs in petroleum mixtures are of greatest concern for human health because of their persistence, and potential for toxic or carcinogenic effects (USFDA 2010).

<table>
<tr><th colspan="2">COMMERCIAL AND RECREATIONAL FISHING AND AQUACULTURE</th></tr>
<tr><th>Parameter</th><th>Action</th></tr>
<tr><td>DURING SPILL/POST SPILL ACTIVITIES (Methods)</td><td>Long-term impact on fisheries:
• Liaise with affected fishing management authorities in impacted jurisdictions;
• Determine the catch composition of species in each of the main fisheries following exposure to the spill;
• Summarise commercial catch and effort data post spill and compare to pre-existing (baseline) information State and Commonwealth government sources; and
• Calculate catch-per-unit effort for fish/shellfish species to determine any change in abundance.
• Post-spill CPUE data will be compared to the baseline data collected from Commonwealth and state databases and analysed using univariate statistics such as analysis of variance and multivariate analyses such as Multidimensional scaling (MDS)
Fish Taint/Health:
• Determine the extent and level of hydrocarbon contamination or tainting in fish / shellfish through field surveys;
• Determine any mortality of species and any fish kills during the spill;
• Determine if seafood / fish from the area meets statutory limits for hydrocarbon residues and is marketable;
• Provide regulatory agencies, fisheries managers and spill responders with information to assist them with evaluation of likelihood to contaminate seafood; and
• Assist in the decision making to restrict, ban, close or re-open a fishery.
Survey methods described in Oil Spill Monitoring Handbook (Appendix L – Standard Operating Procedure for the collection of seafood samples for the analysis of taint) (Hook et al., 2016) will be adopted.</td></tr>
<tr><td>IMPLEMENTATION</td><td>PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies.
• Study team lead will be a fisheries scientist with at least 5 years professional experience in epidemiological studies of marine fish and aquaculture species;
• Field sampling team will be experienced and qualified marine scientists with experience in the collection of fish samples;
• Analysis of fisheries data must be led by an experienced and qualified fisheries scientist with at least 5 years experience in the collation and analysis of fisheries catch data;
• Laboratory services with NATA accreditation.</td></tr>
<tr><td>ANALYSIS AND REPORTING</td><td>• Baseline data report within 8 weeks of Level 2/3 incident;
• Laboratory analysis within 2 weeks of tissue collection;
• Survey reports within 1 week of each survey completion;
• Final Report summarising all data within 8 weeks of final field survey.</td></tr>
</table>

Scientific Study Module 9 (SSM9): Assessment of Impacts and Recovery in Tourism (Socio-economic Surveys)

TOURISM IMPACTS (Socio-economic Surveys)	
Parameter	Action
RATIONALE	Oil spills have the potential for impacts to tourism activities in the area given the unspoilt nature of the natural environment. Marine pollution might affect this perception and result in socio-economic impacts to tourism operators within the region.
AIM	This module aims to: • Quantify impacts to tourism as a result of hydrocarbon contact/exposure; • Assess recovery in tourism.
BASELINE	Baseline data will be obtained from various data custodians including (but not limited to): • Impacts to settlements (Australian Bureau of Statistics (ABS); ABARES; REMPLAN) (includes population characteristics, employment data on a longitudinal basis); • Impacts to local governments (Kangaroo Island Council, City of Port Lincoln, District Council of Lower Eyre Peninsula); • Tourism (ABS, Tourism Australia, South Australian Tourism Commisssion; REMPLAN)
INITIATION CRITERIA	**SSM9** will be intiated in a Level 2/3 spill event and implemented if operational monitoring identifies that visible sheens from the spill are present in SA State waters.
TERMINATION CRITERIA	**SSM9** will be terminated in consultation with relevant state and Commonwealth authorities (NOPSEMA, SA DPTI) when it is deemed that: • Characterisation of impacts to socio-economic conditions has been established; and • Monitoring of recovery is reasonably satisfied for socio-economic conditions.
DURING SPILL ACTIVITIES (Methods)	Methodology will be via desktop. Data will be analysed and compared with REMPLAN and other baseline data.
POST SPILL ACTIVITY	*As per During Spill activities.*
IMPLEMENTATION	PGS will select from competent scientific resources such as GHD, Golders, Jacobs to undertake studies. • Collation of data will be by experienced economists in the collection and analysing of soico-economic data; • Peer review of the survey report, sample design and analysis by experienced economist in socio-economic assessments, analysis and reporting.
ANALYSIS AND REPORTING	• Baseline report within 8 weeks of Level 2/3 incident trigger; • Survey reports within one month of each survey completion (if completed); • Final Report summarising all data 2 months after study termination.

Appendix F: Passive Acoustic Monitoring Equipment Specification

Seiche Measurements Ltd
Bradworthy Industrial Estate
Langdon Road, Bradworthy
Holsworthy, Devon EX22 7SF
United Kingdom
Tel: +44 (0) 1409 404050
Email: info@seiche.com
Web: www.seiche.com

Seiche Measurements LLC
10355 Centrepark Dr
Suite 240
Houston TX77043
United States of America
Tel: +1 713 201 5726
Email: info@seiche.com
Web: www.seiche.com

Equipment Specifications
PGS Geophysical AS

Appendix E
Ref: COR-2014-0025
14 January 2015

CONTENTS

FIGURES

1 Annex 2 Technical Solution / Specification

1.1 Outline

Seiche offers a number of solutions for the provision of Passive Acoustic Monitoring equipment (PAM) on seismic vessels. The electronics monitoring station is standard across all solutions with the additional capability of linking the electronics to a separate location for the monitoring screens. Three different types of towed arrays are offered:

- Standard 250m array
- 230m reinforced tow cable with detachable array section. The standard section is 20m, but longer, bespoke offerings are available.
- Source tow, whereby 20m arrays are attached to the gun and linked through the gun umbilical's to the PAM system.

The system is designed to give a flexible approach to the monitoring of marine noise from a towed hydrophone system utilising industry recognised Pamguard software for data interpretation.

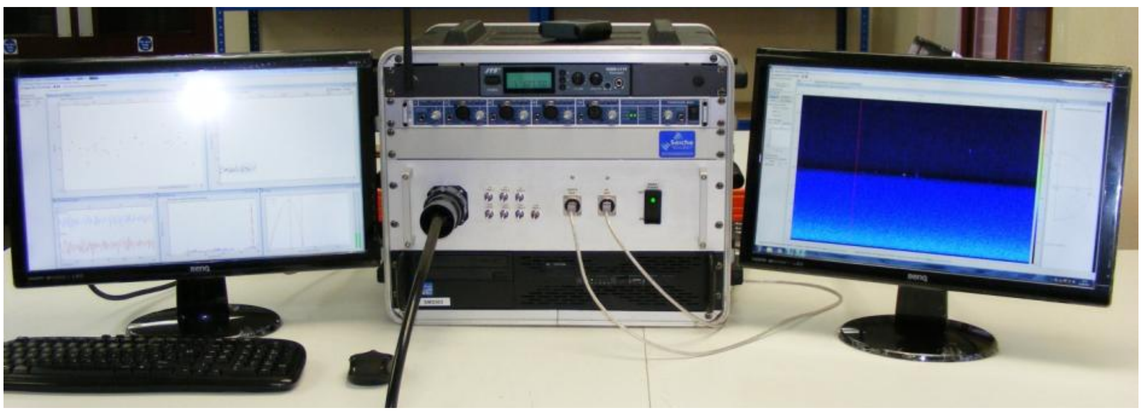


Figure 1. 8U Base unit with Rack-mounted PC and LF and HF monitors

The remote monitoring station enables the base unit to be rack-mounted with other ship based computer equipment and by using the ships internal ethernet system, link to screens in an alternative location on the vessel.

Figure 2. Remote station on bridge (left) and set up screen for Rack mounted base unit (right)

1.2 Electronics Monitoring Base Unit

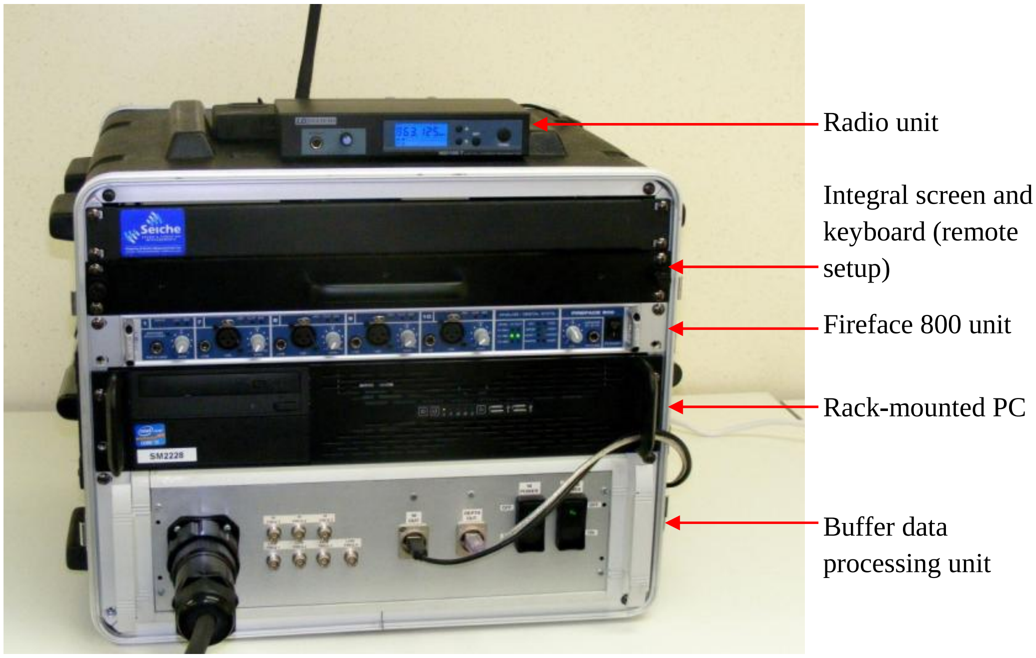


Figure 3. Electronics monitoring base unit

Radio unit

The radio system provides a remote headphone output from the audio output system. Note it is limited in frequency to 16 kHz

Integral screen and keyboard

The rack-mounted integral screen and keyboard can be used to run the rack-mounted PC for monitoring or for troubleshooting. It is contained in a 1U housing which slides out and flips up when in use.

Fireface 800 unit

This unit is used for the low frequency signal. The analog signal from each hydrophone is sent from the back of the buffer data processing unit to the fireface unit. The detected signals are filtered and amplified then fed to the rack-mounted PC via the firewire cable.

Rack-mounted PC

The rack-mounted PC system has an Intel quad core i5 processor with 8 GB of RAM. This custom built PC system has enough power to run both high and low frequency audio data through Pamguard simultaneously from up to four hydrophones.

Buffer Data Processing Unit

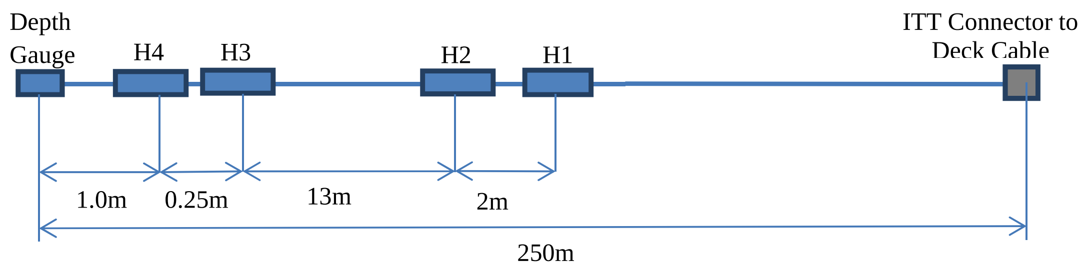
This unit connects the deck cable into the system and splits the analog signal from up to four hydrophones into high and low frequency acoustic data. The high frequency analog signal is converted into a digital signal and is fed via USB to the rack-mounted PC for real time analysis and display. The low frequency analog signal from the hydrophones is fed into the fireface unit which is connected to the PC via firewire. The high and low frequency signal can also be listened to using the BNC connectors for troubleshooting. There is a second USB that enables the depth sensor readings to be input to the PC.

1.3 Towed Sensors

Note that frequency bandwidths can be tailored to suit specific applications and country requirements.

1.3.1 250m Towed Array

The sensor array comprises a 250m array with integral hydrophones and a depth sensor array.



Mechanical Information

Length:	250m
Depth Rating:	100m (not connector)
Diameter:	14mm over cable, 32mm over mouldings, 64mm over connectors
Weight:	60kg
Connector:	ITT 19 pin
BS	500 kg

Hydrophone elements

H1	Broadband	200 Hz to 200 kHz (3dB points)
H2	Broadband	200 Hz to 200 kHz (3dB points)
H3	Standard	2 kHz to 200 kHz (3dB points)
H4	Standard	2 kHz to 200 kHz (3dB points)

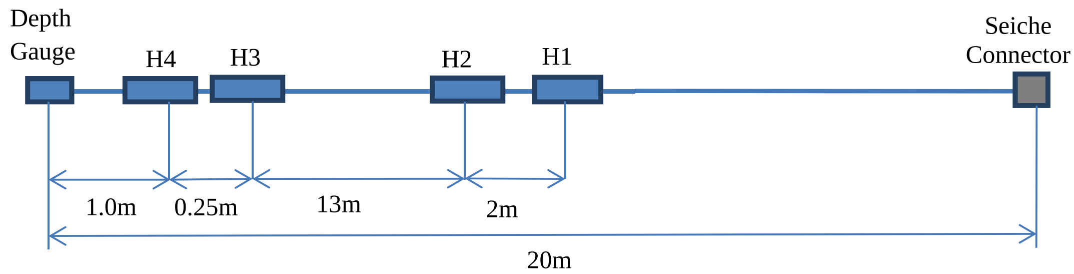
Spacing H1 - H2 (HF detection)	2.00m	1.28mSecs
Spacing H2 - H3 (HF detection)	13.00m	8.32mSecs
Spacing H3 - H4 (LF detection)	0.25m	0.16mSecs

Interface unit Array 1 outputs

Broad band channel sensitivity	-166dB re 1V/µPa
Low frequency channel sensitivity	-157dB re 1V/µPa

1.3.2 20m Towed array

The sensor array comprises a 20m detachable array section with a 230m heavy tow cable. The connectors are designed in house and are fully waterproof. Longer array sections can be provided to improve detections of low frequency vocalising marine mammals.



Mechanical Information

Length:	20m
Depth Rating:	100m (not connector)
Diameter:	14mm over cable, 32mm over mouldings, 45mm over connectors
Weight:	5kg
Connector:	Seiche
BS	500 kg

Hydrophone elements

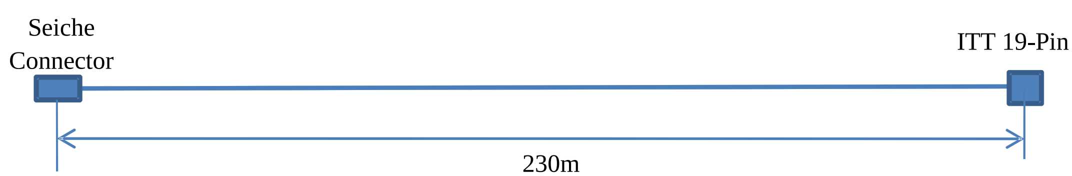
H1	Broadband	200 Hz to 200 kHz (3dB points)
H2	Broadband	200 Hz to 200 kHz (3dB points)
H3	Standard	2 kHz to 200 kHz (3dB points)
H4	Standard	2 kHz to 200 kHz (3dB points)

Spacing H1- H2 (HF detection)	2.00m	1.28mSecs
Spacing H2 - H3 (HF detection)	13.00m	8.32mSecs
Spacing H3 - H4 (LF detection)	0.25m	0.16mSecs

Interface unit Array 1 outputs

Broad band channel sensitivity	-166dB re 1V/µPa
Low frequency channel sensitivity	-157dB re 1V/µPa

1.3.3 230m Tow cable

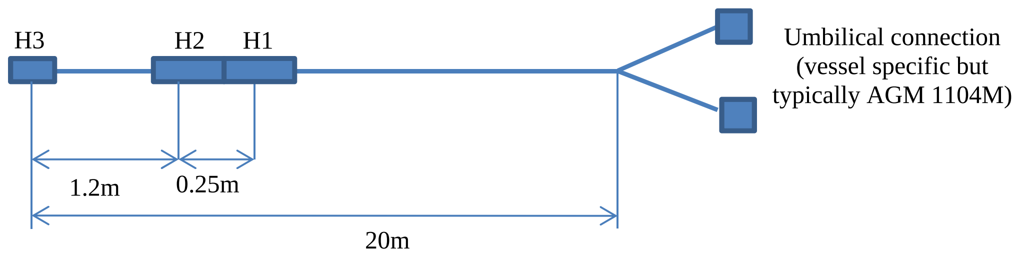


Mechanical Information

Length	230m
Diameter	17mm over cable
Connector	Seiche 36-pin 45mm over connectors
	ITT 19-pin 65mm over connectors
Weight	95 kg
BS	960 kg

1.3.4 20m Source Towed Three Channel Array

The source tow system enables the array to be deployed from the airguns making deployment and retrieval much more efficient and substantially reduces the risk of entanglement with the in water seismic gear.



Mechanical Information

Cable Length:	20m		
Depth Rating:	100m (not connector)		
Diameter:	14mm over cable	32mm over mouldings	38mm over connectors
Weight:	10kg		
Connector:	AGM 1104M 4-way		

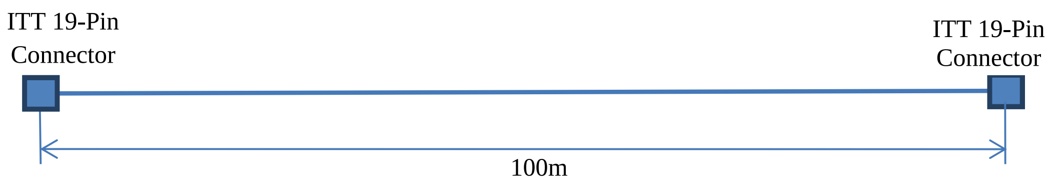
Hydrophone elements

H1	Wide-band	200 Hz to 150 kHz (3dB points)
H2	Wide-band	200 Hz to 150 kHz (3dB points)
H3	Wide-band	200 Hz to 150 kHz (3dB points)

Spacing H1- H2 (detection)	0.25m	0.16mSecs
Spacing H2- H3 (detection)	1.20m	0.80mSecs

1.3.4.1 100m Deck Cable

The deck cable is used for all array options



Mechanical Information

Cable Length:	100m
Diameter:	14mm
Connectors:	19 pin ITT (one male, one female)
Connector Diameter:	64mm
Weight:	25 kg
BS	500 kg

Note that all systems now have two arrays per unit supplied as standard.

Appendix G: Oil Spill Dispersed Oil Calculation

Entrained (dispersed) Oil Zone of Potential Impact Calculation
Assumptions:

1. Volume of MDO/MGO released to the marine environment (over 6hrs) is 850m3
2. Review of Wind Data (EP Wind Roses) between January to May (inclusive) indicates the most probable wind speed is between 12-24 knots
3. Density of MGO/MDO is 0.842 kg/l [tonnes/m3] (APASA, 2013)
4. Weathering data for MDO/MGO, based on most likely wind conditions (15 knots selected) is (ADIOS) 78% entrained over 24 hrs
5. Concentration required for 96hrs to trigger a 95% species 'effects' threshold = 70.5 ppb µg/l or g/ML)
6. Dispersed oil, due to density differential with water, will be in the upper levels of the water column. Calculations are made for 5m water depth

Footprint Calculation:

Volume of MDO/MGO released to Environment = 850.00 m3
Volume of entrained (dispersed) oil in marine waters after 24hrs = 663.00 m3
Equivalent mass of oil = 558.25 tonnes
558246000.00 g
Volume of Water affected by 722m3 MDO/MGO after 24hrs based on 70.5 ppb concentration = 7918382.98 ML
7918382978.72 m3

- Assuming entrained oil is evenly distributed across top 5m of water column: Area = 1583676595.74 m2 (39.8 km x 39.8 km)
    - (158367.66 Ha)
    - (39795.43 m)

Distance Travelled Calculation:

Utilising current information to determine how far this leading edge (worst case concentration) may move parallel to the coastline
Note this does not account for:

- -Additional dilution of concentrations which may occur due to minor cross currents
- Additional degradation/evaporation of the MDO/MGO which occurs over subsequent days
- Dispersion effects which will occur as the plume travels in the down-current direction

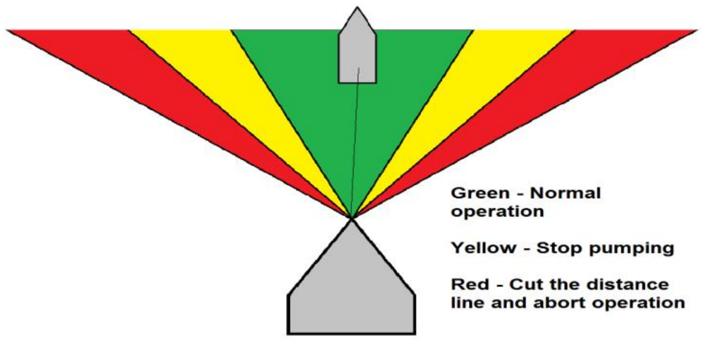
Most likely current speed is approximately 0.3m/s. Distance travelled in a 24hr period = 25920 m
25.92 km
Possible current speed is approximately 0.5m/s. Distance travelled in a 24hr period = 43200 m
43.2 km

Appendix H: PGS Bunkering Procedures

	PROCEDURE			Author: Peter Franklin
	BUNKER OPERATIONS			Owner: Harald Sundby
				Doc number: 864VES00
	BU:	Scope:	Certified doc: No	Subject:
Reviewer(s):				

1. PURPOSE & SCOPE	
Purpose	• The purpose of this procedure is to define the principles for planning and execution of bunkering operation in all PGS operations.
Scope	• The scope of this procedure is to cover bunkering in port, Inline- and Ship to Ship bunker transfers with below limitations. It also applies to PGS operation and procurement of Bunker.

2. RESPONSIBILITIES	
Vessel Manager	• Ensure that notification is given to local authorities, government agencies or clients either directly or by formally delegating the task to the Master on one of the ships engaged in the operation or agent. • Communicate the bunkering plans in due time to the vessels involved to ensure there is time for planning of the operation for it to be done in a safe and controlled manner. • Confirm that vessels performing the bunker operation have specifications of vessels involved. Not only limited to PGS vessel, if loading from a tanker the tanker shall also have specification on the PGS vessel. • Ensure that Master and bridge officers of the delivery vessel and receiving vessel have previous experience in performing offshore bunkering.
Vessel Management Team	• Shall limit exposure as far as possible by planning bunkering and avoid unnecessary exposure such as: o Bunkering in turns (good planning of lines and consider speed reduction to avoid this). o Shooting infill during bunkering. o Increase run in and run out on lines. o Perform bunkering during time sharing when already on down time. o Some vessels are sensitive when K-POS is connected. Use of auto pilot shall be considered during bunkering due to weather and current. o Allowance of bigger overlap when shooting lines on auto pilot. • Ensure that vessel is allowed to do inline fuelling by client.
Bunker procurement	• Ensure that information relating to bunkering of fuel is communicated to Vessel Manager as soon as possible. • If bunker delivery vessel is not on PGS charter the vessels technical specification shall be communicated to Vessel Manager as soon as possible to be able to forward all necessary information to Master on receiving vessel.
Master of receiving vessel	• Has final authority on operational limitation in VMT. • Ensure Bridge to be manned with minimum 2 officers at all times and areas of responsibility agreed in case of emergency situation. Captain + 1 officer are sufficient. • Is responsible to ensure that all personnel involved in the operation onboard understand and follow this procedure and appendixes including emergency plans.

	• Must ensure relevant checklists is completed and filed. Initiate pre-arrival communication between involved vessels and all other relevant parties including backup communication and emergency communication.
	• Depending on method of connection of distance line (hook, bridle or pit) pre-defined sector for stop pumping cutting of distance line in front of receiving vessel must be in place.
	
	• When performing in-line bunkering below scenarios to be consider but is not limited to:
	  o Black out.
	  o Pre-defined avoidance manoeuvres.
	  o Loss of communication.
	• Evaluate steering mode before and during bunker operation in production, if it can be done in K-POS seismic mode or auto pilot.
	• Ensure vessel compatibility assessment is performed when Side-by-side bunker operation is planned. (See Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases)
	• Ensure Risk Assessment and/or Job Safety Analyse is valid and reflects the actual operation for vessels and equipment used in the planned operation.
	• Assess the transfer area and present/forecasted weather is suitable together with the master of the supply vessel.
	• Ensure main and back up propulsion/steering system onboard is ready for immediate use.
	• Make sure that navigational warnings are broadcasted as per international and local requirements.
	• Ensure clear communication of changes between vessels in regards of course, speed and offset is given in good time during offshore bunkering.
	• Masters on receiving and delivering must use the relevant checklist(s).

Master of delivery vessel on charter	• Each Master has responsibility for safety on their respective vessels. • Ensure manning of bridge with 2 officers at all times and areas of responsibility agreed in case of emergency situation. Captain + 1 officer are sufficient. • Ensure clear communication of changes between vessels in regards of course, speed and offset is given in good time during offshore bunkering.

	• Masters on receiving and delivering vessels must use the relevant checklist(s). • Is responsible to ensure that all crew on his vessel is briefed of the planned operation.
Chief Officer	• Calculate and record trim and stability. Make a plan for distributing the weights. • Ensure oil spill equipment is made ready, tested and relevant scuppers plugged before the bunkering operation is commenced. • Ensure fire extinguishing system is prepared as appropriate at manifold. • Make sure announcement is made over the intercom and warning notices that smoking and the use of naked lights e.g. incinerating, grinding, cutting, burning and welding is not allowed on any open decks during bunkering operations.
Chief Engineer	• Make sure technical systems relevant for bunkering is tested, calibrated and prepared to safely receive the bunker. • Ensure all tanks to be filled are prepared, manholes are closed and all relevant valves are set to correct position to receive bunker. • Confirm overflow space are available and has sufficient room to take an overflow of 10 minutes at the agreed rate of filling. • Ensure the relevant crew knows how to use the bunker equipment handled onboard.
Officer on watch	• Agree on area of reasonability in case of emergency. • Ensure proper handover of watch during swift change with special focus on area of emergency. • Carefully monitor the distance between the vessels in an in line bunker operation visually and by using radar.
PC	• Participate in toolbox meeting. • Ensure good planning to limited bunkering exposure. • Plan bunkering with Master for best utilization to avoid bunkering with conflicting operations (MOPO-SIMOPS).
Navigation desk	• Representative to participate in toolbox meeting. • Avoid large offset changes. • Crew in charge at navigation desk must **notify the bridge** prior to any speed or sideways position adjustments when refuelling during seismic operation and receiving vessel is controlled from Navigation desk.

3. PROCEDURE DESCRIPTION

Communication	• Closed loop communication must be used by all involved persons booth externally and internally throughout the operation to avoid misunderstandings. **When the sender gives a message, the receiver repeats this back. The sender then confirms the message. To get the attention of the receiver, the sender can use the receiver's name or functional position.**
Emergency Signals	• Emergency signals shall be agreed in case of any communication failure. This can be by using the vessel horns, bells and/or whistles.
Weather Precautions	• No bunker operation shall be commenced during electrical storms. In case of sudden electrical storm appearance during on-going transfer, the operation shall be suspended and all systems secured until it is considered safe to resume operation. • Before offshore bunkering operations, detailed and trustworthy weather forecasts for the area shall be obtained before the operation begins. Masters of both vessels must agree that the present and forecasted weather and sea state are suitable for the transfer operation. Throughout the approach and mooring operation the visibility must be good enough for safe manoeuvring.
Day- vs. night time operations	• In-line bunkering shall only be commenced at daytime. Lack of daylight will make it difficult to detect and react to any oil spill from the submerged bunker-hose. Operations may be extended beyond dusk to complete an operation if both Masters agree to continue the operation, and that the hose can be sufficiently illuminated to identify any leaks. • For side-by-side bunkering, the operation can continue at night-time as long as the entire bunker hose is above surface and well illuminated.
In line bunkering - Stop pumping and Emergency cut of distance line	• The distance line shall always be cut from the receiving vessel except in emergency where there is no other option. This to avoid the long line is dragged behind the receiving vessel and possible interference with propulsion. In the event when this has to be done a clear order from the master of the receiving vessel shall be communicated: **"STOP – STOP – STOP"** **"CUT THE LINE"** • If vessel is fitted with towing hook with remote and local release where rope cutter is not fitted below terminology shall be used: **"STOP – STOP – STOP"** **"RELEASE THE LINE"** • This must be verbally confirmed by the persons designated to this task and performed without any delay.

In line bunker - Minimum Safe distance	• The intention of the Distance Line is to ensure the distance between the two vessels are maintained in a safe way and shall as far as possible be kept under slight tension throughout the operation. • Minimum safe distance in line between the vessels for this operation is 100 meters when all bunker equipment is set up as per procedure and operation commenced. It can be closer when approaching and adjusting position.

Side by side bunker	• Side-by-side operation shall not be performed by Ramform designed vessels when seismic equipment is deployed.
	• Ramform vessels shall also avoid side by side bunkering in open sea due to design and overhanging equipment. Other option shall be considered and performed only if MOC is approved:
	  ○ Bunkering over tanker stern can be done on case by case.
	  ○ Bunkering bow manifold to tanker with Ramform design can also be performed. 2 lines transferred from bow to side of tanker.

4. APPENDICES

Appendices	• Appendix 01 Checklist For Bunkering in Port • Appendix 02 Checklist For Bunkering Offshore • Appendix 03 Bunker Operation Guideline
Other Procedures and Guideline	• Bunker Procedure Guideline • 865VES01 Bringing vessels alongside” • “865VES01 App 01 Checklist - Bringing vessels alongside”
References	• Ship to Ship Transfer Guide for Petroleum, Chemicals and gases by *CDI, International Chamber of Shipping, OCIMF and SIGOTTO* • IAGC Marine Geophysical Safety Manual • OGP HSE Aspects in a Contracting Environment for Geophysical Operations. Report No.6.92/317 • Ship Owners Operational and Safety Procedures Manual • P&I contact list • MARPOL Annex VI http://www.imo.org/ourwork/environment/pollutionprevention/specialareasundermarpol/Pages/Default.aspx

BUNKERING OFFSHORE

Receiving Vessel's name:	Location:
Discharging Vessel's name:	Date:

Section 1: Before approach and mooring

Both delivery vessel and receiving vessel are to complete these checks in parallel and report to each other prior to moving on to next stage of the operation.

#	Check	Yes	No	N/A	Remarks / readings
1	Has there been a pre arrival communication between supply and receiving vessel?				
2	Has the weather forecast been obtained and are both Masters agreed that the observed and forecasted conditions are safe?				
3	Has it been assessed that the Master and crew of the delivery vessel have adequate competence to safely perform an in-line or side-by-side bunkering?				
4	Have authorities been advised (when applicable) and has a navigational warning been broadcast?				
5	Have the engines, steering gear, control and navigational equipment been tested and found in good order? Are all radars set on most favourable scales?				
6	Have the backup propulsion and steering systems been tested and made ready for immediate use on vessels involved?				
7	Has toolbox meeting been held with all involved personnel? Have relevant procedures and JSA's been reviewed? Has PPE requirements been discussed?				
8	Has a contingency plan been discussed and agreed by all involved crew, including situations which shall activate a controlled stop?				
9	Has Chief Officer calculated trim and stability, and is it approved as per stability book and documented for the planned operation?				
10	Have ship-to-ship primary and backup communication been agreed and tested by all relevant personnel?				
11	Has a vessel compatibility assessment been carried out and preferred side to carry out side-by-side bunkering been decided?				
12	Have the required course and speed information been agreed between supply and receiving vessel and understood? Has instrument room been advised?				
13	Have the fuel hose and lifting/winching equipment been checked and found in compliance with PGS requirements?				
14	Has the Emergency stop for pumping arrangement been tested?				
15	Has the date and results of last routine inspection of the fuel hose been obtained? (It shall be inspected/tested prior to bunkering)				
16	Have Chinese Finger been correctly adjusted to the fuel hose and fastened according to ships details?				
17	Confirm the Towing Hook has been correctly reset, and that it is ready for towing operation, if applicable.				
18	Has the distance line, towing hook, mooring equipment/arrangements including the rope cutter been checked and verified in good order?				

19	Are all relevant scuppers effectively plugged? Has drip-trays and SOPEP spill equipment been checked and is it ready for use at their optimal locations?				
20	Are the manifold connections and arrangements for bunker sampling ready?				
21	Has flow-meter been set to zero?				
22	Has bunker sampling as per DNVPS instructions been reviewed and understood?				
23	Has it been confirmed that the available tanks can accommodate the planned bunker quantity? Are all manholes closed?				
24	Is there free space in overflow tank/space to take an overflow of 10 minutes at the agreed rate of filling?				
25	Are all tank manholes closed?				
26	Is the engine control room on standby?				
27	Has “No smoking, hot work or use of naked lights” signs been posted, and has this been announced on the vessels intercom?				
28	Has the other vessel confirmed this section of the checklist as completed?				

Note: All checks answered with No or N/A requires an explanation in the remarks fields

Section 2: Before bunker transfer

Both delivery vessel and receiving vessel are to complete these checks in parallel and report to each other prior to moving on to next stage of the operation.

#	Check	Yes	No	N/A	Remarks / readings
1	Has all equipment for the emergency release of the distance line been tested prior to positioned/set ready for emergency cutting/releasing?				
2	Has the Safety Line been connected to the distance line on the (Delivering Vessel if delivering vessel is using towing hook and not bridle?)				
3	Has all personnel cleared the mooring area to a safe position before tension test of distance line starts?				
4	Has tension test of distance line been carried out successfully?				
5	Are the correct navigational signals displayed (flags, day-signals as well as navigational lights)?				
6	Has the bunkering hose been properly connected and suspended with a proper hose sock (“Chinese finger”)?				
7	Has deck watches been established with particular attention to moorings, hoses, manifold and SOPEP equipment?				
8	Have all valves on the tanks to be filled been opened to prevent back pressure and overflows?				
9	Has the initial rate, maximum rate and topping-up rate been agreed?				
10	Leak test completed?				
11	Bunkering to be commenced at slow rate?				
12	Has the other vessel confirmed this section of the checklist as completed?				

Note: All checks answered with No or N/A requires an explanation in the remarks fields

Section 3: During bunkering

#	Check	Yes	No	N/A	Remarks / readings
1	Has all pipelines, flanges, hose(s) and similar been checked with no remarks? (Only then can rate be increased to maximum agreed rate)				
2	Has a routine been agreed for regular checks of pipelines, flanges, hose(s) and similar during the entire operation?				
3	Is the pumping rate monitored by hourly calculations?				
4	Is the ballast system operated as per plan during the bunkering?				
5	Has the pumping rate been reduced when tanks are 75% full, and are tanks topped up, one and one?				
6	Has the supplier been given notification to be stand-by and ready to stop prior to completion? (No tanks to be filled more than 90%)				

Note: All checks answered with No or N/A requires an explanation in the remarks fields

Section 4: After bunkering

#	Check	Yes	No	N/A	Remarks / readings
1	Has the fuel hose been blown through with compressed air?				
2	Has the fuel hose been disconnected, and are the manifold connection blanked?				
3	Has the method of disengagement and letting go moorings been agreed and understood by all parties?				
4	Has all scuppers and SOPEP equipment been stored to its location?				
5	Has all system valves been returned to required operational status?				
6	Has labelled and sealed samples been received? Has sample drawn by the vessel been given to the terminal representative? (If applicable)				
7	Has sample for DNVPS been prepared for shipping?				
8	Has all navigation signals been restored to normal setting? Has “No smoking, hot work or use of naked lights” signs been removed?				
9	Has other relevant departments onboard been notified that bunkering operation has been completed and that the supplying vessel has cleared?				

Note: All checks answered with No or N/A requires an explanation in the remarks fields

Verified by:

Master (name/signature):	Chief Engineer (name/signature)	Duty Officer (name/signature)

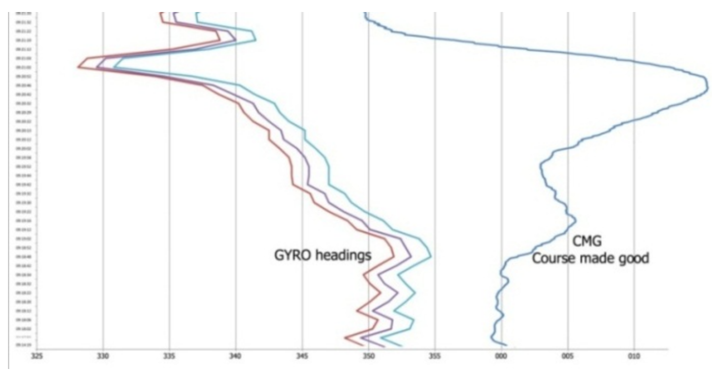
1. PURPOSE & SCOPE

Purpose	• Purpose of this guideline is to give information and guidance, on top of the Bunker Procedure, for bunker operation and how it is normally performed in PGS.
Scope	• The scope of this guideline is to cover bunkering in Port, In-Line and other Ship to Ship transfers of petroleum products.

2. GENERAL GUIDELINES

Communication	• Before any offshore bunker operation pre arrival communication should be established by the Masters as per below: ➢ Vessel specifications including drawing of bunker arrangements if not shared by Vessel Manager. ➢ Confirm the set up of bunker equipment. ➢ Integrity of systems, e.g. navigational, machinery, steering gear, fire fighting equipment, etc. is in good order and reedy for use. ➢ Confirmation fuel/oil transfer equipment to be used are inspected, maintained, tested and certified as per Bunker Equipment Requirements Procedure. ➢ Confirmation all involved parties and persons are conversant to procedure and work instructions. ➢ Details of products being transferred, including copies of Safety Data Sheets. ➢ Confirmation that ships complies with applicable local, national and international requirements including those relating to hours of work/rest.
Selecting the Area, points to consider	• Masters of both vessels to agree on area of transfer and a suitable heading and speed. • Sheltered area provided from sea and swell to be selected if possible. • The sea room and depth of water need to be sufficient for manoeuvring during mooring, unmooring and transfer operations taking into account if the seismic trailing equipment will be deployed during the transfer operation. • The traffic density and characteristics must be evaluated. • Bunkering shall not be performed in any environmental protection zones or areas.
In Line Bunkering Operation	In Line Bunkering is a transfer of petroleum liquid via a hose between a delivery vessel and a receiving vessel. This can be done with seismic equipment deployed where the Delivery vessel take position in front of the receiving vessel to be able to connect a Distance Line and a Hose. • Preparations to receive bunker shall be made of the vessels technical systems which also must be tested as appropriate and set to operational mode (tanks, valves, manholes, alarms, sounding system etc.)

	• Method for transfer of lines and hose in a safe way need to be agreed before this operation is commenced. A signal man must be monitoring the transfer of any line or hose between the vessels giving clear information to crew running the winch. • Suitable side and angle of approach have to clearly be communicated between booth masters before commenced. • Speed and course to be agreed and maintained trough out the approach and transfer operation as far as possible. Any changes shall immediately be communicated between the booth vessels. • All communication to be tested between stations involved in the operation. • Delivery vessel to take position in front of the receiving vessel when given clearance to do so from the master of the receiving vessel. • 1st Messenger line transferred from delivery vessel to mother vessel connected to a Norwegian buoy and the distance line to be fed out in the water to a position where the receiving vessel can pick it up with a hook connected to a throwing line. • Distance line secured to a safety line to be winched from delivery vessel to receiving vessel. The safety line is rigged to prevent the distance line from rip out in the water in front of the receiving vessel. A 2nd messenger line is also connected to the distance line before fed out in the water. • A rope cutter shall be connected on the distance line to be able to perform a safe emergency cut from the receiving vessel it is not equipped with a towing hook with remote and local release. • Once the distance line is connected on the towing points there shall be a tension test performed by increasing the tension on the rope to the satisfaction of booth masters. • 2nd messenger line is used to winch the fuel hose from delivery vessel to receiving vessel. • Once the fuel hose is on deck on the receiving vessel it is connected and secured to the manifold by the TODO coupling and lashings. • Bunker hose shall be adjusted by the delivery vessel to be slack when distance line is tight and then secured to a fixed point in this position. • Pressure test to be performed of the fuel hose to ensure there is no leak on the system. A pressure of 5 bars shall be supplied by one of the vessels and then maintained in the system for at least 5 minutes without any supply. • Transfer of fuel can be commenced at slow rate and gradually increased when system are checked for leaks and when clearance is given from receiving vessel. • Hose watch to be in place trough out the transfer operation to monitor manifold(s), couplings, distance line and hoses. • When bunker transfer is completed and verbally confirmed by the Chief Engineer the fuel hose need to be cleaned by flushing with, diesel if HFO, and air before it is disconnected and transferred back to the delivery vessel.

	• The hose and TODO need to be lowered in to the water in a controlled manner by using the 2nd messenger line. When clear and advised by receiving vessel, the delivery vessel can pull it back onboard. • When fuel hose is secured onboard the delivery vessel the distance line can be disconnected and transferred back to the delivery vessel together with the 1st messenger line.
K-pos	Understanding the possible effects of following a seismic track using K-pos during in-line bunkering • It is vital that the bridge crew of the receiving vessel understand the possible effects of using K-pos to steer along a seismic track, during an in-line bunkering. If the delivery vessel should start to fall off to one of the sides, a sideways force will be introduced by the distance hawser, in which K-pos will counteract with adjusting course in opposite direction.  • In the illustration from a real situation, this is easy spotted. The delivery vessel started to drift off to starboard relative to the receiving vessel. K-pos senses this as a sideways force, and started to compensate this by adjust heading to port. This again made the delivery vessel drift even more to starboard relative to the receiving vessel, introducing even more sideways force in which K-pos compensates for with even more adjustment in the opposite direction.
Notification to navigation department when bunkering in production	Selection of seismic shooting line prior to a bunkering operation • In preparation for a bunkering in seismic operation, navigation department of the receiving vessel shall be informed well ahead and be a part of the tool box meeting. With sufficient time, a seismic shooting line with as little cross-track adjustments as possible shall be selected, for the benefit of a safer operation. • Navigation desk shall be instructed to notify the bridge prior to any cross-track or speed adjustments, and that changes shall be made in small steps only. This is to have sufficient time to notify the discharging vessel prior to any such adjustments. • It shall be avoided to perform an offshore in-line bunkering on a seismic infill line with a lot of cross-track adjustments, due to the increased risks this involved.

Side by side bunkering operation offshore	Bunker offshore side by side is a transfer of petroleum liquid via a hose between a delivery vessel and a receiving vessel at sea. This can be done when seismic equipment is deployed but is not allowed for vessel of Ramform design. Delivery vessel then take position on one of the sides of the support vessels, secure mooring lines and transfer the fuel hose. When seismic equipment is recovered the receiving vessel can go alongside the delivery vessel. E.g. when receiving fuel from tanker offshore. • When receiving from a supply vessel preferably and where possible a test should be made without seismic equipment is deployed to establish the best location for fenders and mooring ropes as well as the position of the two vessels towards each other. • An assessment to be performed on which side to be used, in which position the delivery vessel shall be positioned, position of fender(s) and mooring rope configuration. • Preparations to receive bunker need to be made on the vessels technical systems which also must be tested as appropriate and set to operational mode (tanks, valves, manholes, alarms, sounding system etc.) • Method for transfer of hose in a safe way must be agreed between the vessels before this operation is commenced. • Suitable angle of approach must be clearly communicated between booth masters before it can commence. • Speed and course to be agreed and maintained trough out the approach as far as possible. Any changes must immediately be communicated between the booth vessels. • Communication to be tested between all stations involved in the operation deck, ECR and delivery vessel etc. • Delivery vessel to take position by the agreed side of the receiving vessel when given clearance to do so. Approach must be well monitored, especially if seismic equipment deployed. • Normally this is done when booth vessels are doing speed trough water. This to better control the heading of vessels. • It is beneficial to have a previous tested line marked and ready that can be connected as 1st line by the approaching vessel to easily drop back in to get in to position and stay there throughout the mooring operation. • Up on clearance from masters and once booth vessels are alongside moorings can be connected and the fuel hose can be transferred, secured and connected. • Hoses to be rigged and secured in a way that there will be no bending or pinching of the hose. • Pressure test to be performed of the fuel hose to ensure there is no

	leak on the system. An air pressure of 5 bars shall be supplied by one of the vessels and then maintained in the system for at least 5 minutes without any supply. • Transfer of fuel can be commenced at slow rate and gradually increased when system are checked for leaks when clearance is given from receiving vessel. • Watch man to be in place trough out the transfer operation to monitor manifold(s), couplings, moorings and hose(s) at frequent intervals. • When transfer is completed and verbally confirmed by the Chief Engineer the fuel hose need to be cleaned by flushing with, diesel if HFO, and air before it is disconnected and transferred back to the delivery vessel. • When transfer is completed and verbally confirmed by the Chief Engineer fuel hose can be disconnected and transferred back to the delivery vessel in a controlled manner. • When fuel hose is secured the mooring ropes can be let go as per orders from the master on the receiving vessel who must confirm the delivery vessel is ready to depart.
Bunkering in Port	Bunkering in port is a transfer of petroleum liquid via a hose where receiving vessel is moored alongside a quay ashore. Delivery can be made from tanker, barge, truck or drums etc. • Preparations to receive bunker to be made of the vessel technical systems which also must be tested as appropriate and set to operational mode (tanks, valves, manholes, alarms, sounding system etc.) • Method for transfer of hose in a safe way need to be assessed before this operation is commenced. A signal man shall be in place in charge of the transfer of any line or hose between the vessel and barge or quay giving clear information to crew running the winch. • Notification to local authorities to be made where applicable. • Communication to be set up and tested between all stations involved in the operation; Deck, ECR, barge, terminal, driver of truck etc. • Fuel hose can be transferred, secured and connected. Grounding of the hose should be connected. • Hoses to be rigged and secured in a way that there will be no bending or pinching of the hose. • Pressure test to be performed of the fuel hose to ensure there is no leak on the system. A pressure of 5 bars shall be supplied by one of the vessels and then maintained in the system for at least 5 minutes without any supply. • When given clearance that receiving vessel is ready transfer can be commenced at slow rate and gradually increased when system are checked for leaks. • Watch man to be in place trough out the transfer operation to monitor manifold(s), couplings, moorings and hose(s) at frequent intervals.

	• When transfer is completed and verbally confirmed by the Chief Engineer fuel hose can be disconnected and transferred back to the barge or ashore in a controlled manner.
Draining of hose in port	• To drain the hose to a terminal or barge where there is no earth connected to the hose special precautions shall be taken to avoid possible creation of a hazardous static electrical charge or mechanical damage to tanks. • Procedure to be adopted must be agreed between ship and terminal. • Ullage in the reception tank must be adequate. • To ensure that the amount of compressed air or inert gas is kept to minimum, the operation must be stopped when the line has been cleared. • The inlet to the receiving tank should be located well above any water that may be in the bottom of the tank. • The line cleaning operation to be continuously supervised.

Appendix I: Consultation Report

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Marine Fishers Association of South Australia	Adjacent Fishery to the Duntroon Multi-Client Survey Area	PGS Letter (12/11/16) PGS Letter (07/12/16) (Record 1A) PGS Resend (23/12/16) MFA Email (03/01/17)	03/01/17: No submission advised from the Marine Fishers Association.	No issues or concerns raised	NA	Record 1 Record 1A Record 1B
		PGS Email & Letter (08/09/17) Delivery Receipt (08/09/17) Read Receipt (14/09/17) – Deleted without Reading.	08/09/17: Update of the Duntroon Survey provided to MFASA. Email deleted without reading.	No issues or concerns raised	NA	Record 1C
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised	NA	Record 1D
		PGS Update Letter (20/07/18)	**20/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No issues of concerns raised	NA	Record 1E
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 1F
Australian Fisheries Management Authority (AFMA)	Commonwealth Fisheries Management Authority	PGS Letter (11/11/16) PGS Letter (07/12/16) (Record 2A) PGS Resend (23/12/16) AFMA Email (03/01/17)	03/01/17: AFMA can see that PGS has been in direct contact with ASTBIA. AFMA has nothing further to add.	No issues or concerns raised	NA	Record 2 Record 2A Record 2B
		PGS Email and Letter (08/09/17) Read Receipt (14/09/17)	08/09/17: PGS updated information for the Duntroon survey	No issues or concerns raised	NA	Record 2C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
AFMA (Con't)	Commonwealth Fisheries Management Authority (Con't)	PGS Update Letter (18/1/18) PGS Resend (23/01/18) AFMA Advice (23/01/18)	**18/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. 23/01/18": Appropriate Contact is [CONTACT]	No issues or concerns raised		Record 2D
		PGS Letter (15/06/18)	**15/06/18:** PGS Letter to AFMA detailing the following: There has been a change to the proposed timing of the Duntroon Survey which is now planned for September 1 to November 30, 2019. This period is lower in environmental sensitivity and accommodates stakeholder feedback concerns. PGS would appreciate if AFMA could provide feedback on the impact assessment and the precautionary controls which have been adopted in the Duntroon survey design to prevent possible impacts to the breeding gulper sharks within the fishing closure area. The feedback provided by AFMA will help define the impacts and controls within the Duntroon MC3D and MC2D MSS Environment Plan for assessment by the National Offshore Petroleum Safety and Environment Protection Authority (NOPSEMA). Provision of data associated with impact assessment with the following controls outlined: On a precautionary basis, given the conservation-dependent nature of the gulper shark and the location of the 'breeding' closure area within the Duntroon survey area, PGS assessed acoustic source operation across the 30 nm central 'breeding' zone to limit possible and repeated behavioural impacts to breeding sharks. Accordingly, the Duntroon survey design includes the following controls: • Acquire only MC2D data in the 30nm central breeding area and 15 nm western buffer area and orient seismic lines within those zones (spaced approximately 5 km apart) perpendicular to the closure area (i.e. up/down the slope area). Each MC2D seismic line perpendicular to the slope is expected to traverse the closure area in less than 1.5 hrs (within the central 30 nm closure zone there are only 9-line traversals in total). • The MC2D survey lines which run parallel to the 30 nm central zone closure area (i.e. along the slope) will be positioned outside the closure boundary (refer Figure A1) to ensure there is a low risk of behavioural impact to gulper sharks from these lines and of repeated sound exposure within that zone. • No MC3D survey acquisition will be undertaken in the central 30 nm closure area for gulper shark breeding or the western buffer zone. MC3D acquisition is planned for the eastern 15 nm buffer zone.	No response provided to date	NA	Record 2E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
AFMA (Con't)	Commonwealth Fisheries Management Authority (Con't)	PGS Letter (15/06/18) (Con't)	Based upon the adopted guidelines (Popper et al (2014)) within the 30 nm closure zone, there is a moderate risk of behavioural disturbance to sharks within hundreds of meters of the operating array and a low risk at greater distances during each traversal (9 lines in total separated by 5 km intervals). By adopting this MC2D line layout and eliminating MC3D activity within the 30 nm central gulper shark closure area, PGS has reduced to a minimum the acoustic source operation and the potential for repeated sound exposure in that area, while still obtaining sufficient seismic data to satisfy survey objectives. On this basis, most of the 30 nm breeding closure area carries a low risk of behavioural disturbance. *Masking Impacts*: In accordance with the Popper et al. (2014) masking risk criteria for Type 1 fish (particle motion detection only), there is a low risk of gulper shark masking from the operating array. Accordingly, masking impacts to are expected to be localised and temporary around the constantly moving survey vessel.	No response provided to date	NA	Record 2E
		PGS Email (6/7/18) AFMA Response Email (6/7/18) PGS Email (12/07/18) ARMA Response Email (13/07/18) PGS Response Email (14/07/18) Telephone call PGS/AFMA (16/07/18)	**6/7/18 (PGS):** PGS Request for AFMA Data Form for Commonwealth Fishery data **6/7/18 (AFMA):** Provision of Data Request Form and Information Disclosure Policy. **10/07/18 (PGS):** PGS Form Submission; **13/07/18 (AFMA):** AFMA Response (insufficient specificity about data request – need additional detail). **14/07/18 (PGS)**: Revised PGS submission form for AFMA fisheries catch data. **16/07/18 (PGS):** PGS called [CONTACT] to confirm that data request was suitable. [CONTACT] agreed the request was adequate for submission to the relevant fishery managers to determine if confidential fishing data can be released.	No response to date	NA	Record 2F Record 2G Record 2GA

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
AFMA (Con't)	Commonwealth Fisheries Management Authority (Con't)	PGS Update Letter (20/07/18)	**20/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested possible issued and concerns. **30/07/18:** AFMA responded as follows: Unfortunately, AFMA is not adequately resourced to provide a comprehensive response to your request. We recommend that you contract South East Fishing Industry Association (SETFIA) (or other industry associations) to conduct a review which includes at least trawl footprint and potential impact on commercial operations. All basic information regarding fisheries as well contacts you will need in the course of consulting with stakeholders at http://www.afma.gov.au/sustainability-environment/petroleum-industry-consultation/ AFMA also posts fisheries data which is publicly available at: http://www.afma.gov.au/resources/catch-data/ The above link to our website is particularly useful as it also contains links to many other resources. Your enquiries will also be greatly assisted by the following document, Fisheries Status Reports 2016. This document may answer many of your questions. http://www.agriculture.gov.au/abares/publications/display?url=http://143.188.17.20/anrdl/DAFFService/display.php?fid=pb_fsr16d9abm_20160930.xml	PGS has requested fishing data from AFMA to provided effort and catch data (refer above entry). PGS has also consulted with SSIA (shark hook fishermen) (i.e. [CONTACT] who collates fishing data reports for petroleum activities) understand the confidential nature of the fishery data in the area and the potential for not obtaining any suitable data due to the 5 – boat rule) from commonwealth data sources (refer **Stakeholder Record 61**). Names of fishermen have been provided as an alternative to the AFMA data collection methodology. PGS has utilised all references provided by AFMA to understand spatial and temporal overlap with fishing activity, catch and effort.	NA	Record 2H
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 2I Record 2J
		PGS Reminder email (24/10/18)	**24/10/18:** Email resent to AFMA regarding the controls adopted for the Gulper Shark closure.	No feedback provided	NA	Record 2K

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
AFMA (Con't)	Commonwealth Fisheries Management Authority (Con't)	PGS Telephone Record (30/10/18) PGS Email (1/11/18)	**30/10/18: PGS** had a call with [CONTACT] who transferred PGS to [CONTACT] . [CONTACT] was the contact who responded to our July update, however she only responded to our request for information regarding fishing activities and did not pass on the request for information regarding the Gulper Shark. [CONTACT] is actually the POC for Gulper Shark information, [CONTACT] informed me he briefly looked at it but has not had time to sit down for a throughout review of our control measures or review the literature references. PGS will send [CONTACT] and email today, and follow up with a call tomorrow as we really need this information by the end of week so it can be incorporated into the EP. **1/11/18**: Provision of information relating to gulper shark for assessment to [CONTACT].	No feedback provided.	NA	Record 2L Record 2M
		PGS Telephone Record (5/11/18) AFMA Response (6/11/18)	**5/11/18:** PGS Follow-up call to confirm progress. Feedback to be provided by AFMA on 6/11/18. **6/11/18:** AFMA provided the following feedback: The information and analysis contained in your correspondence seems well considered and thorough. However, we are unable to comment on the likely effectiveness or otherwise of the proposed control measures in minimising impacts on gulper sharks. If you haven't already, I would encourage you to liaise with a gulper shark expert such as [CONTACT] from CSIRO, who should be able to provide more insight on the potential impacts. Likewise, I would encourage you to engage with the Department of Environment, given the conservation status of Southern dogfish. Sorry again for the delay in responding	PGS have consulted with the Commonwealth fishery management authority, as experts in the management of fish stock to establish the suitability of controls to prevent behavioural impacts to the gulper shark. AFMA do not consider themselves expert in this area and have encouraged PGS to engage with CSIRO to identify potential impacts. PGS considers that CSIRO may not be able to fulfil the request – to provide feedback on the adopted controls. PGS will pursue contact with CSIRO as a result of AFMA;s response.	NA	Record 2M
Great Australian Bight Industry Association (GABIA)	Commonwealth Fishery Industry Body (Trawl Fishery)	PGS Letter (11/11/16) PGS Email (23/11/16) (Record 3A) PGS Email (23/11/16) (Record 3B)	**23/11/16**: Provision of information to GABIA associated with PGS's Ceduna survey. Information provided included issues associated with the survey (weather and shark bites on cables), and observation of cetaceans. There was no interaction with fishermen other than general transits outside the survey area. **23/11/16:** New GABIA contact provided	No issues or concerns raised.	NA	Record 3 Record 3A Record 3B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Great Australian Bight Industry Association (GABIA)	Commonwealth Fishery Industry Body (Trawl Fishery)	PGS/ASBTIA/GABIA/ SASIA Meeting (25/11/16) (Record 3C)	**25/11/16:** PGS provided presentation on the proposed project outline for the Duntroon survey. Intention is to follow commitments in the Bight Petroleum EP which expired in the most recent season. GABIA advise that there was no trawling between 133deg 45min and 134deg 45min along the 180m-600m contour due to protected Gulper Shark (Endeavour Dogfish) and GABIA's previous stock survey was probably affected by the previous Ceduna survey. GABIA believes the new survey area should not affect stock assessments but will send maps to verify. There were additional general discussions, but concerns/issues not captured in these minutes will be provided in written responses respectively from ASBTIA, SASIA and GABIA.	No issues or concerns raised	NA	Record 3C
		GABIA Email (02/12/16) (Record 3D)	**02/12/16:** Advice from GABIA that information is being collated to send to PGS regarding fishing areas (from meeting)	No response received to date.	N/A	Record 3D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Great Australian Bight Industry Association (GABIA)	Commonwealth Fishery Industry Body (Trawl Fishery)	PGS Email (28/04/17) GABIA Response email (28/04/17) PGS Response (02/05/17) GABIA Response (01/05/17) PGS Response (02/05/17) GABIA Response (03/05/17) PGS Response (03/05/17) GABIA Response (11/05//17) PGS Response (15/05/17)	**28/04/17:** PGS email to advise that the Duntroon survey will not proceed in 2017 but is targeted for January 1 to May 31, 2018. **GABIA (28/04/17**) response identified a FIS would be undertaken between late February-early April 2018. Requested that PGS to email the survey areas and discuss a plan that limits potential impacts of the seismic work on our resource survey should the areas interact with each other. **PGS (02/05/17)** provided maps showing distance between the closest possible of FIS and Duntroon survey was 88kms. **GABIA (03/05/17)** advises they would seek advice and inform PGS of issues. Concern is that 2015 FIS outcome was worst survey result in a time series of 7 surveys and commercial fishing catches also took a downturn following the 2015 seismic work conducted in the GAB and catches are only starting to recover to levels preceding 2015. Uncertain that an 88 Km distance between the next seismic work and GAB FIS is adequate to minimise impacts on the survey / fishery. GABIA would like to work together to ensure that potential impacts are minimised. **GABIA (11/05/17**) advised: • GABIA had a strong response from the Great Australian Bight Trawl Fishery Statutory Fishing Right (GABTF SFR) Holders re the timing of the PGS Duntroon Survey. • Response to minimise any potential impacts is that the PGS Seismic Survey does not start until after the first week of April in 2018. Please confirm if PGS agrees and schedule this timing? • The 2nd leg of our Fishery Independent Survey will be in the week leading up to the full moon, March 31, 2018. • Also, peak fishing times in the GABTF are from September to May for our key target species, however this season GABIA is experiencing very good commercial catches for a greater period. The suggested timing is also likely to be suitable for the Southern Bluefin Tuna industry located in Port Lincoln that have a small and critical migratory window to locate and catch their fish, from January to mid- April each year. If you can please provide comment re the above request it will be appreciated. I am also reviewing recent science in relation to impacts of seismic survey work on fin-fish / shell fish fisheries and I will share outcome of review ASAP	1. PGS acknowledged concerns and will look at any requirements pending assessment outcomes. PGS will work with GABIA to minimize any potential impacts. 2. PGS understands the concerns GABIA has about the survey timing. However, the resultant small operating window would not allow sufficient time to complete the currently planned program. To amend plans in such a manner prior to understanding the likelihood of impacts is not considered an ideal way to consider this issue, so PGS will carry out an impact assessment based on the plans you have provided and determine impacts. Once prepared PGS is happy to share this for your review and further comments. To help in considering this, it would also be useful to get an understanding of how much flexibility you have in the timing or sequencing of your surveys. 3. PGS undertook a formal assessment of the possible impacts to the FIA from the nearest point of the Duntroon survey to the FIS areas based on the spatial separation of 88 km and determined, based upon the work of Popper et al (2014) that behavioral impacts in fish should not be experienced at this location. PGS also provided the spatial overlap with the 2015 seismic work and the FIS survey areas indicating that the seismic survey was in much closer proximity. Given the large distance, PGS does not need to put controls in place.	Email detailing content of Items 1& 2 sent to GABIA. Assessment and outcomes provided in PGS Correspondence (28/08/17) (*refer next entry*).	Record 3E

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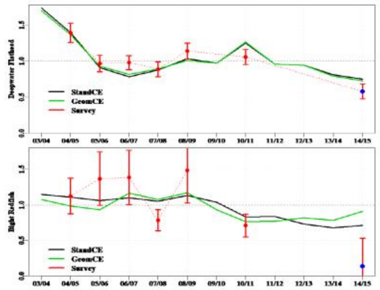
Great Australian Bight Industry Association (GABIA)	Commonwealth Fishery Industry Body (Trawl Fishery)	PGS/GABIA Meeting (28/08/17)
		
		PGS Letter and CSIRO Proposal (28/08/17)
		
		PGS Follow-up Email (05/10/17)
			28/08/17: Meeting to discuss updated information on Duntroon survey and results of the FIS assessment. Provision of overlay details of Duntroon survey vs FIS areas provided.
			Points raised:
			• Maps provided will be useful when meeting with your members tomorrow in discussing the differences between the 2015 survey and the proposed surveys relative to your planned stock assessment surveys
			• It was also interesting to hear about the background to the Gulper shark closure area. The observations you made about the sparse presence of this species in the 15nm buffer zones agrees with what we see in the available literature, with the primary habitat seemingly restricted to the 30nm or so canyon zone as you observed
			Outcomes included (Letter and CSIRO proposal provided):
			PGS is happy to provide the following additional commitments should the project proceed under this EP:
			• PGS will commit to the CSIRO project as outlined in the attachment and share the results with SASIA
			  ○ We believe there could be mutual benefits in the long run in acquiring opportunistic data during seismic surveys on a routine basis and the attached pilot study is seen as a first step in looking at what could be achieved in the future
			• PGS is also happy to provide bathymetric data from any of its 3D seismic surveys with such contouring derived from its seismic data analysis
			  ○ Currently this data can be provided in Maxseas or Olex formats
			  ○ We can also provide raw sounder data from our EA 600 sounders subject to such sounder (or equivalent) being standard equipment on board the selected vessel
			  ○ We are also happy to provide bathy data from our earlier surveys in the Bight if this is of use
			• PGS can provide daily water temperatures during operations should this be of use in any of your modelling
			• PGS can also carry out pelagic sampling as previously carried out for ASBTIA and SARDI on the 2015 survey should this be of interest during the proposed
			We remain happy to discuss other opportunistic areas of cooperation at any time should you think of areas that we can assist.
			05/10/17: Follow-up email to advise of pending EP submission and a link to previous Bight EP.
				No feedback provided to date on meeting, letter or follow-up email. Any further feedback on FIS	NA	Record 3 F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Letter (25/10/17) PGS Acknowledgment (26/10/16) PGS Response Letter (13/11/17)	**25/08/17:** Letter Response to the Letter sent by PGS on 28/08/17. The purpose of the letter is to provide GABIA's position on the timing of the proposed *Duntroon MC3D and MC2D* Marine Seismic Survey (MSS) and the need for PGS Australia Pty Ltd to commit to a timeframe that does not impact on the activities of the Great Australian Bight Trawl Fishery and ensures that the location and abundance of fish species in the GAB are not affected. GABIA is opposed to any MSS work commencing before 1 April 2018 in the GAB. It is unnecessary and unacceptable for seismic activity to be conducted whilst scheduled biannual Fishery Independent Surveys (FIS) are being conducted to develop abundance estimates for the GABTF. The period from November to April is also the period the GABTF experiences its best catch rates for key target species. There is evidence to suggest that as a result of the *Ceduna – MC3D-MSS* (2015) there was a significant impact on the 2015 GABTF FIS and operators reported that abundance of commercial fish species were impacted for a period of at least 18 months following the MSS. Reduced total catches in the period March 2015 – September 2016 correlated with the timing of the MSS. The most compelling evidence GABIA has in relation to the impact of an MSS on the FIS is documented in the most recent stock assessment for Deepwater Flathead as conducted by CSIRO, **ref:** Haddon, M. (2016) Deepwater Flathead (*Neoplatycephalus conatus)* stock assessment based on data up to 2015/2016. Report to October 2016 GABRAG meeting. CSIRO, Oceans and Atmosphere, Australia. 43p In GABIA's view, PGS Australia Pty Ltd is not in a position to provide objective scientific review or analysis and is not in a position to conclude that the proposed MSS will not impact on fish within the GABTF FIS areas located west of the *Duntroon MC3D and MC2D Marine Seismic Survey* areas (as per your statements and conclusions detailed in your letter dated 28 August 2017). Considering the poor outcome of the GABTF FIS in 2015, as a likely result of the *Ceduna – MC3D-MSS* (2015) being conducted at the same time, it is submitted that for PGS Australia Pty Ltd to effectively manage the potential impacts and risks to a level that is to be considered acceptable and as low as reasonably practicable, that scheduling of the *Duntroon MC3D and MC2D Marine Seismic Survey* does not include the period November 2017 – April 2018. This will ensure that the impact of an MSS on the GABTF FIS is mitigated and disruptions to commercial fishing operations are minimised.	PGS cannot commit to commencement of seismic after April 1, 2018 due to survey scope and fulfilling workplan commitments of titleholders. PGS has revised its timeframes to March 1 – May 31 which now offers little activity flexibility. PGS also believes that the conditions present during the 2015 MSS activities (proximate to the FIS in the HOB fishing grounds) are not replicated in the location of the Duntroon survey. Further • PGS believes it has adopted relevant scientific documents and independent modelling to provide the basis of assessment to GABIA; and • There is a level of confusion over the significance of the April 1, 2018 start timeframe as the FIS tender documents indicate surveys after April 1 will occur. **Stakeholder Response Provided:** PGS Australia Pty Ltd (PGS) appreciates your response to PGS correspondence dated 28th August 2017 regarding the planned Duntroon MC2D and MC3D surveys in the eastern Great Australian Bight (GAB). In that correspondence PGS provided GABIA with an assessment of the expected sound impacts to key fishing areas utilised by the Great Australian Bight Trawl Fishery, located at least 86km from the nearest Duntroon survey operational boundary. PGS understands that GABIA is opposed to any marine seismic survey (MSS) work commencing before 1 April. GABIA advises that: • PGS should commit to this timeframe so it does not impact on the activities of the GABTF and ensure that the location and abundance of fish species in the GAB is not affected; • It is unacceptable for seismic activity to be conducted whilst scheduled biannual Fishery Independent surveys (FIS) are conducted to develop abundance estimated for the GABTF; and • The period from November to April is also the period the GABTF experiences its best catch rates for key species. GABIA also advises that PGS is not able to provide objective scientific review or analysis and is not in a position to conclude that there proposed MSS will not impact on fish within the GABTF FIS areas.	Stakeholder Response is identified in Assessment of Merits of Adverse claim/objection.	Record 3G Record 3H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Letter (25/10/17) PGS Acknowledgment (26/10/16) PGS Response Letter (13/11/17) (Con't)	GABIA is of the understanding that this request to not begin an MSS before 1 April 2018 correlates with and supports timeframes requested from the Australian Southern Bluefin Tuna Industry. Whilst GABIA supports sustainable natural resource utilisation in the GAB, we do not support the proposed timeframes as identified in your letter dated 28 August 2017.	From available FIS tender documents provided to PGS by GABIA, PGS understands that the FIS is scheduled for the '*the week leading up to the March and April full moon (2018)*'. PGS understands these full moon dates correspond to 2 March 2018, 31 March 2018 and 30 April 2018. PGS also notes that most FIS locations are in water depths of less than 200 m (Figure 1 of Tender Document). PGS would like to advise GABIA that the Duntroon survey timeframe has been revised to March 1 -May 31 to reduce the overlap with periods considered as having a higher probability of upwelling as far as possible. For March, to avoid overlap with continental shelf areas where productivity may be high due to upwelling, PGS will commence MC3D survey activities in the deeper off-shelf areas of the EPP-41/42 MC3D survey polygon **OR** commence MC2D survey activities in EPP-46, a lower density survey which does not spatially overlap the Kangaroo Island Pool or the areas which show secondary surface upwellings. PGS considers that it has provided an accurate assessment of the sound impacts which may be experienced at the key GABTF fishing and FIS locations in PGS correspondence dated 28th August 2017. Modelling and interpretation of data has been undertaken by consultants utilising best independent scientific data available. The Sound Exposure Guidelines for fishes and sea turtles is provided in Attachment 1 to assist you in verifying the independence of this scientific data. Moreover, PGS would also like to provide GABIA with additional information on ambient sound levels measured at the shelf break area which is routinely fished by the GABTF. BP (McCauley et al, 2012)1 undertook studies into ambient sound levels in the GAB to understand underwater sound characteristics of the area. Sound loggers were deployed near the Head of Bight (HOB) in a water depth of 50 m and two along the shelf break at water depths of approximately 200 m for approximately six months. The measurements were assessed over the bandwidth of 3 to 3180 Hz. Ambient sound was higher at the shelf break sites compared with the HOB site with background sound levels increasing over summer into early winter. The results for the shelf break area, which is coincident with the GABTF key fishing and FIS locations identified ambient sound pressure levels (SPLs) to vary between 74.9 to 144.9 dB re 1μPa (rms).	Stakeholder Response is identified in Assessment of Merits of Adverse claim/objection.	Record 3G Record 3H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Letter (25/10/17) PGS Acknowledgment (26/10/16) PGS Response Letter (13/11/17) (Con't)		Within the PGS assessment provided to GABIA on 28th August 2017, PGS provided a generalized assessment of the predicted received SPL at the nearest key GABTF location from the nearest Duntroon survey operational boundary based upon acoustic modelling performed by JASCO Applied Sciences. Acoustic modelling predicts received sound levels at distances ~86 km, may be in the order of 140-150 dB re 1µPa (SPL) however closer to 140 dB re 1µPa (SPL). On this basis, PGS would expect that any residual sound from Duntroon survey activities at the nearest location to key fishing and FIS areas might approach the upper end of the ambient sound levels measured within the GAB. It is also noted that survey activities proposed for the March timeframe may include the MC2D survey in the western area of the Duntroon survey operational area which is predominantly located in deep water with minimal shelf intrusion (i.e. 93% is in water depths > 200 m). Modelling identifies that sound propagation in continental shelf areas rapidly attenuates and falls below 140 dB re 1µPa (SPL) at a distance of approximately 40 km. For sound footprints on the continental slope and in deeper waters, sound shows little intrusion onto the continental shelf (refer Figure below) and distances quoted to 140 dB re 1µPa are in the seaward direction (not back onto the shelf). PGS concludes from this analysis, independent scientific sound exposure guidelines and the available data on ambient sound levels within the GAB, that residual sound levels from the Duntroon survey are expected to fall within ambient sound levels already experienced in the area. Little-to-no behavioral impact to fish is expected within the GABTF from an operating acoustic array located at a point 86 km from the nearest FIS/key fishing area.	Stakeholder Response is identified in Assessment of Merits of Adverse claim/objection.	Record 3G Record 3H
		GABIA Letter (5/12/17) PGS Email Query (11/12/17)	**05/12/17:** At the recent meeting of the Great Australian Bight Resource Assessment Group (GABRAG, 21 NOV 2017), the meeting considered a paper presented by the scientific member, titled; *On the Potential Effects of a Seismic Survey on Commercial Fishery Catch Rates in the Great Australian Bight* (M Haddon, 2017).	**11/12/17**: PGS Requires additional information to assess the merits of the letter and requests further detail from GABIA. Specific items requested (*but no response provided*): A further request is made to GABIA for the following: • Can you please provide a copy of the Haddon paper? • Are you aware of any reasons for the authors not considering the two seismic surveys that we are taking place at the time. PGS's understanding is that work on the Chevron are was being carried out by TGS at the time also (Nerites MC3D) • Will you be doing a stock assessment survey in 2019, or is the likely plan to be 2018 followed by 2020?	Request made in Email	Record 3I Record 3J

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Letter (5/12/17) PGS Email Query (11/12/17) PGS Response (08/03/18)	**GABIA (05/12/17):** Following an unusually poor result from the Fishery Independent Survey (FIS) in 2015, members of GABRAG were concerned that the Ceduna - MC3D Marine Seismic Survey (MSS), conducted at the same time and in the vicinity of the 2015 Great Australian Bight Fishery Independent Survey, had negatively impacted the 2015 FIS and commercial catch rates in the fishery in the same period. While the previous six FIS (2005 to 2011) had followed a similar trajectory as the commercial catch-per-unit-effort (CPUE), the 2015 FIS failed to follow the commercial CPUE trajectory and the 2015 result was significantly lower. In the analysis below, Figure 1 clearly visualises the scale of the difference between the 2015 FIS, which coincided with the Ceduna - MC3D MSS, and previous surveys in terms of a lower CPUE and divergence from the FIS and commercial CPUE following a similar trend line for deep-water flathead and Bight redfish (the divergence from the trend is most obvious in Bight redfish). This contrast in the data alerted members of GABRAG that the Ceduna – MC3D MSS had biased the results of the 2015 FIS and that MSS, as an activity, influences / alters the location and availability of fish species that naturally occur in the Great Australian Bight.  **Figure 1:** A comparison of the indices from the standardized commercial CPUE and the trawl survey indices for Deepwater Flathead (*Platycephalus conatus*) and Bight Redfish (*Centroberyx gerrardi*) from the GAB. The red lines represent Â± 1.96 Ã— StDev in each year for the FIS mean estimates. GeomCE is the scaled geometric mean CPUE; each time series has been scaled to have a mean of 1.0 across years 2004/2005 to 2008/2009, 2010/2011, and 2014/2015 (Haddon, 2017). With this analysis underpinning concerns that the Ceduna – MC3D MSS had a detrimental influence on the 2015 FIS and commercial CPUE in the same period, further analysis has been conducted by the GABRAG Scientific Member with the aims of quantifying the scale of the impact and to assist GABRAG in formulating advice on the timing of future GAB FIS. The recent study has also enabled GABRAG to define a position on the impacts of Marine Seismic Surveys on the Great Australian Bight Trawl Fishery and the environment more generally.	**08/03/18:** PGS Assessment of Merits: PGS has requested further information to understand the proximity issues associated with MC3D surveys in 2015. Fishing data identifies a short-term decrease in March/April 2015. No additional information has been provided including Haddon (2017). PGS believes based upon the spatial buffer between the GAB trawl sector fishing grounds and the Duntroon OA, negligible impacts to fish stock should occur in these grounds. The PGS survey has already been curtailed in timeframe with the further revision to timeframe (March 15 to May 31) with curtailment of the program possible. Commencing after April 1 is not possible and still meet survey objectives. Options to split survey over multiple years does not achieve titleholder's objectives. **Stakeholder Response**: PGS would like to clarify a couple of items detailed in recent correspondence from GABIA: **Impacts of the Ceduna MC3D and Duntroon Survey Timing:** PGS received on 5 December 2017 GABIA correspondence identifying there were unusually poor Fishing Independent Study (FIS) results in 2015. CPUE indices of Deepwater Flathead and Bight Redfish over the period 2003/4 to 2014/15 were used to demonstrate this anomaly. A study by Haddon (2017) referenced in that correspondence, found that the fishery was unusually depressed during March and April 2015 with concerns that the 2015 Ceduna MC3D survey had impacted negatively on the 2015 FIS and commercial catch in the fishery in the same period. PGS has requested a copy of this report from GABIA to reconcile the location/activity of the Ceduna MC3D survey with the reported lower catches observed. It is also our understanding that the TGS Nerites MC3D survey was acquiring data in the same location/timeframe, so reconciliation of that activity with the catch data would also have some merit. Within this letter, GABIA recommended the following for the Duntroon survey: • The scheduling of the Duntroon survey does not include the period November 2017 to April 2018 so that PGS can effectively manage the potential impacts and risks to a level which is ALARP and acceptable; • PGS commits to operational timeframes that do not impact on the activities of the GAB Trawl fishery that ensure the location and abundance or fish species in the GAB are not affected; and	Contained in an Email with content as described in the Assessment of merits.	Record 3N Record 3I

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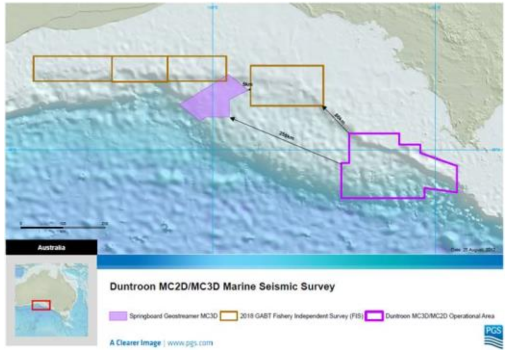
<td>Commonwealth Fishery Industry Body (Trawl Fishery)</td>
<td>GABIA Letter (5/12/17)
PGS Email Query (11/12/17)
PGS Response (08/03/18)</td>
<td>The recent Haddon (2017) study has found through an analysis of raw CPUE (using bias corrected geometric mean estimates) that the commercial fishery was unusually depressed during March and April 2015.The analysis found that average unstandardized CPUE during March and April 2015 was lower by a metric of 10 to 20 Kg / hour compared to corresponding periods between 2010 to 2014 and 2016.
The Table below demonstrates that the Commercial CPUE levels in March and April 2015 were lower when the Ceduna MC3D MSS was conducted in this period in an area close to the Great Australian Bight Trawl Fishery compared to corresponding years.
The unstandardized CPUE analysis in Table 1 forms a key piece of evidence to demonstrate that the Ceduna- MC3D MSS had an impact on actual commercial catch rates and not just the 2015 FIS. The timing of the drop in CPUE (March and April 2015) correlates with GABRAG’s concern that the Ceduna – MC3D MSS had a negative effect upon the 2015 FIS results that was run over the same period. However, to assist in reaching a conclusion on the main influence of the exceptional result in March and April 2015, the Haddon (2017) study applies a statistical standardization process to the raw commercial CPUE data to produce an optimum (statistical) standardized CPUE.
Table 1: Bias-corrected geometric mean estimates for each month, 1 - 12, for the years 2010 - 2016. The averages for March and April 2015 (highlighted) are markedly lower that the other March and April CPUE levels. (Haddon 2017)
<table>
<tr><th></th><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>Average</th></tr>
<tr><td>1</td><td>60.28</td><td>85.03</td><td>46.42</td><td>54.60</td><td>42.57</td><td>42.80</td><td>47.27</td><td>56.03</td></tr>
<tr><td>2</td><td>53.79</td><td>71.76</td><td>47.99</td><td>48.42</td><td>42.64</td><td>43.91</td><td>45.08</td><td>51.61</td></tr>
<tr><td>3</td><td>34.79</td><td>46.77</td><td>44.33</td><td>33.44</td><td>37.10</td><td>30.34</td><td>45.37</td><td>40.30</td></tr>
<tr><td>4</td><td>38.37</td><td>87.02</td><td>43.58</td><td>43.50</td><td>32.81</td><td>24.92</td><td>37.36</td><td>47.11</td></tr>
<tr><td>5</td><td>81.98</td><td>63.72</td><td>51.70</td><td>42.05</td><td>49.91</td><td>48.34</td><td>45.27</td><td>55.77</td></tr>
<tr><td>6</td><td>58.11</td><td>60.37</td><td>30.70</td><td>48.85</td><td>37.91</td><td>36.47</td><td>47.31</td><td>47.21</td></tr>
<tr><td>7</td><td>46.77</td><td>41.52</td><td>30.74</td><td>31.68</td><td>29.11</td><td>32.07</td><td>25.32</td><td>34.19</td></tr>
<tr><td>8</td><td>38.77</td><td>38.12</td><td>31.34</td><td>26.38</td><td>29.04</td><td>42.15</td><td>33.22</td><td>32.81</td></tr>
<tr><td>9</td><td>43.97</td><td>47.33</td><td>44.16</td><td>36.42</td><td>39.91</td><td>45.15</td><td>48.78</td><td>43.43</td></tr>
<tr><td>10</td><td>72.34</td><td>49.57</td><td>54.37</td><td>53.78</td><td>47.15</td><td>64.83</td><td>71.06</td><td>58.05</td></tr>
<tr><td>11</td><td>96.00</td><td>53.71</td><td>66.92</td><td>63.00</td><td>59.73</td><td>65.93</td><td>66.61</td><td>67.66</td></tr>
<tr><td>12</td><td>81.72</td><td>58.78</td><td>66.56</td><td>49.45</td><td>54.97</td><td>69.46</td><td>57.13</td><td>61.43</td></tr>
</table>
The statistical standardization process used by Haddon (2017) is as follows;
LnCE = constant + yrmth + Vessel + DepCat + longzone

The optimum statistical model log-transforms the raw CPUE data and all variables are treated as categorical factors in the model.
The study presented the results by plotting the unstandardized CPUE next to the output of the optimum statistical model to illustrate the effect of the standardization and the extent to which the seasonal cycle exhibited by the CPUE is changed in the months March and April 2015 (Figure 2). This process is only applied and presented for deep-water flathead in the study.</td>
<td>GABIA is opposed to any MSS work before 1 April 2018 in the GAB. It is unnecessary and unacceptable for seismic activity to be conducted whilst scheduled FIS are conducted to develop abundance estimates for the GABTF. The period November to April is also the period where the GABTF experiences its best catch for key species.
More generally the letter outlined that the FIS of stock should not be undertaken at the same time as a proximate seismic survey (‘proximate’ deemed as 60 or more nautical miles).
Diagrams below show the location of the 2015 Ceduna MSS (termed ‘springboard’) overlaid with the key GABIA fishing zones on the continental shelf at the Head of Bight (HOB) and the FIS locations.


The 2015 Ceduna MSS was close to, and in some locations overlapped, the fishing grounds and FIS locations. Seismic survey <u>over</u> fishing ground has been shown to alter abundances and catch of certain species. A summary follows based upon available research (papers referenced at end of email):

Commercial trawl and longline catches over demersal fishing grounds in Norway of Atlantic cod (Gadus morhua) and haddock (Melanogrammus aeglefinus) have been shown to fall by 45% and 70%, respectively, five days after seismic surveys in the Barents Sea (Engås et al., 1996). Reductions in catch rates were observed 18 nautical miles from the seismic shooting area (3 × 10 nautical miles), with the most pronounced reduction in the shooting area.</td>
<td>Contained in an Email with content as described in the Assessment of merits.</td>
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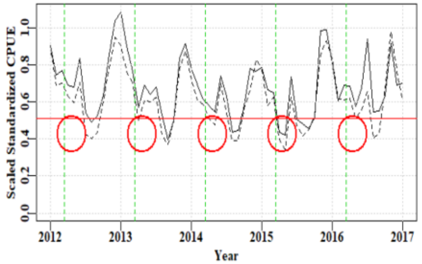
PGS Response (08/03/18)</td><td>

Figure 2: A plot of the un-standardized CPUE (dashed line) and the optimum standardized CPUE (solid black line) for Deepwater Flathead in the GAB restricted to the years 2012 - 2016. The red circles surround the months March and April in each year with the dashed green lines passing through the point for February. Horizontal red lines are also added to assist comparisons across years (Haddon 2017).
Discussion of the Results;
The effect of standardizing the commercial CPUE puts the months of March and April 2015 in the perspective of the whole fishery while considering the expected differences in CPUE that fishing in the different bands of longitude usually bring about. The analysis of unstandardized CPUE (Table 1) provides evidence of a negative influence on CPUE in this period. This is confirmed and reinforced by the standardization process and visualized in Figure 2. The red circles in the plot demonstrate that in March and April 2015 the negative impact on CPUE (both unstandardized and standardized) was exceptional compared to the same time in other years.
The Haddon study states, "It would thus appear that the significant drop in the observed CPUE from the fishery independent survey of the fishery in the GAB, conducted in 2015, was very likely negatively influenced by it being run coincidently with the seismic survey".
The Haddon (2017) paper then provides recommendations on the future interpretation of the 2015 FIS result and future interactions between the GABTF FIS and Marine Seismic Surveys that may be undertaken at a similar time in the GAB. The study recommends the following;
That future Fishery Independent Surveys of fish stocks should never be undertaken at the same time as a proximate seismic survey (where proximate could mean within 60 or possibly many more nautical miles).
Given the scale of the bias in CPUE from the 2015 seismic survey the results from the 2015 FIS, should not be included in future stock assessments of either deep-water flathead or Bight redfish.
.</td><td>Based on the local decline in fish density across the central study area, Engås et al. (1996) hypothesised that the reduction in catch rates was most likely the result of fish moving away from the seismic area due to an avoidance behaviour, but this was not quantified.
Similar reductions in catch rates (52% decrease in Catch Per Unit Effort (CPUE) relative to controls) have been demonstrated in the hook-and-line fishery for rockfish (Sebastes spp.) during controlled discharges of a single airgun (186 to 191 dB) at the base of rockfish aggregations off the central Californian coast (Skalski et al., 1992). The authors suggested that the mechanism underlying the pronounced CPUE decline was not dispersal but rather decreased responsiveness to baited hooks associated with an alarm behavioural response. Based on a companion behavioural study which showed that alarm and startle responses were not sustained following the removal of the sound source (Pearson et al., 1992), Skalski et al. (1992) suggested that the effects on fishing may be transitory, primarily occurring during the sound exposure itself. From the fish CPUEs identified in the GABIA correspondence of 5th December 2017 (Table 1) the transitory nature of the catch effect is supported (i.e. CPUEs increased in May).
In another study, following exposure to airgun noise in a Norwegian fishing ground, gillnet catches increased substantially for redfish (Sebastes norvegicus) and Greenland halibut (Reinhardtius hippoglossoides) (by 86% and 132%, respectively), while longline catches of Greenland halibut and haddock decreased (by 16% and 25%, respectively, compared to pre-shooting levels) (Løkkeborg et al., 2012). These contradictory results were explained by greater swimming activity versus lowered food search behaviour in fish exposed to air-gun emissions. Changes in catch rates of all species studied, including saithe and ling, found all species responded to air-gun sounds. Except for saithe, acoustic mapping of fish abundance did not suggest displacement from fishing grounds. The potential effects of seismic operations on fish distribution, local abundance or catch have varying results possibly due to gear- and species-specific effects (Løkkeborg et al., 2012).</td><td>Contained in an Email with content as described in the Assessment of merits.</td><td>Record 3N
Record 3I</td></tr>
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GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Letter (5/12/17) PGS Email Query (11/12/17) PGS Response (08/03/18)	Following the presentation of this paper GABRAG discussed that this study is significant in that it forms a key piece of evidence of a real-time impact of a Marine Seismic Survey in a regional, habitat and species-specific context relevant to the GAB and southern Australia more generally. GABRAG agreed that the Ceduna – MC3D MSS had a negative effect upon the 2015 FIS result and the evidence of an impact on the commercial fishery at the same time is extremely concerning ***GABIA's position on the Haddon (2017) study in the context of the proposed Duntroon MC3D and MC2D MSS;*** The Haddon (2017) study provides scientific evidence through the analysis of unstandardized and standardized CPUE that the 2015 Ceduna MC3D MSS had a negative impact on commercial fishing operations and the FIS in 2015. This study, especially the presentation of results in Figure 2, supports GABIA's concern that the abundance and location of commercial fish aggregations in the GABTF were significantly impacted by the Ceduna MC3D MSS. This was experienced as a real-time downturn in commercial CPUE during a financially important time of year in the fishery. GABIA members have also experienced additional financial hardship through the loss of their investment in the 2015 FIS. Due to the scale of the bias in the CPUE as a result of the Ceduna MC3D MSS, it has been determined that the 2015 FIS results should no longer be utilised as an input into the stock assessment process employed to establish sustainable fishing levels. In our submission to PGS Australia, dated 25 October 2017, re the proposed Duntroon MC3D and MC2D MSS, GABIA submitted the following; • That scheduling of the *Duntroon MC3D and MC2D Marine Seismic Survey* does not include the period November 2017 – April 2018 so that PGS Australia can effectively manage the potential impacts and risks to a level that are acceptable and as low as reasonably practicable; • The need for PGS Australia to commit to operational timeframes that does not impact on the activities of the Great Australian Bight Trawl Fishery and ensures that the location and abundance of fish species in the GAB are not affected; • GABIA is opposed to any MSS work commencing before 1 April 2018 in the GAB. It is unnecessary and unacceptable for seismic activity to be conducted whilst scheduled Fishery Independent Surveys (FIS) are being conducted to develop abundance estimates for the GABTF. The period from November to April is also the period the GABTF experiences its best catch rates for key target species.	Przeslawski et al. (2016) in catch studies undertaken as part of a seismic survey in the Gippsland Basin fishing ground found no clear evidence of adverse effects on fish or commercial catch rates. The study followed 15 species caught by Danish seine and demersal gillnet and identified in the six months which followed the survey, six species showed increased catch (<u>Danish Seine</u>: tiger flathead, goatfish, elephantfish; <u>Demersal Gillnet</u>: boarfish, broadnose shark and school shark) and three species showed decreased catch (<u>Danish Seine</u>: gummy shark, red gurnard, sawshark). No change was observed in the remainder of species and no change to gummy shark catch was observed for demersal gillnet catches. These results support previous studies in which the effects of seismic surveys on catch seem transitory and vary among species and gear types. **Fishery Independent Surveys (2019):** PGS would like to confirm whether a GABTS FIS will be undertaken in 2019. We understand these activities are not undertaken on an annual basis. Given the very small window of time available to PGS to acquire seismic data, it is not possible for us to defer the commencement of the Duntroon MC2D and MC3D surveys to after the first week of April (requested in GABIA on May 11, 2017) or until after April 1 (requested by GABIA on December 5, 2017). PGS have significantly delayed the commencement of the survey and cannot reduce the window for acquisition any further and still meet survey objectives. As above acquisition during March 15-31 is in deep water (1500m+) in the MC2D area in the south-west of the Duntroon survey area and at least 30 km from the shelf-break (~200 m water depth). **GAB Trawl Sector Fishing Season:** As per the request contained in the PGS correspondence of 11th January 2018, we understand the GABTS fishing season extends from September to May with Bight Redfish targeted in the period February to April. Information provided by GABIA on 11 May 2017 indicated that in recent seasons that the GABTS had experienced "very good commercial catches for a greater period of time", and we would like to understand if the season extends beyond May and what the "greater period of time" means. **Proximate:** Scientific references which assist in determining this separation distance as acceptable would be appreciated.	Contained in an Email with content as described in the Assessment of merits.	Record 3N Record 3I

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GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Letter (5/12/17) PGS Email Query (11/12/17) PGS Response (08/03/18)	GABIA resubmits our key points from our 25 October 2017 submission and we reiterate the importance of not running an MSS in the GAB from November 2017 to April 2018. GABIA is disappointed by the PGS Australia response received 13 NOV 2017 that discounts our submission and advises that you intend to run the Duntroon MC3D and MC2D MSS regardless of our informed submission. We hope that the Haddon (2017) study can provide guidance to PGS Australia on the scale of the impacts an MSS has on fish assemblages and commercial fisheries and assists in identifying the optimum time to conduct the Duntroon MC3D and MC2D MSS so that impacts on the marine environment and commercial fisheries are minimized.		Contained in an Email with content as described in the Assessment of merits.	Record 3N Record 3I
		GABIA Email (27/12/17) PGS Response (30/12/17)	**27/12/17:** Request from new EO for information associated with the planned work program for Duntroon. GABIA have commenced planning for the 2018 GAB Research program and the planning is constrained by the potential Duntroon activity in the area.	**30/12/17:** PGS provides details on the last communication with GABIA for reference addressing two issues: • We understand the potential impact of the 2015 surveys. Just as background, GABIA did not advise PGS of the research surveys that took place in close proximity to the seismic surveys in 2015 during our pre-survey consultation for that project. Unfortunately, this meant it could not be taken into account in our planning • Re current plans, the distance from the closest point of any proposed seismic to the research surveys is 86kms, so is significantly greater. • Nevertheless, it may be possible that timing could be changed, and this is currently under review. In this regard, it would be useful to confirm whether there will be any research surveys undertaken in 2019	Information provided in email.	Record 3K
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **12/01/18 (GABIA Response):** Thanks very much for the update. I'll get back to you shortly with information you have requested. I appreciate the early advice	No further information received.		Record 3L Record 3M

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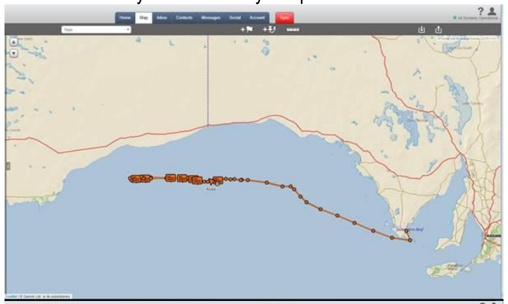
GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Email (27/03/18)	**27/03/18:** Letter to provide requested reports. Following response was provided. ‘Apologies for not getting back to you sooner, but I held off till there had been a meeting to review research across all of the SESSF stocks, including the GAB. The current research program will be continued for 2018 – 2020. As such, the second phase of the 2018 survey began on 28 March and should take 10 days. I have included maps of the survey boat tracks from the first stage of this year’s survey (early March. I have where needed added my comments to your questions in the text below.   Hope this helps. I would appear the risk would be greatest if the two surveys end up in the same general area. As I understand it the FIS Shots are done moving west and then back east but the last couple of days of the trip are purely commercial fishing as the FIS is completed near the border on return. Let me now if you need further information. Provision of Haddon (2017) – On the potential Effects of a seismic survey on Commercial fish rates in the Great Australian Bight’ & Duncan (2018) – A comparison study of cumulative sound exposure levels (CSELs) from typical 3D seismic surveys.	Information provided verifies that there was a decrease in deep-water flathead during March & April 2015 when there was an overlap of a seismic survey and FIS. Report concludes that FIS should not be undertaken at the same time as a proximate survey (where proximate could mean 60 or possibly many more nautical miles).	No response or objection – information only	Record 3N

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	GABIA Email (27/03/18)	Further information provided within the email included the following: • The GAB FIS will not be undertaken in 2019.Based upon the timing and location of the seismic survey it is possible that the GABFIS would be being undertaken further west of the area you propose to survey during the overlapping period • There are reasonably distinct seasons for redfish and deep-water flathead, however GAB trawl boats operate year-round. A Danish seine vessel normally only operates through the summer period within the GAB due to operational limitations • I have attached the most recent work I am aware of including a report by the CSIRO relating to the period of overlap with the previous FIS and seismic work and a study undertaken for the Northern Territory Seafood Council.	Information is acknowledged.	No response or objection – information only	Record 3N
		PGS Update Letter (23/07/18) GABIA Response Email (25/07/18)	**23/07/18 (PGS):** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Letter contained an assessment of new timeframe against previous GABIA concerns (i.e. temporal overlap with FIS). Information was also provided on the possible impacts to abundance effects and stock levels which may be affected. Email also requested meeting with GABIA in later July/early August. **25/07/18 (GABIA**): I could do Tuesday (31/7) any time after 12PM in the city.	No issues or concerns raised	NA	Record 3O

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
GABIA	Commonwealth Fishery Industry Body (Trawl Fishery)	PGS/GABIA Meeting (31/08/18) Meeting Minutes (02/08/18) PGS Email Follow-up (10/08/18)	**02/08/18**: Meeting Minutes reflect the following: Thanks for meeting with PGS on Tuesday in Adelaide, it was great to meet you and learn more about the operations of the trawl fisheries. As discussed, we would be grateful if you could request of your members the below information which would enable PGS to undertake a specific impact assessment of each fishery that may be active within the Duntroon operating area. As mentioned all information will be kept confidential and only provided in the prepared EP to NOPSEMA for assessment. Any copies of the EP provided to other stakeholders would have this confidential information redacted. The information we are requesting is specific to the Duntroon OA and the period of the survey September 1 to November 30. Items would include: • Catch within the Duntroon OA by target species (i.e. Bight redfish and Deepwater flathead); • The period of fishing in the OA (i.e. light fishing possible throughout the period (no pattern); fishing around the full moon; fishing while en-route to the main HOB fishing grounds). • During the survey what is the best way of communicating with them and spatially avoiding their activities. Please don't hesitate to be in touch if you have any question on the above, and as always please feel free to pass on [CONTACT] or [CONTACT] details to anyone who would like to contact us directly about any information or concerns.	No issues of concerns raised. No further feedback	NA	Record 3P
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 3Q

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Rock Lobster Advisory Council (SARLAC)	South Australian Lobster Fishery Industry Association	PGS Letter (11/11/16) SARLAC Response (13/11/16) (Record 4A) SARLAC Response (17/11/16) (Record 4A)	**13/11/16:** Feedback indicated that SARLAC had been concerned for many years about the impact of seismic on rock lobster and other marine species. The recent research report FRDC 2012-008 – Assessing the impact of marine seismic on south east scallop and lobster fisheries had identified significant detrimental impacts to lobster wellbeing including impacts out to 365 days and the potential for increased predation and potential reproduction impacts. Assessment of egg production is critical to maintaining export accreditation and damage to rock lobsters in SA is likely to impact across the stock. View of SARLAC is that survey work should not proceed until suitable controls can be identified and implemented to address concerns. SARLAC are unaware of any proven demonstrated controls.	*PGS will assess Research Report FRDC 2012-008 against the proposed Duntroon survey location and provide a response. From preliminary review the survey area appears to lie outside of measurable catch areas and the source falls to below 160 dB re 1μPa².s within 2000 m of the source. PGS understands that the referenced study was performed at very close range to the test species and the Duntroon survey operating in water depths of approximately 130m.* **19/12/16**: PGS has assessed FRDC Paper providing a summary of the findings with respect to Southern Rock Lobsters and the impacts to the development of lobster embryos exposed to airguns (no significant difference in exposed and control groups). PGS considers that the study by Day et.al (2016) provides important observations into possible sub-lethal effects of seismic airguns for particular study conditions. Observations are considered relevant for surveys undertaken in shallow waters on limestone substrates with observed SEL exposures more than 186dB re 1μPa². s. It is noted that the observed impacts may be attributable to 'near-field' particle movement given the proximity of the airgun to the test species (~6 m). Lobsters are known to be sensitive to surrounding water movement as this is how they detect prey. These near-field impacts cannot be immediately aligned with the Duntroon multi-client survey given the minimum water depths are 100 m, however PGS acknowledges that there may be some observed behavioural impacts in shallow-water surveys with significant SEL exposures.	PGS commitment to respond after a full assessment of the report. *Provided preliminary assessment details as identified in italics.* **19/12/16:** PGS Response to FRDC Paper (Record 4D)	Record 4 Record 4A Record 4D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	PGS/SARLAC Meeting (21/11/16) (Record 4B)	**21/11/16:** SARLAC provided an overview of the industry structure and PGS provided survey areas and proposed timings of surveys. SARLAC raised issue of released FRDC paper and PGS advised that the paper was being reviewed to understand whether the results could be extrapolated to actual seismic operations. This review will be provided to SARLAC. SARLAC's current position was to seek compensation for displacement and/or economic loss suffered by lobster fishermen. PGS advised that preferred approach to avoid displacement was through planning if possible. PGS is happy to review any proposal presented. SARLAC advised that there were seasonal variations in fishery and it was difficult to describe activity levels at this stage, however SARLAC agreed that mutual planning would be best and surety for the industry would only be provided by proceeding with an appropriate and agreed framework for compensation in place. SARLAC's position is that no party should suffer a detrimental economic impact as a result of these activities and in the medium to long term, if it is demonstrated that seismic survey activity has caused or contributed to any actual impact on rock lobster abundance, recruitment or catchability, fishers will be compensated for any resulting economic loss. Mutually agreed that best first step was to look at maps of normal lobster trapping activity and possible operational overlaps. SARLAC also advised that deep sea crab fishing may occur in the operational area and would provide some information on operators (operates under "Miscellaneous licence").	No further response received to date. Deep sea crab impacts considered in EP (**Section 6.2.3.2**). Refer also to [CONTACT] (Stakeholder No 44)	Meeting Minutes Agreed.	Record 4B
		SARLAC Letter (04/12/16) (Record 4C)	**08/12/16**: Letter advising of replacement of SARLAC Executive Officer from [CONTACT] to [CONTACT].	No issues or concerns		Record 4C

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	PGS Letter (19/12/16)	**19/12/16:** PGS Assessment of the FRDC Publication 2012/008 in response to meeting request. Findings were as follows: **Review of FRDC publication 2012/008: Assessing the Impact of Marine Seismic Surveys on South-east Australian Scallop and Lobster Fisheries (2016)** PGS has assessed the recent FRDC publication relating to the impact of marine seismic surveys on lobster fisheries as it relates to the proposed Duntroon multi-client survey to be undertaken in the eastern Great Australian Bight in water depths between 100 m and 2400 m. The lobster study by Day et al. (2016) involved passing an airgun with a volumetric size of either 45 in^3 or 150 in^3, at a water depth of approximately 5.2 m in total water depths of 10 – 12 m over test species. The sound exposure level (SEL) of the operating sources was estimated at between 200-205 dB re 1μPa^2.s (@ 1m) and the received maximum SELs by test species ranged from 186 – 190 dB re 1μPa^2.s (calculated). Test species were generally observed for 120 days post exposure however one study maintained and assessed test species over 365 days. The study environment was located on a hard limestone reef platform. The selection of the 150 in^3 airgun size, and test conditions, was selected based upon modelling of a commercial seismic source to emulate the passage of a large air-gun array operating in water depths of 30-100m water depths passing within a 200-500 m range of the test animals. The study consolidates the findings of four separate study events: • Winter 2013: 45in^3 airgun operated at standard pressure (2000psi); • Winter 2014: 150 in^3 air gun operated at low pressure (1300 psi); • Winter 2014: 150in^3 airgun operated at standard pressure (2000 psi); and • Summer 2015: 150in^3 air-gun operated at standard pressure (2000 psi). The study observed the following results: • No adult lobster mortality was observed during the study (four experiments);	Information was provided to SARLAC in response to a meeting action item.	NA	Record 4D

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	PGS Letter (19/12/16)	• Sub-lethal effects were observed in adult lobsters as follows: ○ Tail extension reflexes, measuring potential neural impairment, showed no significant difference between control and exposed lobsters for surveys undertaken during winter. For the survey undertaken during summer, the ability of exposed lobsters to maintain tail extension was significantly reduced. Immediately after exposure (day 0), lobsters exposed to air gun signals showed a 32% decrease in tail extension compared to control lobsters that were not exposed. This response persisted to 14 days after exposure, where the exposed lobsters had a 23% decrease in the ability to maintain tail extension. Effects of stress in lobsters are known to be exacerbated in warm summer conditions which may explain why the response was only observed in the summer study event. This disruption, given the observed duration of the response, suggests that more complex reflexes and behaviours, such as escaping from a predator might be impacted although these ecological implications were not studied. ○ Lobster righting times were significantly longer in three of the four study events. Exposed lobsters experienced, in general, more than doubled righting times with the slowed righting persisting for 365 days post exposure and after a moult. Further investigation into exposed lobster statocysts identified significant damage to hair cells, which correlated with impaired righting times. Given the damage persisted for 365 days post-exposure and after a moult, the observed damage may be permanent. For the study event (winter 2014) which did not observe a difference in righting, lobsters were sourced from an area which was subject to higher levels of anthropogenic noise (e.g. sound from recreational and large cargo ships and possibly localised pumping systems). Lobsters in this area are extensively monitored and are thriving, making the ecological implications of statocyst damage, in particular to test species which have pre-existing environmental damage unclear. It also raises the possibility that lobsters are able to adapt to statocyst damage as these (fourth study) lobsters did not display impaired righting reflexes	Information was provided to SARLAC in response to a meeting action item.	NA	Record 4D

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	PGS Letter (19/12/16)	○ Haemolymph assays between control and exposed lobsters showed no significant difference in biochemistry between the two groups showing that lobsters are physiologically resilient to airgun signal exposure. In one survey event (winter 2014), the haemolymph refractive index, measuring the nutritional health of the animal, showed a reduced refractive index at 120- and 365-days post exposure. This was not found in any of the other three survey events ○ Haemocyte counts, a measure of immune response, increased showing a significant response to exposure in all four experiments with the exposure resulting in a reduction in cell numbers. Decreases in haemocytes indicates a response to trauma or stress and typically leaves the lobster vulnerable to infection. The lobsters in this study did not show any visible signs of infection and no mortality was observed, however, they were maintained in laboratory conditions. Further study was recommended to assess whether immunity is altered and if there is any impact to animals in the wild • Studies into the development of lobster embryos following exposure to air-guns early in embryonic development identified that hatched larvae were found to be unaffected in terms of egg development, the number of hatch larvae, larval dry mass and energy content and larval competency (i.e. survival in adverse conditions). In the winter 2013 study event, a slight but significant difference was found in larval length, with exposed larvae 1.5% longer. However, this difference is unlikely to be biologically relevant, as it is well within the range of natural variation in embryo length. These results suggest that exposure during the early embryonic stage did not impair the development and hatching of lobster larvae. <u>Sound Reception in Lobsters</u>: Specific studies examining the effect of seismic survey signals on crustaceans, including larval stages, are relatively rare. However, there is sufficient evidence to indicate that sound plays an important role in the general behaviour of both larval and adult crustaceans (Stanley *et al.*, 2011; Stocker, 2001; Moriyasu *et al.*, 2004; Lovell *et al.*, 2005) including rock lobster species (Buscaino *et al.*, 2011).	Information was provided to SARLAC in response to a meeting action item.	NA	Record 4D

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	PGS Letter (19/12/16)	Crustaceans lack gas filled organs (e.g. swim bladders) required for sound pressure detection but appear sensitive to low frequency acoustic stimuli arising from particle motion (Edmonds et al. 2016). Awareness of sound is believed to be associated with mechanical disturbances of surrounding water/sediment as detected by a pair of statocysts organs located in the antenna and an array of internal and external hair like mechano-receptors (sensilla). No data is available on the frequency-specific hearing/particle motion detection capability of lobsters although some preliminary experiments have shown responses to water vibrations in the frequency range 20–180 Hz. For hermit crabs, this frequency is 5 – 400 Hz and for *Panopeus* crabs between 90 and 200 Hz (Edmonds et al. 2016). <u>PGS Duntroon multi-client survey Assessment</u>: The study by Day et al. (2016) provides important observations into possible sub-lethal effects of seismic airguns for particular study conditions. Observations are considered relevant for surveys undertaken in shallow waters on limestone substrates with observed SEL exposures in excess of 186dB re 1µPa^2·s. It is noted however, that the observed impacts may be attributable to 'near-field' particle movement given the proximity of the airgun to the test species (~6 m). Lobsters are known to be sensitive to surrounding water movement as this is how they detect prey. These near-field impacts cannot be immediately aligned with the Duntroon multi-client survey given the minimum water depths are 100 m, however PGS acknowledges that there may be some observed physiological and behavioural impacts in shallow-water surveys with significant SEL exposures.	Information was provided to SARLAC in response to a meeting action item.	NA	Record 4D
		SARLAC Letter (21/12/16) (Record 4E)	**21/12/16:** Response from SARLAC acknowledging receipt of the review of the FRDC paper. SARLAC still following up on the information requested about rock lobster fishing.	No issues or concerns stated.		Record 4D Record 4E

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	SARLAC Email (13/01/17) (Record 4F) PGS Feedback (17/02/17)	**13/01/17:** Email from SARLAC in response to the FRDC summary identified three issues: • A statement provided in the summary "*Haemolymph assays between control and exposed lobsters showed no significant difference in biochemistry between the two groups showing that lobsters are physiologically resilient to airgun signal exposure*" was challenged. SARLAC identified that the observed results instead suggest that "*the haematological homeostasis (maintenance of electrolyte, metabolite and enzyme balance in the haemolymph –the invertebrate analogue of blood) of J. edwardsii is reasonably resilient to seismic acoustic signals, at least at the levels experienced in this study*". • SARLAC would appreciate forwarding of measurements to verify the claim that ""that the observed impacts may be attributable to 'near-field' particle movement given the proximity of the airgun to the test species (~6 m)" as they are unaware of the existence of such measurements. SARLAC identified that the study used arrays sizes which utilised modelling (by McCauley) which suggested a large commercial seismic source at short range (< 200 m for lobsters) operating in 30-100 m water depth would produce higher sound exposure levels and ground motion than were produced in our experiments. As such there is potential for increased impacts from a full array. An additional note included PGS wording regarding "some observed behavioural impacts in shallow-water surveys with significant SEL exposures". Instead physiological, structural and neurological (reflex) impacts were observed. • Southern Rock Lobster is a single stock across southern Australia. Damage to Southern Rock Lobsters may impact on reproductive capacity likely to impact across the stock which is of concern to the industry. Survey work should not proceed until suitable controls are identified and implemented to address concerns. SARLAC is not aware of any suitable and proven/demonstrated controls.	PGS has reviewed the wording of the summary provided and does not disagree with the modified wording. This wording will be adopted into Section 6.2.3.2 of the EP. • <u>FRDC 2012/008 Impacts of marine seismic surveys on scallops and lobster fisheries</u> PGS has reviewed the FRDC paper with respect to lobsters only as the Duntroon survey is located in depths, and on substrates in a dynamic environment, which do not support scallop fishing. PGS acknowledges that the study is comprehensive, and the summary provided to SARLAC does reflect the content and results in your email related to haemolymph biochemistry and haemocyte count. PGS is very happy to modify wording within the summary contained in the Environment Plan to reflect that "*haematological homeostasis (maintenance of electrolyte, metabolite and enzyme balance in the haemolymph) of Janus edwardsii is reasonably resilient to seismic acoustic signals at least to the levels experienced in the study*" • <u>Near-field Particle Movement:</u> From the FRDC 2012/008 Report, PGS has reviewed the study design and location associated with lobster exposure. Within the 'General Methods' section of the report (pages 5 and 6) it establishes that two study sites were selected with the lobster study at a depth of 10-12 m deep on a limestone platform. Table 1 within that report details that the depth of the gun tow was 5.1m. On this basis the distance between the acoustic source and test subjects were between 4.9 and 6.9 m. There are many studies which reflect on the 'near-field' effects of sound and the response of marine fauna to the particle motion component of the sound rather than the pressure component. Myrberg (2001) provides a good summary of this:-	Information provided in Record 4G	Record 4F Record 4G

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	SARLAC Email (13/01/17) (Record 4F) PGS Feedback (17/02/17)	**(As per item above)**	*As sound passes through water its pressure component is accompanied by oscillations of water particles along the axis of propagation. Pressure being a scalar quantity, provides information on sound intensity, but no information about the direction of propagation. Particle motion has three inter-related vector quantities - displacement (distance the water particle moves), velocity (speed and direct of water movement) and acceleration (rate of change in velocity). Sound pressure and the resulting particle motion are related to each other and also to the distance from the sound source. When the sound is far from a source, the pressure and particle motion both fall off at the same rate (sound is considered a 'plane wave'). As the source is approached, the particle motion increases at a much faster rate than its corresponding pressure since the particle motion is caused by the motion of the source itself (the acoustic 'near-field'). The distance where the ratio of pressure and particle motion remains constant is termed the near-field/far-field boundary. This boundary is frequency dependent, the lower the frequency the larger the near-field. For example, the near-field for a sound of 500 Hz extends about 3 m from the source in water.* For airgun sources where the predominant frequency range is less than 200 Hz, the near-field/far-field boundary where the particle motion component of the sound wave is much larger relative to the sound pressure component, is at a greater distance than this from the source. Test species involved in the lobster study were at distances from the acoustic source considered to be within the 'near-field' of the sound wave and the results obtained reflect the effects of an acoustic source operating in close proximity to the test subjects. For this reason, PGS believes that these study results are relevant to shallow-water seismic surveys, but full extrapolation of the results into deeper waters where marine species lie in the 'far-field' and are not subjected to the larger near-field particle motion components of the sound wave, have not been established.	Information provided in Record 4G	Record 4F Record 4G

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	SARLAC Email (13/01/17) (Record 4F) PGS Feedback (17/02/17) (Record 4G)	**(As per item above)**	While there have not been substantial studies undertaken for effects on lobsters in 'far-field' environments, there have been studies undertaken for scallops in the 'far-field' which produced different results from those reported by Day et al (2016). Przeslawski et al (2016) in a recent study undertaken by Geoscience Australia assessed impacts to scallops from an acoustic array in the Gippsland Basin for a survey operating in water depths of between approximately 40 – 70 m. This study confirmed scallops at received sound levels of 150 dB re 1μPa2.s with particle velocities of 171 dB re 1nm/s at a distance of more than 1 km did not cause mass mortalities two months after exposure. <u>PGS considers that these 'near-field' conditions are not replicated in the Duntroon survey area.</u> • <u>Lobster Larvae:</u> The FRDC report identified that there were no observed acoustic impacts on berried (egg-carrying) females and on the larval development stages which followed. On this basis, once in a berried state impact to lobster stock should not be significant. Lobster larvae may be present in the water column for 12-24 months given their long-lived larval stage. Studies undertaken on plankton and fish egg mortality identified that only eggs within 10 m of an operating acoustic array may be affected which is low compared with the natural mortality of fish eggs. PGS does not consider that the Duntroon survey which operates over a limited range of the area of the fishery (~9%) is expected to significantly impact on the sustainability of the fishery, particularly as only 4% of the catch is taken from water depths greater than 90 m.	Information provided in Record 4G	Record 4F Record 4G

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South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	PGS Email (17/02/17) SARLAC Email Response (15/03/17) PGS Response (19/03/17) SARLAC Response (19/03/17)	**17/02/17:** PGS Advice that the possible timing in 2017 is April 1 rather than March 1. **15/03/17:** SARLAC advises that if surveys are planned to proceed in April it is keen to see a compensation framework for the industry set up in SA that addresses the immediate, medium and long-term impacts of the activity. This has been raised by SARLAC with PGS in previous discussions. SARLAC are aware and have been provided with similar compensation arrangements that were put in place by Origin in Victoria. **19/03/17**: SARLAC identifies the following: • SARLAC agreed that if possible, avoiding displacement and / or economic loss through mutual planning would be best however certainty and surety for the industry would only be provided by proceeding with an appropriate and agreed framework for compensation in place. SARLAC's position is that no party should suffer a detrimental economic impact as a result of these activities and in the medium to long term, if it is demonstrated that seismic survey activity has caused or contributed to any actual impact on rock lobster abundance, recruitment or catchability, fishers will be compensated for any resulting economic loss. • SARLAC will work with the NRLZF to provide catch and effort data if possible. MFAs in which fishing is reported are readily available through PIRSA Fisheries & Aquaculture • SARLAC prefers for this activity not to occur. Anecdotally for many years' fishers have indicated their concerns re negative impacts on species, this is now being backed up by credible independent research. • SARLAC wants to develop, agree and implement an adequate compensation framework *before* this activity commences. Implementing a compensation framework to ensure, in a worst-case scenario, there is no detrimental economic impact to operators as a result of these activities was in no way on contingent on us first exploring 'operational overlaps' • We don't want the activity to occur. Our position is a compensation framework MUST be in place before this activity commences. Origin was able to deliver this in quick time in Victoria with the Rock Lobster industry there.	**19/03/17:** PGS considers the best first step was to actually look at maps showing your activities and where operational overlaps might occur. PGS would appreciate this information from the NZRLF. **23/03/17**: PGS apologies if misunderstood, but the wording "best first step is to look at maps of normal lobster trapping activity and possible operational overlaps" is literally the first step, as if there were no overlaps then anything further becomes redundant. In the same meeting PGS also invited SARLAC to present a proposal, and this is yet to be received either. I assumed this was due to the potential overlap still being looked into.	Documented on email records (Record 4H).	Record 4H

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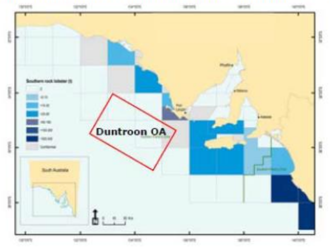
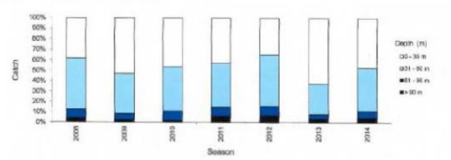
South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	SARLAC Email (24/03/17) PGS Response Email (30/3/17)	**24/03/17:** SARLAC reiterates that implementing a compensation framework to ensure no detrimental economic impact is not contingent on exploring 'operational overlap'. SARLAC presented a precedent in relation to the principles for such compensation was set in Victoria because of the interactions between Origin and the Victorian Rock Lobster Association, that information is attached to this email. Position is (repeated): *Certainty and surety for the [Rock Lobster] industry would only be provided by proceeding with an appropriate and agreed framework for compensation in place. SARLAC's position is that no party should suffer a detrimental economic impact as a result of these activities and in the medium to long term, if it is demonstrated that seismic survey activity has caused or contributed to any actual impact on rock lobster abundance, recruitment or catchability, fishers will be compensated for any resulting economic loss.* *SARLAC does not want the activity to occur. SARLAC's position is a compensation framework MUST be in place before this activity commences. Origin were able to deliver this in quick time in Victoria with the Rock Lobster Industry there.* I am now very nervous about this survey proceeding (in late April) before any agreement has been reached in relation to the issue of development of a compensation framework for our industry. SARLAC is concerned about the misrepresentation of SARLAC's views and position through the consultation being facilitated by PGS.I would like to ensure no ambiguity and has advised NOPSEMA of concerns.	**30/3/17:** PGS appreciates the email and the Origin attachments. PGS understands that the Origin documents would be confidential in nature. There has been no misrepresentation by PGS. PGS has neither received any prior proposal for compensation from SARLAC, nor any data to support the need for any compensation agreement to be developed. Accordingly, there has been no opportunity to review, and subsequently consider, your proposal. In the absence of any additional SARLAC data, PGS has carried out an impact assessment using publicly available data provided by PIRSA, and finds that given the available catch data in the area the survey, any impact is unlikely to result in any significant impact to the catch or sustainability of the fishery, and as such does not intend to put into place a compensation framework as per the Origin model provided. Additionally, information at hand suggests that the limited areas of overlap should allow for reasonable operating protocols being put in place such that any spatial conflict impact is minimal. PGS acknowledges that either industry can affect the other's operations in our respective roles in carrying out operations in the shared marine zone in which we both work. This is a risk and business cost to both parties, and we should work on minimizing that impact by respectively taking reasonable measures through good planning and communications	Information as represented in assessment of merits and claims is provided in email records	Record 4H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	SARLAC Response Email (31/3/17) PGS Response (07/04/17) PGS Update (20/04/17)	**31/03/17:** SARLAC advises it is dealing with NOPSEMA directly. Regarding a proposal for compensation, the Origin compensation agreement was sent for arrangements put in place for Victoria recently. Re supporting data; refer to the results of FRDC Project 2012-008, there is apparent evidence of significant detrimental impacts from seismic testing to Southern Rock Lobster such as: • Significant damage to Southern Rock Lobster health and wellbeing. • Impacts on Southern Rock Lobster balance still being observed 365 days post-seismic exposure - indicating exposure may cause permanent damage to balance mechanisms of Southern Rock Lobsters. • Damage to these sensory receptors could leave Southern Rock Lobsters more vulnerable to predation and may also impact on their ability to successfully reproduce. SARLAC requests a copy of the risk assessment. PGS acknowledge that your activity may affect our industry's operations, and that it may impact the sustainability of the fishery and possibly catches, even if not 'significantly' in your opinion. It is of zero comfort to our industry that *you* have determined that *your* activity is 'unlikely' to result in any 'significant' impact to the catch or sustainability of the fishery. Any impact, no matter the 'significance', is unacceptable to our industry. As per earlier emails to you, PGS proceeding despite there being the risk of impacting our industry, which it seems clear there is, without any safeguards / surety for our industry in place (compensation framework) is not acceptable. Our preference is for the activity not to occur, especially given the scientific evidence which supports it is harmful to Southern Rock Lobster. It is also not surprising that, based on the results of your own impact assessment on your own proposed activity; you have decided not to put in place a compensation framework. You refer to the risk and business costs to both parties from either party affecting the other operations. Our industry should not be put at risk because of your activity; our industry should suffer no impacts because of your activity. If, in the worst-case scenario, our industry is impacted, we should be compensated, and such a process should be established, agreed and put in place before any damaging activity commences. This is not unreasonable, other companies have done it.	PGS does not believe that the significant detrimental impacts described by SARLAC hold merit, particularly given the previous assessment documentation exchanged between SARLAC and PGS on the results of FRDC Project 2012-008. The evidence presented in Day et al (2016) did not identify there was significant detrimental impacts from seismic testing to the southern rock lobster. Day et al (2016) identified: • There was no lobster mortality impact observed during the study (to 365 days); • Statocysts (balance organs) were damaged up to one year later measured through 'righting time' response. While this damage may be permanent (not determined), the impacts of such damage have not been established. It is noted that only three out of four study groups experienced this difference in righting times. The group selected for the fourth exposure were sourced from an area subject to higher noise (i.e. sound from recreational and large cargo ships) with pre-existing damaged statocysts however the population in that location are thriving, near carrying capacity (Kordjazi et al, 2015) and survival rates are around 95% (Gardner and Green, 2009). This makes the ecological implications of statocyst damage unclear, however in the example cited reproduction attribution through statocyst damage cannot be supported. It also raises the possibility that lobsters are able to adapt to statocyst damage. PGS believes the conclusions drawn by SARLAC from the Day et al (2016) study are not accurate. In addition, statements about permanent damage to statocysts may occur from seismic, however it is also apparent that this damage occurs in other high non-seismic sound source areas. Detrimental impacts from such statocyst damage have not demonstrated, and evidence exists, that this damage may not have detrimental impacts to the lobster populations. Based upon available evidence, the statement of significant detrimental impact to southern rock lobster does not hold merit. As an additional point, the Day et al (2016) study was undertaken in shallow water where particle motion conditions are high. The Day et al (2016) study conditions are not representative of the Duntroon survey area (i.e. depths > 100m) and study conditions possibly represent a 'worst-case' study design.	Information as represented in assessment of merits and claims is provided in email records	Record 4H

Stakeholder	Relevance to Activity (& ‘interests’)	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator’s response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Rock Lobster Advisory Council (SARLAC) (Con’t)	South Australian Lobster Fishery Industry Association	SARLAC Response Email (31/3/17) PGS Response (07/04/17) PGS Update (20/04/17)	All the good planning and intended communication cannot guarantee against our industry being impacted if this activity goes ahead, we insist on the compensation framework being in place.	The significance of survey activity on southern rock lobster catch and sustainability is provided below. Review of the NZRLF identifies the Duntroon survey area is in an area which does not contribute significantly to commercial catches of rock lobster. As shown in **Figure 1**, catch is classified as confidential (i.e. areas where catch relates to less than five licences) or not present at all. Based on fishing status reports, while encounter with lobster fishermen is possible the intensity of fishing is low. Figure 1: Distribution of Commercial Catch of Southern Rock Lobster 2012-2013 (PIRSA, 2015)  Review of the Northern Zone Rock Lobster Fishery Status Report (2015/16), identified that the Duntroon survey area overlaps the outer subzone of the SA Rock Lobster Fishery. The total allowable catch for the fishery for 2015/16 was 360 tonnes, with the outer zone contribution 60 tonnes (Linnane et al. 2016). **Figure 2** provides the spatial trend in rock lobster catch by depth for 2014/15. Only 4 % of the catch is taken from water depths greater than 90 m (i.e. 14.4 tonnes per annum) (Linnane et al. 2015). Figure 2: Catch by Water Depth (2014/15)  Survey activities are not expected to threaten the sustainability of the SA lobster fishery based upon the recent sub-lethal impacts to lobsters observed by Day et al. (2016). An assessment of the proportion of the lobster fishery which may be exposed to survey activities has been estimated at ~ 1.3 tonne (or 0.4%) of the annual catch.	Information as represented in assessment of merits and claims is provided in email records	Record 4H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	SARLAC Response Email (31/3/17) PGS Response (07/04/17) PGS Update (20/04/17)	**Continued.**	This is based upon the TACC for the fishery (360 tonnes), the proportion of catch taken from water depths greater than 90 m (4%) and the possible proportion of the fishery which is coincident with the Duntroon survey (~9%)*. Given this TACC is routinely not met (i.e. 2015 – 342 t) (Linnane et al, 2015), the stock affected by seismic (if overlap occurs) would not be expected to impact on the sustainability of the fishery. Additionally, the fishery is classified as "sustainable" by the Commonwealth Government with the 2015/16 fishery biomass estimated at 2,073 tonnes and a total fishery exploitation rate of 16 % (i.e. 360 tonnes per annum) (Linnane et al. 2016). PGS considers that the SARLAC statement associated with 'any impact, no matter the significance, is unacceptable to or industry' ignores natural mortality rates within species and impacts from other sound sources to the species and believes it does not hold merit. ** Note further information supplied to PGS from SARDI identifies there is <u>no spatial overlap</u> between survey activities and southern rock lobster fishing grounds. Impact to the sustainability of southern rock lobsters from survey activity within the fishery is therefore not expected.* <u>Other:</u> Further to the above, PGS does agree that minimizing costs to parties affected by overlapping interests should be managed as best as possible and strongly believes that this is best achieved by a cooperative approach. PGS routinely faces significant additional costs to its seismic operations due to these overlapping interests as it strives to reduce impacts to other marine users as much as is reasonably possible while helping the oil industry satisfy their work obligations to the Commonwealth government. For example, from an 8-month weather window in this project area, results of discussions with fisheries and other stakeholders has led to a maximum 3-month work window this season. Tight operating windows come at a significant cost to our industry as fleet management becomes complex and inefficient. Certain commitments were also made with respect to where in the survey operations PGS would commence in order to further reduce impacts. This can only be achieved through open dialogue as provided by other fisheries.	Information as represented in assessment of merits and claims is provided in email records	Record 4H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	PGS Email (28/04/17)	**28/04/17:** PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No claims or objections raised.	NA	Record 4H

		PGS Letter (28/08/17)
		
		SARLAC Email (29/08/17) (confirming receipt)
		
		PGS Email (31/08/17)
		
		PGS Email (05/10/17) (requesting feedback)
			28/08/17: Information provided included an update to the Duntroon survey, summary on plankton, details on spatial overlap of the NZRLF and the Duntroon Survey area and compensation issue. Additional PGS information was to look at areas of cooperation with the items suggested below (resulting from other discussions with fishing groups). The 2015 Ceduna MC3D was used as an example in the Bight where PGS shared data with CSIRO under the IMOS project lead with the development of a potential pilot study (provided in attachment).
			PGS is happy to provide the following additional commitments should the project proceed under this EP:
			• PGS will commit to the CSIRO project as outlined in the attachment and share the results with SARLAC
			  ○ We believe there could be mutual benefits in the long run in acquiring opportunistic data during seismic surveys on a routine basis and the attached pilot study is seen as a first step in looking at what could be achieved in the future
			• PGS is also happy to provide bathymetric data from any of its 3D seismic surveys with such contouring derived from its seismic data analysis
			  ○ Currently this data can be provided in Maxseas or Olex formats
			  ○ We can also provide raw sounder data from our EA 600 sounders subject to such sounder (or equivalent) being standard equipment on board the selected vessel
			• PGS can provide daily water temperatures during operations should this be of use in any of your modelling
			• PGS is also looking at opportunistically sampling plankton in response to the recent research referenced in our attached letter, if this can be achieved efficiently with the proposed resources:
			  ○ Currently we are awaiting CSIRO's recommendations as to whether this can be reasonably;
			  ○ If it is viable and cost effective, PGS will proceed with this initiative and share findings.
			PGS remain happy to discuss other opportunistic areas of cooperation at any time should you think of areas that we can assist.
			05/10/17: Follow-up email to advise of pending EP submission and a link to previous Bight EP for completeness.
			
			No response has been provided by SARLAC to date.
				No feedback provided to date on letter or follow-up email.	NA	Record 4I

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Rock Lobster Advisory Council (SARLAC) (Con't)	South Australian Lobster Fishery Industry Association	SARLAC Email (19/09/17)	**19/09/17:** Email to advise of a change in address for SARLAC.	Item noted. No action	NA	Record 4J
		PGS Update Letter (19/1/18) SARLAC Response (22/01/18)	**19/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **22/01/18:** Thanks for the notification. I will be in touch	No issues or concerns raised	NA	Record 4K
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 4L
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 4M
Wildcatch SA	Industry body coordinating issues across multiple fishery sectors	PGS Letter (11/11/16) PGS Resend (30/12/16)	No response provided.	No issues or concerns raised	NA	Record 5 Record 5A
		PGS Email and Letter (08/09/17) Read Receipt (10/09/17)	**08/09/17:** PGS provided information update on the Duntroon survey.	No claims or objections raised	NA	Record 5B
		PGS Update Letter (19/7/18)	**19/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback provided to date	NA	Record 5C
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 5D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	PGS Letter (11/11/16) PGS/ASTBIA Meeting Arrangements Email (17/11/16) PGS/ASBTIA/GABIA/ SASIA Meeting (25/11/16) (Record 6A)	**25/11/16:** PGS provided presentation on the proposed project outline for the Duntroon survey. Intention is to follow commitments in the Bight Petroleum EP which expired in the most recent season. Sarin Marine Farms (SBT) was interested in the bathymetry derived from the 3D. *PGS to advise if bathymetry under the BP 2012 survey area was available.* Stehr Group (SBT) keen to review the sea state used to support the PGS preference not to work from June to September. This would be the best time from ASBTIA's perspective. ASTBIA identified that due to the cooler water temperatures, the tuna season is likely to start later in 2017 and run longer. *ASTBIA will request a start date late March/early April.* The Karoon area also poses a larger concern for the CSIRO SBT stock assessment surveys given the bigger overlap with the CSIRO aerial transects. ASTBIA request that PGS arrange moored sensors a month ahead of survey to measure ambient levels, and then to keep them there for sound source verification (SSV) during survey • If overlap is not avoidable with SBT operations, KR will request that we keep received levels at tuna aggregation sites and across tow paths to within ambient for those locations (ambient including signals from current transient shipping) • TV noted the likely request but stated that it was extreme given any vessels operating near the tuna would result in sound above ambient; TV suggested a buffer should be based on levels below those likely to cause a startle response • Further discussion needed on establishing buffer, but all agreed it would be ideal if timing could be such that there was no operational overlap. ASBTIA will request that PGS provide baseline benthic studies; suggested CSIRO or SARDI for pre-survey then repeat survey(s) post seismic survey. There were additional general discussions, but concerns/issues not captured in these minutes will be provided in written responses respectively from ASBTIA, SASIA and GABIA.	Minutes of Meeting accepted between parties. **19/12/16:** PGS has provided weather and sea state data and seismic efficiency to Stehr group which identified that efficiency of operations fell dramatically in months June to October (Record 6B). **19/12/16:** PGS advised that bathymetry within BP's acreage could be provided in a month or so and can be supplied in MaxSea format or Olex format. PGS requested clarification on the format desired.	Meeting Minutes accepted (Record 6A) **19/12/16**: Weather and sea-state Conditions provided by PGS (Record 6B) **19/12/16:** Feedback on provision of bathymetric data by PGS (Record 6C).	Record 6 Record 6A Record 6AA Record 6B Record 6C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response Email/Letter (Record 6D)	**19/12/16:** ASTBIA advises that: • It cannot accept any alteration to start a seismic survey in EPP-41/EPP-42 at an earlier point in time to the position agreed with Bight Petroleum in 2012. This agreement was to start the survey after 1st March if fishing or towing operations were completed OR after tuna towing operations were completed if this occurred at a later point in time. In 2012 ASTBIA fully anticipated that tuna companies could find a reasonable compromise and commence their fishing operations earlier so all tuna were captured, and towing completed before the seismic survey began. However, based on the 2016-17 fishing season, the unusually cool ocean conditions preclude an earlier start to fishing operations. The later start will mean that fishing and towing operations are likely to continue into March 2017. • Regarding the EPP-46 area, previous discussions with another seismic provider proposing to operate in this location clearly showed there was no need to start operations earlier than 31st March. ASTBIA expect PGS to adopt a similar operational program to genuinely adhere to ALARP principles. • Due to the increasing uncertainty about ecological and behavioral impacts of these large scale 3 D surveys in deep waters of the GAB, ASTBIA requests that noise loggers be deployed at least 4 weeks prior to the commencement of any survey and that a baseline benthic ecological survey be undertaken before and repeated after seismic operations.	**Item 1:** PGS believes that ASBTIA may be mistaken about its request that Bight Petroleum delay its survey commencement to "AFTER tuna towing operations were completed if this occurred at an earlier or later point in time." Publicly available documents suggest that ASBTIA was supportive of operations commencing March 1 as follows: • *Commence on March 1 on deep water race track (well away from pontoon towing area)* • *In the event pontoon towing and tuna ranching are still proceeding when Bight complete the deep-water racetrack (unlikely), additional mitigation measures will include:* • *Close on-water communication and cooperation will be implemented between the seismic and fishing operations* • *Towed pontoons will have the right of way over the seismic vessel* • *The source will not be activated and will be shut down if a towed pontoon comes within 3kms of the source* PGS has self-imposed a larger shutdown zone and as such believe our approach to be fair and reasonable. **Item 2:** Given the uncertainty as to whether the 2018 CSIRO survey will proceed, PGS proposes a Jan 1 earliest start date subject to the CSIRO survey not proceeding in 2018, or a March 1 earliest start should that survey proceed. PGS cannot comment on why another operator was happy to have such a tight window in that particular season with an unknown scope of work. PGS believes that a minimum 3-month window from a potential operating window of 8 months is not unreasonable, noting the mitigations that will be in place. PGS has assessed potential impacts to SBT based on available scientific literature and considers with spatial buffers adopted between the two activities, behavioral impacts to SBT should only be experienced within kilometers of the operational array. On this basis, PGS believes the two activities can be undertaken at the same time and a suitable outcome determined (*this response has been provided as part of Record 6J to ASBTIA*).	Response provided in Record 6E	Record 6D Record 6E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response Email/Letter (Record 6D)	**19/12/16:** Response Continued	**Item 3:** **Benthic studies -** PGS is supportive in principle of the need for more research but would like more details of what the nature and purpose of this survey might be please. Without further details, PGS suggests that it might be more suitable to refer this to the GAB Operator's group next meeting for feedback rather than consider it within the scope of this EP. **Monitoring of Noise (before & During Survey):** • PGS considers that the noise modelling performed by JASCO Applied Sciences is sufficiently accurate to inform the environmental assessment. Nevertheless, PGS can perform in field sound source verification through its streamer data. This would be processed by a third party and results can be provided to ASBTIA for future reference. This follows a system used recently for the NZ regulator (who probably has the strictest code of conduct in the industry for potential marine mammal impacts). This only picks up received levels in the particular azimuth behind the vessel, so won't represent all areas, but is still a very useful validation measure • Given the highly variable relative locations of towed pontoons with respect to the survey vessel, it is hard to see what benefit could be derived from post processed data from moored hydrophones during this survey. **Offset:** PGS agrees that an offset from towed pontoons should be observed. It is noted in previous public documents that ASBTIA agreed with Bight that a 3 km separation would be maintained by the seismic contractor. i.e., the seismic vessel would give way to towed caught tuna and maintain a buffer of 3 kms. Previously, PGS committed to a 10km buffer during its Ceduna MC3D project. PGS considers that 10 km is a conservative but appropriate buffer based upon McCauley et al. (2000)* where changes in schooling behavior were observed at a SPL of 161-166 dB re 1µPa.	Response provided in Record 6E	Record 6D Record 6E
		PGS Email (24/01/17)	**24/01/17:** Email to ASBTIA advising that the 2017 survey has been pushed to April 1 – May 31, 2017.	No Response to date	NA	Record 6E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	PGS Email and Letter (10/02/17)	**10/02/17:** Thank you for notifying that PGS is able to address our concerns over the timing of marine seismic survey work within the EPP41, EPP42 and EPP46 permit area. This location is the major feeding grounds for younger Southern Bluefin Tuna (SBT) on their annual feeding and global migration route; it is also a critically important area for the independent stock assessment that sets the international catch limits for the species; and is an important catching and towing area for the Australian fishery. With a start date on or after the 1st April 2017 potential conflict with all of these aspects is reduced. We welcome your company's efforts to genuinely reduce impacts on other stakeholders to what could truly be deemed As Low as Reasonably Practical.	No issues or concerns raised.	NA	Record 6EA
		PGS Email (17/02/17)	**17/02/17:** Email to ASTBIA advising them on project status and providing update on the bathymetry data provision on the combined BP and Ceduna MC3D surveys.	NA	NA	Record 6E
		PGS Email (28/02/17) ASTBIA Email (02/03/17) PGS Email (02/03/17) ASBTIA Email (02/03/17) PGS Email (08/03/17) PGS Email (20/04/17)	**28/02/17:** PGS advises that the EP was submitted to NOPSEMA. **02/03/17**: ASBTIA identifies that the timeframe for Season 2 commencing on January 1 is not acceptable and the 2018 survey needs to be discussed further.	**02/03/17:** PGS advises that the summary states the maximum range of dates, but the EP states that the earliest start date in 2018 would be Jan 1 should the CSIRO stock assessment aerial surveys not proceed next season, or March 1 should the surveys proceed, as per correspondence. PGS is happy for ASBTIA to have a copy of the EP and discuss further.	As per email correspondence. EP was provided to ASBTIA as requested.	Record 6E
		PGS Email (20/04/17)	**20/04/17:** PGS advises that the EP requires further work and there are now no plans to acquire in the 2017 year. The EP will be revised to cover the 2018 season. PGS will keep ASBTIA updated. *No response provided.*	Not Applicable	NA	Record 6E
		PGS/ASBTIA Telephone Record (03/07/17) ASBTIA Email (04/07/17)	**03/07/17:** PGS/ASBTIA discussion raises the following issues: • Understood that it is yet to be decided as to whether the CSIRO stock assessment aerial survey will go ahead in 2018, and that it could be that we have to wait until the October meetings to find out. We'll keep an eye on the CCS website as suggested. https://www.ccsbt.org/ • Understood that ASBTIA still has a very strong preference for seismic surveys to not commence in the Oct to Dec period due to concerns about possible impacts on migration of SBT into the area. In this respect I can confirm that PGS has no plan to acquire seismic data in the GAB this calendar year • ASBTIA will send a letter shortly regarding the recently released paper on impacts of seismic on plankton.	No issues or concerns raised in the meeting.	NA	Record 6F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Email & Correspondence on Plankton (04/07/17)	**4/07/17:** ASTBIA raised the following issues: Of relevance to this EP is that after the multiple large-scale 3D marine seismic surveys through the western and central GAB area in 2012, 2014, 2015; the eastern area of the GAB has become increasingly important for the juvenile\ (2 to 5 years old) SBT stocks that return to this globally significant forage area seasonally every year. This includes the area that is Currently proposed in this survey. As such our concerns for this proposed work remain primarily around the timing of the survey operations. Though please note that recently published research1 raises additional concerns about seismic survey activities in this area. Locally caught sardines are the source of 80% of the Ranched SBT food supply, more than 50% of the diet of sardines in South Australia is crustaceans and krill are a significant component of these. ***We request:*** 1. That Sound Exposure Level modelling is provided with a source located in a north western, a south eastern and a central position of the acquisition area (optionally a south western location also). 2. That sound source verification (SSV) is Undertaken with noise loggers that are deployed at least 4---weeks prior to the commencement of any survey. Note that IMOS currently station an acoustic logger near the south eastern corner of the proposed area this would be an acceptable location for SSV across the survey area. 3. No seismic survey activities are undertaken prior to the 31st March in any season. 4. The air guns utilized in this area are the minimum power required for effective acquisition.	PGS has assessed the impacts associated with survey operations during the survey period. The selection of timeframe has been made on competing environmental sensitivities which are present at different time of the year, observing however, that to complete the given scope of surveys a period of 150 days is required. Assessment of impacts has used internationally recognised thresholds and PGS has positioned timeframes for surveys to limit the potential for disturbance. For example, the MC2D survey is predominantly deep-water and can be undertaken within the January-May timeframe without substantially encroaching on shelf activities. PGS has supplied this rationale to ASTBIA, recognising commitments made about CSIRO surveys and additional modelling information so an informed discussion around survey timeframes can proceed. Additional information provided to ASBTIA includes: • An assessment of acoustic impacts to plankton and associated sardine egg stock. The Duntroon survey does not overlap areas of high sardine egg density. Additionally, the assessment of acoustic sound to plankton and eggs identifies that the impacts are expected to be below natural mortality rates in the marine environment. • Sound exposure modelling is provided at the requested locations. These results identify that there is very little ingress of sound onto shelf-environments from dee-water acquisition; • ASTBIA has requested that noise loggers are used to verify sound. PGS considers that the modelling characteristics of the proposed survey area are sufficiently understood, and data loggers will not add significant benefit in actively controlling impacts; • The airgun selected is the lowest volume array required to deliver the required data (3260 in^3 lower than previously utilised volumes of 4130 in^3). To fulfil the survey scope, 150 days is required. PGS cannot commit to no survey activity before 31st March 2018.	Response to concern and additional information request provided in PGS Letter correspondence (28/08/17)	Record 6G

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person

Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	PGS/ASBTIA Meeting (28/08/17) to discuss content within PGS Letter and CSIRO Proposal (28/08/17)	**28/08/17:** Meeting to discuss updated information on Duntroon survey. Outcomes included (Letter and CSIRO proposal provided):
			Meeting was a very useful discussion, and PGS understands that our main difference rests with timing and ASBTIA's preference that we do not start work until late March 2018. This appears to be a point that we may not reach easy agreement on, and PGS hopes that our proposed sequencing of the respective project elements would allow ASBTIA to be more flexible on this item.
			PGS is happy to provide the following additional commitments should the project proceed under this EP:
			• PGS will commit to the CSIRO project as outlined in the attachment and share the results with ASBTIA
			  ○ We believe there could be mutual benefits in the long run in acquiring opportunistic data during seismic surveys on a routine basis and the attached pilot study is seen as a first step in looking at what could be achieved in the future
			• PGS is also happy to provide bathymetric data from any of its 3D seismic surveys with such contouring derived from its seismic data analysis
			  ○ Currently this data can be provided in Maxseas or Olex formats
			  ○ We can also provide raw sounder data from our EA 600 sounders subject to such sounder (or equivalent) being standard equipment on board the selected vessel
			  ○ We are also happy to provide bathy data from our earlier surveys in the Bight if this is of use
			• PGS can provide daily water temperatures during operations should this be of use in any of your modelling
			• Contrary to the attachment and as discussed today, PGS can now provide sound monitoring on the following basis:
			  ○ PGS will rent and ship the monitoring unit to and from Port Lincoln, and make it available for at least 30 days during the active survey period
			  ○ PGS will arrange for 3rd party analysis of the recorded data
			  ○ ASBTIA members to deploy and retrieve the unit on a moored buoy in accordance with the deployment instructions provided by our equipment provider.
				No additional issues raised from meeting.	NA	Record 6H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	PGS/ASBTIA Meeting (28/08/17) to discuss content within PGS Letter and CSIRO Proposal (28/08/17) (Con't)	• As discussed, PGS is also looking at opportunistically sampling plankton in response to the recent research referenced in our attached letter, if this can be achieved efficiently with the proposed resources: ○ Currently we are awaiting CSIRO's recommendations as to whether this can be reasonably achieved ○ If it is viable and cost effective, PGS will proceed with this initiative and share findings We remain happy to discuss other opportunistic areas of cooperation at any time should you think of areas that we can assist. Also, regarding our discussions on ASBTIA's previous position with respect to Bight Petroleum's timing, and offsets to towed pontoons, you thought today that ASBTIA had agreed a late March start unless towing operations had completed, but publicly available documents state the following agreement with Bight was in place: • *Commence on March 1 on deep water race track (well away from pontoon towing area)* • *In the event pontoon towing and tuna ranching are still proceeding when Bight complete the deep-water racetrack (unlikely), additional mitigation measures will include:* ○ *Close on-water communication and cooperation will be implemented between the seismic and fishing operations* ○ *Towed pontoons will have the right of way over the seismic vessel* ○ *The source will not be activated and will be shut down if a towed pontoon comes within 3kms of the source* PGS is making the same commitments in respect of the 3D surveys and has increased the separation distance from 3kms to 10kms.	No additional issues raised from meeting	NA	Record 6H
		PGS Email (05/10/17) ASBTIA Email (06/10/17) PGS Response Email (06/10/17)	**05/10/17:** Further email to ASBTIA providing link to previous Bight Petroleum Lightning EP and requesting feedback as Duntroon EP is to be shortly submitted to NOPSEMA. It is recognized the link is not really relevant as ASBTIA as they had a copy of the Duntroon EP which superseded the Bight Lightning EP. **06/10/17:** ASBTIA response identifying a response is forthcoming. However, the position held by ASBTIA is that seismic operation prior to March 31 is not acceptable or ALARP.	PGS considers that the measures in place to prevent disruption to SBT operations will prevent disturbance to capture stock in pontoons on the shelf. PGS notes ASBTIA's position and remains in disagreement on this point. Further assessment will be made of any further information.	<u>PGS Response</u>: Noted on ASBTIA's position and that we unfortunately remain in disagreement on this point. We will of course continue to assess any further info you provide should it be received after submission and understand you may be delayed.	Record 6I

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Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Letter (07/10/17) PGS Response (18/10/17)	**07/10/17:** ASTBIA provided a response to the PGS letter dated 28/08/17 with the following key concerns: 1. We firstly would like to make note of the Permit holders' expressed preference to split the seismic surveys into multiple phases (Karoon consultation May, and August 2017). The first season would involve a 2D survey of the permit site, which is entirely able to be completed with a start date after 31st March. Followed by a complete analysis of the data to enable a focussed and condensed 3D survey starting after the 31st March the following year. Also, that the Bight Petroleum EP has lapsed and the conditions appearing there-in are outdated and therefore no-longer relevant (not that there was any agreement of 10km being an acceptable stand-off, what was discussed through the consultation was that with the lower quota at that time, 2012, fishing operations could be completed before the commencement of the seismic acquisition).	Unfortunately to meet the work program commitments of PGS clients, acquisition is required over one season. This is also more operationally efficient. The Duntroon survey is now planned for the period 1 March to 31 May considering ASBTIA's concerns and in line with reasonable efforts of goodwill between the industries. Operations will commence in deeper water areas of the MC3D survey area or in the MC2D survey area. The MC2D survey is a low-density survey with minimal overlap with the continental shelf. It is also located west of the main Kangaroo Island upwelling system. This helps protect continental shelf areas which may experience episodic upwellings during March. The Duntroon Survey Acoustic modelling report identifies that the deeper water areas show that small sound encroachment onto the shelf environment from deep-water acquisition. PGS understand that the Bight Petroleum Lightning EP has lapsed. This, however, does not detract from the controls which were developed to prevent overlap with, and interference between, the two activities (SBT stock ranching and seismic operations). PGS considers that the two activities are compatible with spatial buffers applied to prevent disturbance to fish stock.	Information as provided in the Assessment of Merits and Claims has been provided to ASBTIA.	Record 6J
			2. What we now know from research currently being done by Japan (tagging and monitoring SBT movements in the GAB and Southern Indian Ocean), is that through 2012 to 2017 SBT choose to avoid operating seismic vessels by distances exceeding 100's of kilometres. Any seismic vessel operating closer than this to a pontoon of tuna under tow poses an UNACCEPTABLE RISK to the Australian Tuna Ranching Industry. The Japanese studies are building on 2 decades of research previously undertaken by CSIRO Australia. CSIRO's research demonstrated the Great Australian Bight is the most important feeding ground for the entire global population of Southern Bluefin Tuna for at least the first 5-years of the fishes' life; and that the foraging residency period is seasonal (migrations into the region occur from late October with SBT remaining in the area until April).	PGS has adopted all available literature within the updated Duntroon EP to assess impacts to commercial fishing operations during the survey period. Literature has identified that the risk of behavioural disturbance to fish is high close to the vessel (tens of metres) and low at greater distances (thousands of meters) based upon the work of Popper et al., (2014). On this basis, a spatial buffer of 10 km between operations is expected to prevent any behavioural disturbances to SBT located in pontoons. Note this is in addition to undertaking acquisition activities in deeper water where sound impacts onto the continental shelf are very low. The ASBTIA 'avoidance' information presented here appears inconsistent with observations recorded from survey vessels in the Great Australian Bight (GAB) during acquisition activities in the past few years. These observations identified foraging SBT adjacent to the vessel (photos can be provided). PGS will request Japanese report reference (or copy) which observed SBT avoidance 100s km from the operating array to inform the Duntroon EP.		

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Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Letter (07/10/17)	**3.** It is entirely possible for PGS to avoid this risk given that a large proportion of the PGS fleet is currently tied up with no work. There is no reason why the timing of these surveys in the GAB cannot abide by the "ALARP and ACCEPTABLE" principles as stipulated by the regulator, NOPSEMA.	PGS advises that vessels which are tied up in Norway does not influence timing assessments	Information as provided in the Assessment of Merits and Claims has been provided to ASBTIA.	Record 6J
			4. Our concerns regarding the Duntroon Survey remain primarily around the timing of the seismic operations. We view what is being proposed as a direct threat to the Australian SBT Fishery Ranching Operations. But we also have wider concerns that seismic surveys undertaken through the upwelling period in the upwelling zone and Kangaroo Island Pool region could be a threat to the ecosystem that supports the global population of juvenile SBT. The Southern Bluefin Tuna is a globally managed population of fish. The Great Australian Bight is a critically important area seasonally for this species for at least the first 5 years of its life	As above, PGS has looked at the potential for impact to SBT ranching operations for the month of March when the two activities may coincide in the area in the Duntroon EP. The Duntroon survey has adopted controls within that month to spatially limit shelf environments where there *is a potential* for upwelling conditions to occur. PGS considers with the deep-water or MC2D area acquisition during that period, spatial overlap and impact to upwellings is reduced. Additionally, with the additional controls proposed for preventing impacts to SBT ranching (10 km buffer) PGS believes SBT ranching will be largely unaffected (and possibly more affected by commercial shipping sound in the shelf area). On this basis, PGS understand that it meets the legislative conditions of the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Section 460 – Interference with Other Rights) which requires that PGS undertake the survey in a manner that does not interfere with fishing to a greater extent than is necessary for the reasonable exercise of its rights under the petroleum authority to acquire the seismic data.		
			5. The "Kangaroo Island Pool" has been omitted from the assessment of environmental and socio-economic sensitivities; this is fundamental to the productivity of the entire eastern GAB. And is directly covered by the proposed survey and the modelled sound transmission. Also note that upwelling in the region occurs through November and ceases by April/May	As identified by previous comments, PGS has not omitted the Kangaroo Island Pool from the assessment of environmental and socio-economic sensitivities in the Duntroon survey area. In fact, the upwelling system underpins the list of environmental and socio-economic identified in the updated information sent in September 2017. Factors listed in that information were targeted in relevance to stakeholders and not a comprehensive list of all factors considered. PGS appreciates feedback that the upwelling system has ceased by April/May.		

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Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Letter (07/10/17)	**6.** Airgun selection – PGS may well have selected and modelled a lower airgun array volume, 3,260cui compared to the 4,130cui previously used in the western GAB, however if utilising 2 or 3 of these arrays (as stated p3) this elevates the capacity to well in-excess of what was utilised by PGS in 2012 and 2015. How the size of this array relates to the ecological impact recorded from a 150cui gun was not covered by the review provided as Attachment A.	Seismic surveys always use alternating arrays to acquire data. As there are two or three arrays operating on an alternating sequence, the effect is not cumulative. The sound attributes produced by each array are the same and dictated by the operational pressure, volume and design of the array. Source volumes do not correspond linearly with source output levels but instead follow a cubic-root relationship. A reduction in source volume has only a minor influence on source level. For example, an 8,000 in^3 array produces about twice the loudness of a 1,000 in^3 array when all other parameters held constant (i.e. number of elements and spatial dimensions of the array). The source array utilised in the McCauley et al (2017) field study utilised the 150 in^3 array in shallow water to simulate sound exposures expected during deeper water acquisition. This study was primarily focussed around impacts to scallops and lobsters with a very limited (2 day) study of impacts to plankton. CSIRO has identified some issues with the study design and the observed study outcomes and strongly recommends additional (repeatable) research is undertaken. This is now being performed by the Australian Institute of Marine Science (AIMS) on the North-west Shelf. McCauley et al. (2017) utilised the temperate waters of Tasmania in their study. The CSIRO review was based on McCauley et al. (2017) work and extrapolated impacts from the 150in^3 airgun to an array of ~3,000 in^3 like the array proposed by PGS.	Information as provided in the Assessment of Merits and Claims has been provided to ASBTIA.	Record 6J

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Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Letter (07/10/17)	**7.** The modelled and simulated findings in the review of the North-West Shelf have very little to no relevance for the Great Australian Bight. This work needs repeated for a temperate and upwelling-driven ecosystem preferably with some real field data collected to verify the modelled and simulated findings. And none of the information written relates to species and conditions of the GAB	PGS through its survey design will limit spatially and temporally overlap with continental shelf areas which may experience upwelling conditions. While CSIRO warns against directly applying the results of the study *quantitatively* to other regions with different oceanographic conditions, there are many insights in the paper which inform survey design and limit impacts to plankton. Factors relevant to the Duntroon survey include: surveys conducted in regions with more dynamic ocean circulation are likely to have less net impact on zooplankton (applies to Duntroon); surveys conducted in regions off the shelf edge are likely to have lower less absolute impacts on zooplankton (75% of Duntroon survey is in deep water); and undertaking surveys in seasons with lower zooplankton biomass will reduce impacts (Duntroon avoids spatial overlap areas which may experience upwelling conditions) (Richardson et al. 2017). These insights have informed the Duntroon survey design to minimise seismic impacts on plankton. Recognising the quantitative limitations with the NWS results, the study identifies plankton impacts are localised within, or near, the survey area. It also shows that the plankton recovery time is rapid. While the oceanography in the Duntroon survey area differs from the NWS (i.e. GAB ocean conditions are more dynamic and sea temperature is cooler) which may serve to decrease the level of plankton biomass removal but increase recovery times, undertaking additional modelling for GAB conditions is not expected to alter the general findings of the screening study. PGS does not see merit in undertaking a similar study for the GAB currently. PGS does see merit in confirming the plankton findings of McCauley et al (2017) which is being undertaken by the AIMS.	Information as provided in the Assessment of Merits and Claims has been provided to ASBTIA.	Record 6J

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Australian Southern Bluefin Tuna Industry Association (ASBTIA) (Con't)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Letter (07/10/17)	**8.** Please provide the full report for the Sound Exposure Level Modelling, including the justification why this cuts off at 120dB when published scientific literature and open access data recorded from the GAB area indicate ambient sound levels on the shelf are much lower/quieter than this.	The Duntroon Survey Acoustic Modelling Report will be sent to ASBTIA. Sound Threshold Selection: The selection of sound thresholds selected was arbitrary. The SPL plots also have a lower threshold of 120 dB re 1µPa. Ambient Sound: Based upon work undertaken by BP (McCauley et al, 2012) in the GAB to understand underwater sound characteristics of the area, sound loggers were deployed near the Head of Bight (HOB) in a water depth of 50 m and two along the shelf break at water depths of approximately 200 m for approximately six months. The measurements were assessed over the bandwidth of 3 to 3180 Hz. Ambient sound was higher at the shelf break sites compared with the HOB site with background sound levels increasing over summer into early winter. The results, in SPL, were: • HOB: 73.5 to 131.9 dB re 1µPa (median of 97.1 dB re 1µPa); and • Shelf break: 74.9 to 144.9 dB re 1µPa (median of 111.7 dB re 1µPa).	Information as provided in the Assessment of Merits and Claims has been provided to ASBTIA.	Record 6J
			9. And a question regarding the comment on page 5 "that the IMOS station is not suitable as a noise logger as it only measures to a maximum of 165dB" – are PGS anticipating that their vessels will produce sound levels exceeding this at that distance.	This noise logger was discounted on the basis that it logs once every 5 – 15 minutes. Please confirm that this would be adequate for your purposes.		
		PGS Email (03/11/17) ASBTIA Email (6/12/17) PGS Email (6/12/17)	03/11/17: Provision of a Dropbox link for the Duntroon EP 6/12/17: ASBTIA requests password 6/12/17: PGS resends password	No issues raised		Record 6K Record 6L
		PGS Email (18/12/17)	18/12/17: Request to ASBTIA to provide the following information: • Please update us on plans for this season's surveys, along with likely future surveys. • Also, would you be able to send us historical tuna catch tow plots including any recent data?	No response to date		Record 6M

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	PGS Update Letter (19/1/18) ASBTIA Response (19/2/18) PGS Response (21/02/18) ASTBIA Response (23/01/18) PGS Response (27/01/18)	**19/01/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. 23/01/18: ASBTIA Response Thank you for reconsidering the dates, this is an improved scenario and we will formally respond by early next week. Fishing commercially has been a little slow for us so far, it is looking like a later migration of ranch-sized fish this season. However, the recreational fishers are very happy with the abundance of small tuna in the shallow coastal waters at the moment. ASBTIA added that they cannot accept anything occurring prior to April 1. 28/02/18: PGS advise of some personnel changes and a pending response to the ASBTIA letter provided.	Refer to Correspondence below		Record 6N Record 6O
		ASTBIA Response (19/02/18) PGS Acknowledgement (21/02/18) PGS Response (08/03/18)	**19/2/18 (ASBTIA):** 1. ASBTIA notes the amended survey program is a more reasonable proposition towards accommodating SBT migration into the GAB summer-autumn feeding grounds: but does not adequately consider the significance of the proposed area to a multitude of apex predators including SBT.	ASBTIA has received the Duntroon MC3D and MC2D Marine Seismic Survey Environment Plan (Revision 1) which was submitted to NOPSEMA on 20th October 2017. Within that document, PGS details the biology and habitat of these key predator species together with the presence of key ecological features such as the Kangaroo Island Pool, canyons and upwelling; assesses impacts of the survey activity and applies controls to prevent and mitigate sound impacts to these features. The Duntroon survey EP details the relevant cetaceans (Section 3.7.5), shark and fish species (Section 3.7.4), fur seals and Australian sea lions (Section 3.7.6) and seabirds (Section 3.7.8). Data referenced in Evans et al. (2017)1 has been utilized to describe the biology, habitat and presence of species within the eastern GAB and allow for assessment. PGS understands the seasonal sensitivity of the eastern GAB upwelling area and for this reason has delayed the commencement of Duntroon survey activities to March 15 with any March activity undertaken in deep water (at least 1500 m deep) outside biologically important areas and located at least 31 km from the shelf break, a topographic feature where higher densities of SBT have been observed. Other important SBT topographical features where higher numbers of SBT have been observed include inshore reefs, islands and rises (Cowling et al., 2002). The Duntroon OA does not overlap with inshore reefs, islands and rise features.	Refer to Assessment of merit response (sent to stakeholder)	Record 6P Record 6Q Record 6R

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response (19/02/18) PGS Acknowledgement (21/02/18) PGS Response (08/03/18)	2. ASBTIA continues to have serious concerns that the impact of these high intensity large scale MSS on SBT is not confined to the season in which the seismic acquisition occurs. The cumulative impact we are continuing to experience since 2012 means that this particular survey area poses a far greater risk than the previous surveys. Consequently, a much higher degree of caution is required in assessing ALARP. The scale, intensity, location, duration and frequency of surveys since 2012 is entirely new to the GAB area and ecosystem, so cumulative impact must be a consideration in NOPSEMA's Assessment process The SBT fishery has experienced considerable (640+km) displacement after the multiple seismic surveys from 2012. As the surveys have progressed eastward so have the aggregating population of Ranch-sized SBT (Figure 4). These are now located at the most eastern extremity of what is viable for tuna ranching operations. Any further expansion of seismic survey footprint eastwards especially through the key period that SBT are known to use the area poses an unnecessary and unacceptable risk to the Tuna Industry.	Displacement of the SBT fishing grounds to the eastern GAB between 2012-2015 as a result of seismic surveys undertaken in deep-water environments where measured sound at shelf break noise loggers differed in ambient noise levels by 1 dB between when seismic was present and when it was not present (McCauley et al, 2013) cannot be supported by PGS. SBT stock has not been impeded from entering eastern GAB environments during this period and PGS understands that the 2014 season where SBT were located closer to Port Lincoln was one of the best and shortest seasons due to the abundance of fish closer to shore (ABC News, 2014). PGS also notes that MSS activity is not new in the eastern GAB with over 20 2D MSSs in the area since 1966, the latest undertaken in 2003 by Santos. Instead of MSS activity, Eveson et al (2015) identifies the environmental variable which most influences SBT spatial distribution within the GAB is sea surface temperature. PGS understands that the location of the SBT 'fishing grounds' within the GAB differs from year to year. Between 2003 and 2008, the 'fishing ground' was located along the outer GAB continental shelf between approximately 130oE to 133oE (Basson and Farley, 2014). However, Davis (2000)7 identifies that SBT were consistently found at Nullarbor and Eucla in the late 80's and at Victor Harbour/Backstairs Passage/The Pages region in the eastern GAB in the late 70's early 80's. Based upon this information, the latest position (2011+) of the SBT fishing ground lies within the historic SBT fishing ground range. This observation is also supported by Klaer et al (2002) for the period 1982-2000. PGS has delayed the commencement of the Duntroon survey to March 15, 2019. For MC2D acquisition undertaken between March 15 – 31, spatial buffers will be implemented to provide separation between survey activity, areas of high productivity and important foraging areas (i.e. area has minimum water depths – 1500 m, spatial separation from the shelf break of at least 31 km). Based upon available internationally recognized criteria for disturbance to fish (Popper et al., 2014), no disturbance to SBT fishing/ranching located on the continental shelf is expected during March (recognized as the end of the SBT fishing season).	Refer to Assessment of merit response (sent to stakeholder)	Record 6P Record 6Q Record 6R

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response (19/02/18) PGS Acknowledgement (21/02/18) PGS Response (08/03/18)	3. SBT are a global roaming migratory species of substantial international commercial and conservation interest and formal Agreements (see Figure 5; www.ccsbt.org and www.iucn.org). The seasonal use of the GAB by SBT remains stable and consistent over multiple years despite inter-annual variation in winter foraging sites between individuals. This highlights the importance of the GAB as a summer-autumn habitat of national significance for all juvenile SBT (for at least the first 5-years of every individual fish) and therefore is of global importance for the SBT population and species recovery.	PGS agrees with this assessment. The importance of the eastern GAB is reflected in the Duntroon EP Environment Description (Section 3.7.4.5).	Refer to Assessment of merit response (sent to stakeholder)	Record 6P Record 6Q Record 6R
			4. We re-iterate - the numbers of SBT returning to the GAB start to rise in November, peak in December/January and continue entering the area through to as late as March. SBT naturally start departing the GAB area from mid- April with the majority having left the region by the end of July.	PGS agrees with the entry period of SBT into the GAB, however in accordance with Evans et al (2017), the departure date of juvenile SBT from the GAB is highly variable but begins in February. There is a period of about 100 days from mid-April to mid-July when most departures occur (Basson et al. 2012). This information is reflected in the Duntroon EP.		
			5. Seismic surveys prior to the natural departure time are no longer acceptable until such time that SBT re-colonize the areas subject to the multiple high intensity long duration seismic surveys occurring from November 2011 to June 2015. Prior to the first of these (by PGS Nov 2011 to June 2012), the outer shelf area of the central GAB was a consistently reliable and predictable location for Ranch sized SBT to aggregate for the entire summer-autumn fishing season (Figure 7, Figure 8). The range extension shown in 2009 and 2011 are the normal response to strong La Ninã events, typically SBT still reliably aggregate through the core fishing region of the outer shelf between 131 to 133oE but search effort focuses around fishing vessels that will capture the Ranch stocks closer to Port Lincoln when the opportunity presents. Normally SBT distribution returns to that core fishing area in the season following the La Ninã event, as occurred in 2010. These broader climatic cycles have occurred historically and SBT and fishing vessel's response remains consistent through those times	PGS cannot delay the Duntroon survey until July/August 2019 when SBT have departed from the GAB. Notwithstanding the presence of southern right whales on the South Australian coastline from May to October, the acquisition window has been selected to avoid adverse weather conditions which occur through the winter months and may pose additional unavoidable safety risk and excessive downtime prolonging the overall duration of the survey. PGS has supplied weather-related efficiency data based upon NOAA Hindcast Data (2010-2014) to ASTBIA on 19th December 2016 which supports PGS's preference not to acquire from June to September. PGS has discussed its position on fishing ground displacement and 'normal range' in Item 2.		

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response (19/02/18) PGS Acknowledgement (21/02/18) PGS Response (08/03/18)	6. We are concerned that the information provided on sound exposure levels through this consultation has limited application for the area and work proposed. The contoured sound level plot is modelled for a smaller single source (3,010 cui) than that intended to be used "2 or 3 arrays of 3,260 each". In addition, the plot cuts off at 120dB, this is just not appropriate when peer reviewed published literature of low and biologically relevant frequencies (24 and 1000Hz) demonstrate ambient sound levels for the area (when no seismic survey vessels are present) are below 70 to 90 dB. This further highlights the necessity of sound source verification starting before the vessel enters the area, continues through the duration of the survey and includes a period after the survey vessel has departed the GAB.	The configuration of a seismic array significantly influences the sound output. While the largest operational array will be of 3260 in3 (volume), it's configuration produces an equivalent sound output than the 3090 in3 array. Accordingly, PGS has modelled the sound propagation for the 3090 in3 array within the Duntroon survey area. As previously explained in correspondence dated 18th October 2017, even though there are two or three arrays operating on an alternating sequence, there is no difference in noise emissions from the individual arrays operating every 8 seconds, for example versus three firing alternately every 24 seconds. The sound attributes produced by each array are the same (but alternating in time sequence) and dictated by the operational pressure, volume and array design. The Duntroon MC3D and MC2D Marine Seismic Survey EP (Revision 1) Section 6.2.1 provides a comparison of the different sound outputs from the different sized arrays verifying that the 3090 in3 array has the greatest sound output across the frequency spectrum. Source volumes do not correspond linearly with source output levels but instead follow a cubic-root relationship. A reduction in source volume has only a minor influence on source level. For example, an 8,000 in3 array produces about twice the loudness of a 1000 m3 array when all other parameters are held constant (i.e. number of elements and spatial dimensions of the array). Modelling Isopleths: As previously advised, the selection of sound isopleths presented in the acoustic modelling report was arbitrary. Ambient Sound: PGS has reviewed ASBTIA's reference (McCauley et al (2016)12) relating to ambient sound and cannot find the stated 70 to 90 dB (ambient sound) for sound frequencies between 24 to 1000 Hz. However, in reviewing the basis for this paper, McCauley has utilised results from the BP Developments noise survey13 during and after the Ceduna MSS at the Head of Bight (HOB). Measured ambient sound was higher at the shelf-break (200m water depth) compared with the measured sound on the shelf at the HOB (50 m water depth). Ambient sound levels were found to increase over summer to early winter. As previously provided, ambient sound results from this study (in SPL) were: • HOB: 73.5 to 131.9 dB re 1µPa (median 97.1 dB re 1µPa); and • Shelf-break: 74.9 dB to 144.9 dB re 1µPa (median of 111.7 dB re 1µPa).	Refer to Assessment of merit response (sent to stakeholder)	Record 6P Record 6Q Record 6R

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response (19/02/18) PGS Acknowledgement (21/02/18) PGS Response (08/03/18)		The Duntroon MC3D and MC2D Marine Seismic Survey EP (Revision 1) Section 3.5.4 provides a discussion on ambient sound. While McCauley et al (2016) references 'ambient sound' as background *noise from all sources except for identifiable sources such as a ship or a whale but may include noise from large numbers of animals and distant ships*, given the location of the Duntroon OA and the level of third-party shipping present, periods where there is 'ambient sound' alone will be low. The Duntroon OA subsumes the busy Investigator Strait to Cape Leeuwin shipping channel (4+ heavy commercial vessels per day with broadband sound emitted at 180-190 dB re 1µPa (SPL) (at hull)) and other vessels (e.g. fishing with expected sound emission between 165 to 180 dB re 1µPa SPL (at hull)). Sound Source Verification (SSV): PGS intends to undertake SSV to verify the accuracy of the Duntroon survey acoustic modelling. PGS has also offered sound logger equipment to ASBTIA for installation near pontoons to verify sound received by captured SBT. PGS will supply equipment and process data at the completion of survey activities, however this arrangement is awaiting confirmation from ASBTIA that SBT fishermen will install and maintain sound loggers provided while at sea. PGS would appreciate feedback on this.	Refer to Assessment of merit response (sent to stakeholder)	Record 6P Record 6Q Record 6R
			7. Air guns are known to produce a great deal of "waste" energy (frequency drift). Analysis of Australian seismic surveys demonstrate sound levels being elevated in all frequencies relevant to 'hearing generalist species of fish. This frequency drift completely blankets frequencies detected by tunas (50-1100Hz). Lower impact exploration technology exists.	PGS has considered use of quieter technologies (air guns with bubble curtains, marine vibrators, DTAGS) for the Duntroon survey. Other than eSource which would costs $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of survey and may result in prolonging of total survey duration.		
			8. Gulper Sharks are not a concern of ASBTIA – plankton and its role in ecosystem function and SBT attraction to GAB area ARE. This seismic survey can be planned to occur after peak periods of heightened GAB productivity.	PGS understands that ASBTIA's interest in the Duntroon survey is potential impacts to SBT. As discussed in Item 2, controls have been adopted to prevent sound impacts to high productivity areas and associated important foraging areas during March which lies in the peak period of GAB productivity.		

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response (19/02/18) PGS Acknowledgement (21/02/18) PGS Response (08/03/18)	9. SBT in the GAB have a varied diet routinely including pelagic crustaceans and fish, but also squids and a range of other invertebrates that are particularly abundant through upwelling periods. There is considerable uncertainty about the impact that high-energy sound impulses have on these components of the SBT's diet. This needs to be accounted for in the ALARP and Assessment process.	As identified in Item 2, the Duntroon survey design avoids spatial overlap with areas of upwelling during the peak upwelling period. Associated impacts to crustaceans and cephalopods within upwelling areas during peak high productivity periods in the GAB is not expected. The Duntroon MC3D and MC2D Marine Seismic Survey Environment Plan (Revision 1), Section 6.2.3.3 (Marine Invertebrates) assesses indirect impacts of sound exposure to crustaceans and cephalopods to prey species. Apex predators are considered when assessing impacts to prey species.	Refer to Assessment of merit response (sent to stakeholder)	Record 6P Record 6Q Record 6R
			10. Proposed studies by AIMS are commendable but PGS must note that the outcomes of that study are relevant to a tropical ecosystem similar to that location and are not necessarily transferable or applicable to a complex deep-water temperate ecosystem like that at the shelf-slope interface of the Southern Ocean in the Great Australian Bight. The physical and biological ocean processes supporting the ecosystems of each of these locations are very different.	Repeatability in the plankton mortality findings of McCauley et al (2017) is expected to be undertaken by the Australian Institute of Marine Science (AIMS). CSIRO identified shortcomings with the McCauley et al, (2017) survey design and replication of these mortality results must be completed as a priority. PGS considers mortality test results will be directly applicable to the Duntroon survey area, just as the plankton mortality tests undertaken in Tasmania were relevant, and were applied to, the tropical North West Shelf study performed by CSIRO (Richardson et al., 2017).		
			11. 2D and 3D Marine Seismic Survey acquisitions have successfully occurred in the GAB region throughout April, May, and June historically; with some surveys continuing operations even into July (PIRSA data base 2013).	Refer to Issue 5 relating to weather response. In addition to weather limitations, commitments have been made with other stakeholders not to acquire seismic data post May 31, 2019.		

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASTBIA Response (19/02/18) PGS Acknowledgement (21/02/18) PGS Response (08/03/18)	12. Historically large-scale 2D Marine Seismic Surveys have managed to accommodate the timing being requested from this proposal. And given the large amount of data that already exists for the eastern GAB – re-analysis of existing data sets must be a priority.	Refer to Issue 5 relating to weather response for survey timeframes. With respect to accommodation of timing, the alternate option to PGS is to split the Duntroon survey over multiple seasons. Titleholders are required to undertake acquisition surveys within the timeframes committed to the Australian government or run the possibility of losing their petroleum title. In addition, acquisition over multiple seasons would incur additional mobilization/demobilization costs (estimated ~AUD6M). On this basis, splitting surveys over multiple seasons will not achieve the necessary objectives. 2D seismic data is available for the EPP-41/42 area. Reprocessing existing data yields improved results. Industry preferentially reprocesses existing seismic data for reinterpretation wherever possible as this is a considerably less expensive option compared with acquisition activities. New data is acquired when further definition and understanding of the geology is acquired. The cost in acquiring new data drives companies to get the most out of existing data. New data acquisition can also a commitment to the Commonwealth by acreage holders. No 3D seismic data exists for the EPP-41/42 area. In addition, only limited 2D seismic data exists over EPP-46 and full coverage of the EPP-46 acreage is required.	Refer to Assessment of merit response (sent to stakeholder)	Record 6P Record 6Q Record 6R
		PGS Update Letter (23/07/18) PGS Follow-up on meeting (25/07/18)	**23/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. PGS requesting a meeting with industry association.	No feedback to date	NA	Record 6S
		PGS Email (24/09/18)	**24/09/18:** PGS provision of the revised sound modelling as promised in the face-to-face meeting held on the 2/08/18.	Response was associated with a request from ASBTIA.	NA	Record 6T
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	Feedback provided in entry below.	NA	Record 6U

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	**3/10/18:** Key issues arising include the following: ***Background to current situation*** We try to provide an appreciation of the importance of fishing and aquaculture to the Eyre Peninsula and South Australian regional economy. It has taken decades of investment into the vessel fleets, large shore-based fixed infrastructure and the workforce to develop SBT Ranching to what it is today. It has also taken very long term sustained investment (close to 40 years) in stock assessments and global management to ensure the industry is sustainable and able to be replenished every year (see www.ccsbt.org). ASBTIA continues to be frustrated and disappointed by consultation approaches of PGS and other companies. The comments in the correspondence provided 7th March 2018 clearly show that the hundreds of hours invested by ASBTIA and its members into consultation with PGS and its representatives since August 2012 has effectively been wasted. The recent concession to change the survey window (correspondence July 2018) is further evidence of the unacceptable consultation burden imposed by the Duntroon survey since 2016. If what is currently being proposed (September to December) was a serious alternative, why wasn't it considered or proposed after the first "consultation"? We note that we are equally critical of other survey companies which have dragged out the consultations. The extreme is the oil companies themselves who are never prepared to consider any mitigation measures. This is an important reason why we have reluctantly reached the position to totally oppose drilling in the GAB.	Consultation: PGS understands your frustration with consultation on the proposed Duntroon survey. To provide background to this consultation, when initiating this survey PGS identified the previous Lightning Marine Seismic Survey (MSS) timeframe (March to May) as being suitable to ASBTIA based upon the negotiated mitigation controls negotiated with Bight Petroleum in the 2014 Lightning MSS Environment Plan (EP). PGS adopted this 'previously-worked' timeframe so as to not 'waste previous consultation efforts'. In light of this history, PGS has over the past two years has placed effort into identifying controls, both spatial and temporal, and providing independent technical assessments to ASBTIA so both parties can understand the potential impacts of the survey activity on southern bluefin tuna (SBT) and agree on proposed mitigation measures to ensure impacts as ALARP and acceptable. PGS identified that selection of the survey within the 'previously agreed timeframe' was not leading satisfactorily to an agreed position and amended the timeframe to a period where SBT have been shown not to be present in the eastern GAB ((Evans et al, 2017). Given the lack of temporal overlap, impacts to SBT are prevented and associated stock assessment surveys are not affected. PGS has not elected to drag out consultation for this survey as this is not in PGS's interests. The additional technical requests which have been forthcoming as a result of consultation activities have resulted in significant additional independent studies to satisfy concerns. ASBTIA has been among those stakeholders who have requested this additional detail.	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	***Impact of the surveys*** As a consequence of PGS's consultation approach, ASBTIA now has an extra 2 years of observations on SBT distribution in the GAB; i.e. where the wild fish are choosing to feed and aggregate. What this clearly shows is that the impact of large-scale marine seismic surveys in this area is LONG TERM, extending for years after the survey was undertaken. SBT have not returned to the locations where the vast majority of Ranch-suitable fish had aggregated at the sea surface for the previous 20+year period before the first ever large-scale long-term 3D seismic survey undertaken in the GAB, which was in 2012. The fish migrating into the GAB's globally significant feeding area now were not born at that time of the intense 3D seismic survey activity between 2012-2015 - this suggests a fundamental change in the ecosystem rendering it no longer attractive to hungry migrating juvenile SBT. Note that the physical characteristic of sea temperature has remained highly suited to SBT throughout those seismic survey areas indicating the reduced attractiveness is biological and relevant to apex predators. Therefore, we have come to the position that the SBT Industry cannot accept any risk of further expanding this dead zone that is apparent for years after the seismic survey finishes.	<u>Impact of Surveys in the GAB</u>: PGS appreciates your feedback on the additional years of observations on SBT distribution in the GAB and would appreciate any additional information and independent references you can provide to inform to the Duntroon EP. As per the information provided in PGS correspondence dated 7th March (Item 2), the ASTBIA's position with respect to long term displacement of SBT from the fishing grounds where they have aggregated for the last 20+ years as a result of seismic survey activity cannot be supported by PGS. PGS has previously requested more information about the tuna fishing operations to assist in assessing the impact of seismic surveys in the GAB but has not been provided with any substantial data to assess ASBTIA's claims. PGS provides the information below. *Displacement of the SBT fishing grounds to the eastern GAB between 2012-2015 as a result of seismic surveys undertaken in deep-water environments where measured sound at shelf break noise loggers differed in ambient noise levels by 1 dB between when seismic was present and when it was not present (McCauley et al, 2013) cannot be supported by PGS. SBT stock has not been impeded from entering eastern GAB environments during this period and PGS understands that the 2014 season where SBT were located closer to Port Lincoln was one of the best and shortest seasons due to the abundance of fish closer to shore (ABC News, 2014). PGS also notes that MSS activity is not new in the eastern GAB with over 20 2D MSSs in the area since 1966, the latest undertaken in 2003 by Santos. Instead of MSS activity, Eveson et al (2015) identifies the environmental variable which most influences SBT spatial distribution within the GAB is sea surface temperature.* *PGS understands that the location of the SBT 'fishing grounds' within the GAB differs from year to year. Between 2003 and 2008, the 'fishing ground' was located along the outer GAB continental shelf between approximately 130°E to 133°E (Basson and Farley, 2014). However, Davis (2000) identifies that SBT were consistently found at Nullarbor and Eucla in the late 80's and at Victor Harbour/Backstairs Passage/The Pages region in the eastern GAB in the late 70's early 80's. Based upon this information, the latest position (2011+) of the SBT fishing ground lies within the historic SBT fishing ground range. This observation is also supported by Klaer et al (2002) for the period 1982-2000.*	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

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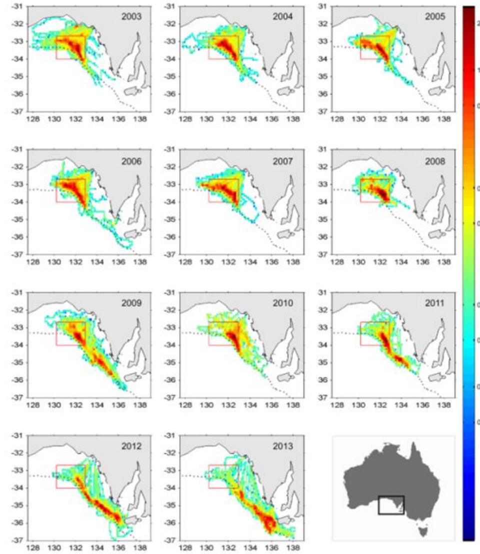
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	**Impacts of Surveys (Con't)**	In addition to this information provided, Figure 1 provides the distribution of SBT during the austral summer (January to March) based upon aerial survey data for 2003-2013 (Basson & Farley, 2014). This information shows distinct movement of SBT along the continental shelf at the shelf break to the east prior to 2012. Based upon the evidence provided, the shift in SBT location cannot be attributed to seismic survey activity but to natural seasonal variability within the SBT fishing grounds. Figure 1: Distribution of SBT over GAB during Austral Summer (Jan-Mar) based on aerial survey data for 2003-2013 (Basson & Farley, 2014) 	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	***Specific issues***
			Addressing items raised in correspondence 7th March - the requirements to capture SBT for Ranching are fundamentally very different to the situation described in PGS correspondence - which applied before multiple countries co-operated to develop and introduce a GLOBAL management plan including catch limits for this species. Australia restructured operations by initially developing direct airfreight fresh sashimi product, then SBT Ranching and more recently ultra-low temperature preservation of ranched product.
			As a quick re-cap of our points over the last 6 years:
			• SBT Industry (Fishing and Ranching) is 100% Australian owned and operated, a rare, if not unique situation in the modern Australian economy.
			• More than 99% of the product is exported, meaning NEW money into Australia.
			• Port Lincoln SBT Ranching industry is Australia's largest aquaculture export industry; and generates 1,000 FTE's on Eyre Peninsula and SA (www.pir.sa.gov.au).
			• ***All this relies totally on the GAB ecosystem being undamaged***.
			• After 30 years of International management, SBT stocks are responding to the global conservation efforts and becoming a reliable, renewable, and sustainable resource.
			• The GAB is the only area from the entire total global range of SBT where a fishery independent scientific assessment of the stock's recruitment status can occur.
			    · This is fundamental for continuing to monitor recruitment and rebuilding of the population. The species currently remains listed as 'Critically Endangered' by IUCN and Conservation Dependent under Australia's Environment Law (the EPBC Act).
			    · And is critically important data required for the scientific setting of the sustainable global catch limit (Total Allowable Catch or TAC) – see later.
			• Australia has a 35% share of the Global TAC; Japan 35% and the rest is shared between Korea, Taiwan, New Zealand, Indonesia, South Africa and the EU.
			• Investment to reach the current stock situation that shows indications of species recovery and supporting quota increases goes into the tens of millions from multiple countries including Australia (see www.ccsbt.org).
			• The Australian Ranching industry captures a very minor selection of individual schools of SBT so that the majority of the fish are left to replenish the global stock and parental biomass and satisfy the ecological niche that SBT are evolved to occupy.
				<u>Specific Issues</u>: PGS notes that ABSTIA's reference to correspondence 7th March is non-specific, however PGS appreciates the update of the information provided for the SBT fishery. PGS will ensure that any information provided within the Duntroon EP reflects the information provided in this correspondence.	Information provided in PGS Response (Record 6W)	Record 6V
						Record 6W

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	Fishing to keep SBT alive for Ranching is an entirely different operation to the 'catch and kill everything whenever and wherever it is first sighted' as occurred before International quotas were introduced for this species. Ranching has taken decades of investment (both time and money) to develop and perfect the infrastructure and techniques to maximize fish survival and to enhance fish growth performance.		Information provided in PGS Response (Record 6W)	Record 6V Record 6W
			The relevance of the fishery management system in Australia The official Commonwealth Government policy in Australia is that fisheries are managed by Individual Transferable Quotas (ITQs). One of the reasons for this is that in times of natural disasters, stock reductions and low prices, the ITQ owners will trade the permanent ITQ Right and rationalise the industry – so that adjustment/restructuring will be internally funded, and not rely on government funding. The other core aim of the ITQ system is that the Right becomes the borrowing collateral. This enables the funding of ITQ rationalisation, seasonal funding of value adding such as Ranching, and the capital expenditure required to continue to be internationally competitive. In the SBT case, the international catch quota is set by a scientific model which uses three data sets. Because of the core position of the GAB in the global migration and feed supply of SBT, two of the three data sets in the model are from the GAB (see www.ccsbt.org). These two GAB data sets are the key ones because they are based on genetics and independent of the fishery. These two key data sets rely on spatial and temporal consistency. This means that external factors such as seismic surveys or oil spills can result in major distortions in the data so making them of limited use. The further problem is that these distortions affect migration and feeding for many years. When this happens, and quotas are reduced, the collateral value of the ITQs automatically reduces – leading to bankruptcies and major job losses.	<u>Relevance of the fishery management system in Australia</u>: PGS understands that the fishery is managed by Individual Transferrable Quotas (ITQs) with the international quota set by a scientific model supplied by data from the GAB. PGS has selected the Duntroon survey timeframe to prevent impacts to migrating juvenile SBT and any associated effects on data which is provided into that model. Accordingly, PGS considers that any spatial and temporal impacts to SBT are avoided by selecting this timeframe. Sound from acoustic sources does not remain in the environment after survey activities have been completed. Further, the selected timeframe does not coincide with SBT survey activities. As per information provided in PGS correspondence dated 16th July 2018: *PGS also understands that CSIRO undertakes an SBT gene-tagging program where initial fish tagging occurs in the GAB in late summer and re-sampling of fish via commercial catch occurs a year later across the fishing season (December to March). CSIRO also undertakes aerial surveys in selected years between January 1 and March 31 to visually assess SBT abundance. CSIRO identified that the Duntroon survey area bordered the southern end of several transects of the SBT aerial survey area. The Duntroon survey timeframe (September 1 to November 30) does not impact upon those CSIRO surveys (aerial and tagging).*		

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	***Dependence on the GAB*** Globally, Ranching of SBT can only occur in the waters adjacent to Port Lincoln in the lower Spencer Gulf and the entire year's business is dependent on accessing seed stock from the GAB. This includes the area PGS proposes to survey while SBT undergo their seasonal migration into the resident feeding area of the GAB. Successful fishing for Ranching operations is totally reliant on reliable surfacing behavior at **predictable** locations over periods of weeks to months at a time. What makes an area within the GAB predictable for SBT is where surface water temperatures are favourable in an area where there is an abundant food source within the deep scattering layer. The deep scattering layer is composed of multiple species of zooplankton and occurs in areas where water depths are between 100 to 500m-depth; zooplankton are at risk of shattering with seismic blasts (evidenced by the field study using a single 150cui air gun). If the Duntroon survey is to proceed, ASBTIA will expect PGS to monitor, measure and transparently report on these plankton populations, and received sound levels throughout the area within the seismic survey 'acoustic foot print' for a period of time BEFORE the survey commences and at staggered intervals while the survey is underway. The baseline data collected pre-survey is to be used to set threshold levels where the "control measure" is to immediately cease seismic operations if the pre-agreed thresholds are breached. ***SBT make annual cyclical journeys of 5,000 to 16,000km between the GAB to other areas across the Southern and Indian Ocean. It is essential that these fish are able to adequately 're-fuel their tanks' to manage and survive these long-distance journeys. Anything that compromises the time and quality of food supply in this vital area risks adversely affecting the population.*** ASBTIA believe this survey poses a very real and significant risk to SBT Ranching, PGS has not provided any substantive material to demonstrate otherwise.	<u>Dependence on the GAB</u>: PGS notes ASBTIA's position that the Duntroon survey timeframe is positioned '*while SBT undergo their season migration into the resident feeding areas of the GAB'* and that '*successful fishing for ranching is totally reliant on reliable surfacing behaviour at predictable locations over periods of weeks to months at a time*'. As identified in PGS correspondence dated 16th July 2018, PGS has been cognisant of this aspect of your activity and has positioned the survey to prevent disruption to migrating SBT and your fishing activities. Further as per PGS correspondence dated 16th July 2018 - *The altered timeframe has been selected to avoid the period of heightened GAB productivity associated with upwellings which predominantly occur between December and April. PGS is proposing to monitor oceanic/climate parameters in the November period for conditions leading to upwelling. If blue whale presence is identified during these upwelling-favourable conditions, the Duntroon survey will be curtailed for the season. Given these survey constraints, impacts to high productivity upwelling waters (& associated pelagic crustaceans, fish, squid and invertebrates) are prevented and foraging impacts to SBT entering the GAB are not expected.* With respect to ABSTIA's comments regarding the sound modelling, PGS would like to highlight that ASBTIA is making inappropriate comparisons of sound and spectral levels. PGS agrees to utilising sound loggers within the southern right whale calving biologically important area (BIA) to verify propagation modelling and provide additional confidence in future modelling. PGS would be agreeable to participating in plankton monitoring studies during seismic survey operations provided it is financially supported by stakeholders. This work would be considered as new science to further the understanding of the effects of seismic sources on plankton. Based upon the information provided to ASBTIA and the altered survey timeframes, PGS does not support ASBTIA's position that the '*survey poses a very real and significant risk to SBT ranching'* and believes the comment regarding the lack of provision of substantive material to demonstrate otherwise does not hold merit.	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	Impact of sound on natural biological processes: Changing survey dates to a 3-month period prior to and overlapping the onset of SBT migration into the GAB does not address concerns over the longer-term damage to the ecosystem. We note that *the onus is on the proponent or creator of the risk to provide sufficient data in a transparent manner so that potentially impacted stakeholders can assess the potential risk to their operations.*	Impact of sound on natural biological processes: ASBTIA has been the recipient of a full copy of the previous Duntroon Survey EPs which have assessed the impacts of acoustic operation on all biological processes within the eastern GAB ecosystem. Based upon the information provided within those documents, PGS considers that ASBTIA's statement that PGS "*does not address concerns over the longer-term damage to the ecosystem*" and "*does not consider the impact of the survey will potentially have on the natural biological processes that enhance the ecosystem's entire regional productivity through spring and into summer*" does not hold merit.	Information provided in PGS Response (Record 6W)	Record 6V Record 6W
			Masking Impacts Changing survey dates to a 3-month period prior to and overlapping the onset of SBT migration into the GAB does not address concerns over the risk of masking navigational cues based on the ambient acoustics of the region.	Masking Impacts: In all fishes, the inner ear is directly stimulated by particle motion associated with the acoustic field through differential movement of the body and sensory epithelium relative to the otolith or otoconia mass (des Vries 1950; Pumphrey, 1950; Popper and fay, 2011; all in Dale et al, 2015). Species that are able to use sound pressure in addition to particle motion, such as the direct connection between the pressure-detecting swim bladder and the inner ear found in otophysan fishes (e.g. goldfish, catfish and relatives) or close proximity of the ear to a gas-filled chamber such as a swim bladder, generally have wider hearing bandwidths and greater sensitivity compared with species which more heavily rely on particle motion for hearing (Chapman and Hawkins, 1973; Fay and Popper, 1974, 1975; in Dale et al 2015). Song et al. (2006) examined the morphology of the inner ear of the Bluefin tuna (*Thunnus thynnus*) and hypothesised that the species probably does not detect sound much over 1 kHz. Other related species such as the yellowfin tuna (*T. albacares*) can detect sounds from 0.05 to 1.1 kHz with best sensitivity of 89 dB re 1µPa at 500 Hz (Iversen, 1967). Anatomical studies on the inner ear of several tuna species (Popper et al., 1981; Song et al., 2006) identified a lack of connection between the swim bladder and inner ear suggesting that tuna is primarily sensitive to the particle motion component of the sound field. Dale et al., (2015) identified in the Pacific bluefin tuna, the greatest sensitivity hearing was in the range 400-500 Hz with sharp decreases in sensitivity at higher and lower frequencies. Lowest sensitivity of the measured frequencies was at 325 and 800 Hz. This frequency range falls within the upper end of the spectrum for the species which lack a connection between the swim bladder and inner ear (Dale et al, 2015).		

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Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	Masking Impacts (Con't)	Movement of fish through water potentially has significant impacts on their ability to detect sound. As fish swim, water displacement caused by the fish produces a flow field around the body which can be either laminar or turbulent (Anderson et al 2001; in Dale et al, 2015). These boundary layer effects impact on the body both spatially and temporally fluctuating pressure and particle motion fields referred to as flow noise, which may mask important environmental sound stimuli to fish. Flow noise can be particularly problematic for fast swimming species such as tunas, as it increases rapidly with swimming speed (Urick, 1983; in Dale et al, 2015). Free swimming Pacific bluefin tuna swim at speeds that average 1 m/s or more (Blanke et al, 2007; in Dale et al, 2015) with maximum swimming speeds of 20 m/s (Wardle et al, 1989; Matcinek et al, 2001; in Dale et al, 2015). Masking impairs an animal's hearing with respect to the relevant biological sounds normally detected within the environment. In effect, masking raises the threshold for detection by an animal. While the consequences of fish masking have not been fully examined, effects on survival, reproduction and population dynamics may result (Popper et al. 2014). Data on hearing for all vertebrates tested to date, including fish, show that the degree of masking relates both to the level of the masking noise and the frequencies it contains. In fish, pure tone sounds are masked most readily by noise at the same and immediate adjacent frequencies, falling within a critical band (Popper et al. 2014).	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

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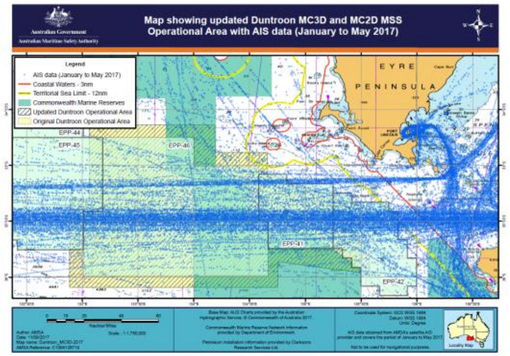
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	<u>Masking Impacts (Con't)</u>	Masking may occur where a noise exceeds the absolute hearing thresholds of an animal and is likely to occur for most fish at some locations and times due to the varying level of background noise that occurs in all aquatic environments. Data on masking by seismic air guns are not available for any species, however masking is possible for the time that fish are exposed to air gun sound and may occur when animals are sufficiently far from the source where sounds merge and become more continuous (Nieukirk et al. 2004). Popper et al. (2014) surmised that "*It is likely that increments in background sound within the hearing bandwidth of fish may render the weakest sounds undetectable, render some sounds less detectable, and reduce the distance at which sound sources can be detected. Energetic and informational masking may increase as sound levels increase, so that the higher the sound level of the masker, the greater the masking".* However, masking only occurs while the interfering sound is present, and therefore masking resulting from a single pulse of sound (such as an air gun shot) or widely separate pulses would be distinguishable and unlikely to significantly affect an individual's overall fitness and survival. ASBTIA has identified the risk of the Duntroon survey masking navigational cues of the SBT based on the ambient acoustics of the region. This implies that SBT use acoustic cues for their migration, however this position is not scientifically supported, simply because it is extremely difficult to study and prove how tuna navigate. As previously identified, tuna do not have a high hearing sensitivity with their best hearing sensitivity in the range of 300-800 Hz. The fish would have to rely on clearly audible acoustic cues in this frequency range for navigational purposes. The only known oceanographical feature producing sounds in this frequency range is wind and waves. If SBT had migratory routes which followed the coastline closely this assumption might support their use of 'navigational cues' but as a pelagic offshore species, the reliance on navigational cues shows little relevance. As determined by Eveson et al. (2015), it's more likely that sea surface temperature is the key factor influencing their migration into the GAB.	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	<u>Masking Impacts (Con't)</u>	In additional, Evans et al (2017) identified that the timing of past geophysical surveys within the GAB had overlapped the spatial and temporal occurrence of juvenile SBT. The direct measurement of spatial overlap had inherent errors estimating the position of juvenile SBT at exact times. The authors concluded that "*while some parameters could be identified as influencing the behaviour of juvenile SBT, which ones, and the strength and direction of the relationships, varied temporally and across individuals. This made identifying clear relationships between behaviour and environmental parameters difficult, suggesting that the drivers for behaviour of juvenile SBT are complex, and potentially interdependent and covarying in nature*". Further, the authors did observe that during geophysical surveys, at a broadscale, tagged juvenile SBT individuals remained in the broader vicinity of the GAB during survey periods and for individuals where observations are available across multiple years, the individuals continued to return to the GAB over the austral summer period. These observations are consistent with the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper et al, 2014) which assess behavioural effects of sound on fish. SBT, a fish species with a swim bladder not involved with hearing (a 'Type 2' fish), has a high risk of behavioural disturbance near the sound source (tens of metres) and a low risk of behavioural disturbance kilometres from the sound source. The risk of disturbance is therefore localised around the sound source, temporary as the vessel moves through the survey area and likely to affect only a small proportion of any free-ranging fish at any one time if juvenile SBT are actually present in the area. Marine fauna observer (MFO) records from previous geophysical surveys (Ceduna and Nerites MSSs) located in the central/west GAB observed SBT (with no unusual behaviours) while the acoustic source was operational (A. Levings, pers.com 2017; L. Wosniak pers com, 2014). Similarly, in accordance with Popper et al (2014), a Type 2 fish has a *very low risk of masking* impact at any distance from the operational array given their anatomical makeup. If masking did occur mechanisms have been found in terrestrial animals and marine mammals which reduce the masking effect (i.e. 'masking-release' mechanisms) including: spatial or temporal release from masking, within-valley ('dip' – i.e. quieter gaps) listening or comodulation masking release (Erbe et al., 2016).	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	**Sound Modelling** To compare what PGS is proposing with these 2 large-scale long-term 2D and 3D marine seismic surveys in the Duntroon application to the 4-day 2D survey undertaken by Santos in 2003 (or previous low power, short duration surveys in the area) is misleading. Increasing the number of lines (as occurs with surveys operating over longer time periods) substantially increases the cumulative sound exposure levels at longer ranges. The sound modelling report provided by PGS on the 24th September 2018 continues to include misleading information that is not reflective for the area in which the survey is proposed. The 'JASCO Acoustic Modelling Assessment v1, 19th September 2018' does contain substantially higher quality information compared with the previous version of July 2017. However, it is very concerning that the later version continues to utilize an absolute lower limit of 120dB re 1μPa^2 to define the spatial extent of noise pollution. This is clearly much louder than sound levels actually recorded from the region.	Modelling Report: Noise produced from seismic surveys depend upon the source size and can be compared with previous surveys, particularly since international standards have a per pulse or cumulative (24hr) isopleth to determine impacts. The acoustic modelling report is not designed to define the spatial extent of noise pollution defined by the distance to the 120dB re 1μPa^2.s SEL isopleth, but rather the modelling study considers a region of 200 km by 200 km centred on a source. The modelling study reports distances to isopleths within this modelling region. The tables of maximum and 95% distances to unweighted per-pulse SEL and SPL (Tables 12, 13, 14 and 15) consider distances to 130 dB SPL and per-pulse SEL with the ranges to the lowest levels being close to or beyond the boundary of the modelling area. The sound levels reported in the modelling report are broadband sound levels over the stated frequency range (10-25000 Hz). Broadband sound levels cannot be compared to spectral levels as ASTBIA have done in their correspondence of 3rd October 2018. Spectral levels are denoted by units that have a /Hz component to them, such as 95dB re 1μPa^2/Hz.	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	**Ambient Sound** Ambient sound for the period of the survey can be seen with the image below (CMST Report) and detailed in the table, Appendix 2 - both clearly show that the natural soundscape for this area at the proposed survey time is below 95dB re 1μPa2/Hz across all relevant frequencies (10-3000Hz). *Ambiguous modelling does not allow assessment of the potential area at risk* of eliciting behavioural response or masking of acoustic cues likely involved in the navigation of migrating SBT into GAB feeding areas.	PGS understands that the ambient sound profile provided in your correspondence dated 3rd October 2018 (ASBTIA Figure 5 and Appendix 2) relates to the IMOS station located to the west-south-west of Kangaroo Island (36º 7.6' S, 135º 55.0' E). The IMOS station monitors ambient sound within that location but does not represent the ambient sound throughout the eastern GAB. As you would be aware, a major shipping channel bisects the Duntroon operational area (refer Figure 2 below) which, on advice from AMSA (2018), carries very heavy vessel traffic (on average 4+ heavy commercial vessels per day. Commercial shipping produces significant sound levels with container ships typically have a source level of 180-190 dB re 1µPa (Richardson et al, 1995). A sound logger positioned within this shipping lane in the eastern GAB would produce a significantly different 'ambient' profile to that from the Kangaroo Island IMOS station referenced. ASBTIA is not utilising modelling provided effectively to understand the impacts from the activity comparing with accepted international standards for sound impacts. The modelling undertaken is not ambiguous and does allow for behavioural impacts to be assessed. ASBTIA's statement does not hold merit. Figure 2: Commercial Vessel transit across the Duntroon OA (AMSA, 2018) 	Information provided in PGS Response (Record 6W)	Record 6V Record 6W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Peak Industry Body for the Southern Bluefin Tuna Industry	ASBTIA Response Letter (3/10/18)	**Meeting ALARP** With this in mind, we cannot accept that any long-term seismic surveys in the GAB can operate to ALARP. Changing the survey window to a 3-month period through spring that overlaps the start of the upwelling season does little to allay our concerns over wider ecosystem damage and risking SBT migration into the GAB. In addition to this, lower impact technologies ARE available and therefore must be adopted in deep water locations where sound transmission has the potential to impact over a much larger spatial area. For operators to ignore this is not upholding NOPSEMA's expectation that the Australian oil and gas sector are striving for World's Best Practice. The fact that SBT have not returned to those areas previously subjected to large-scale long-term seismic surveys between 2012-2015 – means this new area needs to be assessed and regulated in an extremely precautionary manner. Monitoring conditions (biota and sound) before, during and AFTER the survey is completed must be an obligatory minimum requirement if any further seismic surveys are to occur in the GAB, and especially where they overlap the area that is the driving force underpinning the entire GAB's productivity.	Meeting ALARP (Lower Impact Technologies): As identified in PGS correspondence dated 7[th] Match 2018, PGS has considered use of quieter technologies (air guns with bubble curtains, marine vibrators, DTAGS) for the Duntroon survey. Other than eSource which would costs $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of survey and may result in prolonging of total survey duration. ASBTIA's statement about the SBT not returning to those areas previously subjected to long-term surveys between 2012-2015 as previously discussed does not hold merit. PGS have aligned to temporal window of the survey to utilize down-welling periods, undertake higher sensitivity and potential upwelling areas during these periods and put protective mechanisms in place during November to prevent significant impacts to highly productive areas should an upwelling occur.	Information provided in PGS Response (Record 6W)	Record 6V Record 6W
Department of Defence (Air Command)	Defence Authority advising of Defence Activities adjacent to survey area	PGS Email (13/11/16) ADT Read Receipt (14/11/16) (Record 7A) DOD Response (04/12/16) (Record 7B)	**04/12/16:** Defence has no objections to the proposed activities. Defences provides the following comments: ○ PGS to notify the AHS in the designated area a minimum of 3 weeks prior to the activity commencement. The AHS is contactable at [EMAIL] ○ PGS to provide a weekly summary of planned activities for the survey vessel to de-conflict any training activities that may occur during the proposed survey operation. This information needs to be sent to [EMAIL]	PGS will adopt these notification requirements within the EP.		Record 7 Record 7A Record 7B
South Australian Sardine Industry Association (SASIA)	Adjacent Fishery to the Duntroon Multi-Client Survey Area	PGS Letter (12/11/16) PGS/ASBTIA/GABIA/ SASIA Meeting (25/11/16) (Record 8A)	**25/11/16:** PGS provided presentation on the proposed project outline for the Duntroon survey. Intention is to follow commitments in the Bight Petroleum EP which expired in the most recent season SASIA noted that his preferred timing for survey was in line with ASBTIA's due to sardine stock assessment surveys that occur mid-March, although late March was probably ok • Will provide map with their survey areas • Noted limited likely impact on actual fishing SASIA had concerns on possible impact of seismic in spawning areas. There were additional general discussions, but concerns/issues not captured in these minutes will be provided in written responses respectively from ASBTIA, SASIA and GABIA.	Refer Response below	Meeting Minutes Agreed	Record 8 Record 8A

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Sardine Industry Association (SASIA)	Adjacent Fishery to the Duntroon Multi-Client Survey Area	SASIA Email (08/12/16) Record 8B	**08/12/16:** SASIA provision of sardine spawning grounds. SASIA still await a final draft of 2016's survey, however, the main distribution of eggs seems to be moving out of the shallower waters and closer to the shelf. As mentioned in the meeting of 25th November, this spawning window for sardines is quite small and we fear that surveys could influence our egg count should a survey be conducted in early February through to early March.	**08/12/16**: PGS has assessed the overlap of the Duntroon survey with the Sardine Fishery Management area. The northern most boundary of the Duntroon survey area lies at a similar latitude to Coffin Bay which is at the southern border of whare significant levels of sardine eggs have been recorded. Does not appear to have a spatial overlap. PGS recognises that here is seasonal variation in this. Studies which have been undertaken into seismic impacts of fish eggs have found that unless the eggs are at close range to the source there are no observable effects on the viability of the eggs. Effects will be localised. DNV (2007) identified that a study by Saetre & Ona (1996) which looked at impacts to cod and herring larvae at a population level from a typical seismic survey. Impact was found to be minor compared with the very high natural mortality rates for the eggs. Impacts from the Duntroon survey are predicted to be very slight on this basis.	**08/12/16**: PGS acknowledging receipt of claim and will respond. **19/12/16:** PGS Response to concerns raised (Record 8D).	Record 8B Record 8D
		PGS Email (9/12/16)	**09/12/16:** Request to SASIA for contact for [CONTACT] of Marine Scale-fish Fishery.	No response received to date.	N/A	Record 8C

		PGS/SASIA Meeting (28/08/17)
		
		PGS Letter and CSIRO Proposal (28/08/17)
		
		PGS Follow-up Email (05/10/17)
			28/08/17: Meeting to discuss updated information on Duntroon survey. Outcomes included (Letter and CSIRO proposal provided):
			PGS is happy to provide the following additional commitments should the project proceed under this EP:
			• PGS will commit to the CSIRO project as outlined in the attachment and share the results with SASIA
			  ○ We believe there could be mutual benefits in the long run in acquiring opportunistic data during seismic surveys on a routine basis and the attached pilot study is seen as a first step in looking at what could be achieved in the future
			• PGS is also happy to provide bathymetric data from any of its 3D seismic surveys with such contouring derived from its seismic data analysis
			  ○ Currently this data can be provided in Maxseas or Olex formats
			  ○ We can also provide raw sounder data from our EA 600 sounders subject to such sounder (or equivalent) being standard equipment on board the selected vessel
			• PGS can provide daily water temperatures during operations should this be of use in any of your modelling
			We remain happy to discuss other opportunistic areas of cooperation at any time should you think of areas that we can assist.
			05/10/17: Follow-up email to advise of pending EP submission and a link to previous Bight EP together with an electronic copy of the catch-and effort data for the sardine fishery with Duntroon survey overlaid.
				No feedback provided to date on meeting, letter or follow-up email.	NA	Record 8D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
South Australian Sardine Industry Association (SASIA)	Adjacent Fishery to the Duntroon Multi-Client Survey Area	PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 8E
		PGS Update Letter (20/07/18) PGS/SASIA Telephone Conversation (25/07/18) & Email Resent with correct email address.	**20/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 8F
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 8G
Primary Industries and Regions South Australia (PIRSA) Fisheries and Aquaculture	South Australian Fisheries Management Authority	PGS Letter (12/11/16) PIRSA Email (14/11/16) (Record 9A) PGS Letter (14/11/16) (Record 9B) PIRSA Delivery Receipt (14/11/16) (Record 9C) PIRSA Letter (06/12/16) (Record 9D)	**14/11/16:** Mail response advising of new contact as Mr [CONTACT] (Record 9A) **06/12/16:** PIRSA identified that the survey area overlaps many commercial fisheries. Comments provided are based upon recent research reports on seismic impacts to fisheries. These reports suggested that further research is required to understand medium and long-term effects on invertebrate and fish species and populations. The research noted that improved processes for communication and relationship building between fisheries and petroleum industries are considered to minimise issues identified with these surveys. About the Duntroon survey PIRSA recommends direct consultation with: ○ SA Rock Lobster Advisory Council (SARLAC) ○ South Australian Sardine Industry Association (SASIA) ○ Marine Fishers Association of SA (MFASA) ○ Central Zone Abalone Fishery ○ Abalone Industry Association of SA Inc. ○ Recreational Charter Boat Fishery ○ RecFish SA ○ South Australian Northern Zone Rock Lobster Fisherman's Association Area overlaps spatially with the migratory pathway for the southern Bluefin tuna and coincides with the location and timing of the aerial surveys conducted by the CSIRO for the management of SBT quotas. On this basis it is recommended that the ASBTIA and AFMA are consulted.	PGS has acknowledged this information in the EP and contacted all additional fishing industry bodies not previously consulted. PGS has utilised a face-to-face communication methodology with affected fisheries to build relationships and establish good communication pathways.	NA	Record 9 Record 9A Record 9B Record 9C Record 9D

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Primary Industries and Regions South Australia (PIRSA) Fisheries and Aquaculture	South Australian Fisheries Management Authority	PGS Email and Letter (08/09/17) PIRSA Read Receipt (9/9/17) PIRSA Email and Letter (21/09/17) PGS Email (21/09/17)	08/09/17: Provision of additional information to PIRSA regarding the Duntroon Survey. 21/09/17: PIRSA Response to the information provided included the following: • As the proposed area overlaps spatially and temporally with many South Australian Fisheries, there may be impacts on these fisheries from seismic surveys. PIRSAs previous comments related to these possible impacts provided to PGS in correspondence dated 6 December 2016 are still valid and you should continue to consult directly with industry associations as advised in that correspondence. • For further information in relation to this matter, please contact [CONTACT] Program Leader Commercial Fisheries.	PGS believes it is appropriate that continued consultation with fishery groups is undertaken despite the low recorded fishing effort in the area. PGS will continue to liaise with these groups.	PGS Response: PGS acknowledges that they have and will continue to follow the advice to consult directly with industry associations as per the PIRSA letter	Record 9D
		PGS Update Letter (19/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 9E
		PGS Update Letter (18/07/18)	**18/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **15/08/18:** PIRSA reiterated requirements on correspondence dated 6th December 2016.	PGS is continuing to follow this advice.	NA	Record 9F Record 9FA
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds. **02/10/18:** PIRSA reiterated requirements on correspondence dated 6th December 2016.	No feedback provided.	NA	Record 9G Record 9H
South Australia Recreational Fishing Advisory Council (SARFAC) (now SA RecFish)	Peak Industry Body for South Australian Recreational Fishers	PGS Letter (12/11/16) Delivery Receipt (13/11/16) PGS Resend (23/12/16)	No response provided.	No issues or concerns raised	NA	Record 10 Record 10A Record 10B
Commonwealth Fisheries Association (CFA)	Commonwealth Fishing Industry Association	PGS Letter (13/11/16) Delivery Receipt (13/11/16) PGS Resend (23/12/16)	No response provided.	No issues or concerns raised	NA	Record 11 Record 11A Record 11B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Commonwealth Fisheries Association (CFA)	Commonwealth Fishing Industry Association	PGS Email and Letter (08/09/17) Delivery Receipt (08/09/17)	08/09/17: PGS information update to CFA on Duntroon survey. No response received to date	No issues or concerns raised	NA	Record 11C
		PGS Update Letter (19/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 11D
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No issues or concerns raised to date	NA	Record 11E
		PGS Reminder Email (3/10/18)	**3/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 11F
Australian Maritime Safety Authority (AMSA)	Commonwealth Marine Safety Regulator and Combat Authority for Vessel spills in Commonwealth waters	PGS Letter (13/11/16) AMSA Read Receipt (14/11/16) (Record 12A) AMSA Email (15/11/16) (Record 12b)	**15/11/16:** AMSA advised that both EPP-46 and EPP-41 overlap the major east-west shipping routes in the GAB. The Duntroon survey (Phase 1 & 2) will encounter heavy traffic and this is of a concern to AMSA. Recommended measures include: • Guard/support vessel to support operations and be active and have exceptional communications with all commercial shipping in the area. There is a considerable speed difference between commercial and seismic vessels; • Survey lines are planned to minimise interaction with commercial shipping; • Seismic vessel must display day shapes, lights and streamer reflective tail buoys to indicate the vessel is in tow and therefor restricted in her ability to move. Visual and radar watches must be maintained on the bridge at all times. • Survey and support vessels will need to be active in maintaining exceptional communication with nearby commercial shipping • Survey vessel to notify the Joint Rescue Coordination Centre (JRCC) through [EMAIL] for radio-navigation warnings 24-48 hours before operations commence. The JRCC will require the vessel's details (name, call-sign and Maritime Mobile Service Identity (MMSI)) satellite communications details (including INMARSAT-C and satellite phone) and area of operation and need to be advised when operations start and end. • The AHS must be contacted though [EMAIL] no less than 4 working weeks before operations commence for the promulgation of related Notices to Mariners (NTM). • Please contact [EMAIL] with any queries or updates to the survey.	All, but one precaution has been adopted for commercial shipping/fishing within the Environment Plan (refer **Section 6.8**). PGS cannot realign the survey lines. For operational safety and data quality reasons the preferred shooting direction in the GAB is determined by the dominant swell direction. Seismic acquisition in the GAB is preferred to run perpendicular to the wave direction (parallel to the wave crest/trough line) (i.e. not east/west parallel to shipping routes). The additional benefit of acquisition in this direction is that data quality is improved. The pressure variations induced by the swell over top in hydrophones become relatively consistent (not dynamic or "pulsing"). The increased data quality leads to improvements in safety by reducing exposure hours (shorter project duration). Acquiring data in alternative directions would entail additional time to re-acquire data not accepted due to the severity of "swell noise". This is a real and very significant issue when acquiring in areas of high magnitude and long period swell (GAB). Unfortunately, some acquisition programs, such as 2D marine seismic, require more than a single direction of acquisition to provide a beneficial data volume. Where this type of technique is required most of seismic lines should be ideally oriented perpendicular to the dominant wave direction. As a necessity to tie in the sparse grid of widely spaced 2D lines some additional lines may be required parallel to the wave direction.	Email acknowledging control measures and notification periods.	Record 12 Record 12A Record 12B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Maritime Safety Authority (AMSA)	Commonwealth Marine Safety Regulator and Combat Authority for Vessel spills in Commonwealth waters	PGS Email (28/04/17)	28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No claims or objections raised.	NA	Record 12BA
		PGS Email and Letter (11/09/17) AMSA Email Response (12/09/17)	**11/09/17:** Update to Duntroon survey provided to AMSA. Response Summary includes the following: Thank you for providing AMSA with an update on the Duntroon MCD and MC2D marine seismic surveys. Thank you also for providing information in your *Table 2: Duntroon Options/Controls assessment to reduce interaction with commercial shipping*, and ALARP assessment. Please note the proposed survey areas in both EPP-46 and EPP-41 (where most of the survey activities will occur) overlap the major east / west shipping route through the Great Australian Bight. This is a commercial shipping route for vessels transiting between Cape Leeuwin, Western Australia and Ceduna, South Australia. The proposed Duntroon survey will encounter transiting heavy vessel traffic and is of primary concern to AMSA. Note that there are more vessels traversing this area since AMSA communicated with you in November 2016 and with the previous plot showing data from July to September 2016. On average the updated Duntroon operational area will encounter 4+ heavy commercial vessels per day. PGS has stated that the length of tow for the 3D MSS is up to 12 streamers with a length of 8,100m and an estimated width of 1,800m and the length of tow for the 2D MSS is one streamer at approximately 10km in length. Considering the length of tow, the guard/support vessel is recommended to be active in cooperation with the survey vessel to maintain exceptional communications with all commercial shipping in the survey area. This is because there will be a considerable speed difference between commercial shipping and the survey vessel whilst the latter is conducting operations. It is worth noting that any related avoiding action by commercial shipping, should it be necessary, should not increase and/or compound the navigational risk to other shipping in the vicinity and hence it is highly recommended that survey lines are planned to minimise this interaction with commercial shipping.	As per previous entry, PGS will adopt all controls listed except alignment of seismic lines with shipping channels. The assessment of merits for this control has been provided in the previous entry.	Information has been provided in response email.	Record 12 C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Maritime Safety Authority (AMSA) (Con't)	Commonwealth Marine Safety Regulator and Combat Authority for Vessel spills in Commonwealth waters	PGS Email and Letter (11/09/17) AMSA Email Response (12/09/17)	The seismic vessel must display appropriate day shapes, lights and streamers, reflective tail buoys, to indicate the vessel is towing and is therefore restricted in her ability to manoeuvre. Visual and radar watches must be maintained on the bridge always. The survey vessel and any support vessels will need to be active in maintaining exceptional communications with any nearby commercial shipping. Please have the survey vessel notify the Joint Rescue Coordination Centre (JRCC) through [EMAIL] (Phone: [PHONE] or [PHONE]) for radio-navigation warnings 24-48 hours before operations commence. The JRCC will require the vessel's details (including vessel name, call sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone) and area of operation and need to be advised when operations start and end. Additionally, the Australian Hydrographic Service must be contacted through [EMAIL] no less than four working weeks before operations commence for the promulgation of related Notices To Mariners (NTM). Please contact us at [EMAIL] with any queries and updates to the proposed Duntroon Multi-Client Marine Seismic surveys	As above.	Please find Response in Record	Record 12 C
		PGS Update Letter (21/1/18) AMSA Response (22/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **22/1/18:** Thank you for the update on the Duntroon MC3d and MC2d seismic surveys. AMSA notes that this survey has been delayed until 2019, the survey timeframe and the modified MC3D survey area. Previous advice provided by AMSA on 12 September 2017 remains extant.	No Issues of concerns raised.	NA	Record 12D
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No additional feedback to date	NA	Record 12E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Australian Maritime Safety Authority (AMSA) (Con't)	Commonwealth Marine Safety Regulator and Combat Authority for Vessel spills in Commonwealth waters	PGS Reminder Email (1/10/18) AMSA Feedback (2/101/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds. **2/10/18:** AMSA has minimal additional feedback at this point in time regarding the possible extension of the MC3D/MC2D survey into the 2020 season. Provided you maintain the conditions you outlined in your 17 July 2018 letter to AMSA, in particular; • Notification of the survey by the survey vessel to the AMSA Joint Rescue Coordination Centre (JRCC) 24-48 hours before operations commence for radio-navigation warnings; and • Notification to the Australian Hydrographic Service no less than four working weeks before operations commence to allow for a Notice to Mariners to be issued. AMSA is satisfied with your proposed "planning notification". However, given the project uncertainty and long timeframe till the operation commences please provide us with updates as operations develop.	PGS will keep AMSA advise of any changes to the survey developments.	NA	Record 12F Record 12G
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Scientific Organisation which undertakes marine research in waters of the survey area	PGS Letter (12/11/16) Delivery Receipt (13/11/16) PGS Email (17/11/16) CSIRO Email (18/11/16) (Record 13A) PGS Response Email (19/11/16) (Record 13A)	**19/11/16:** Southern Bluefin Tuna Transect Lines provided to PGS by CSIRO	PGS has utilised information within Duntroon EP	NA	Record 13 Record 13A Record 13B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Scientific Organisation which undertakes marine research in waters of the survey area	CSIRO Email/Letter (04/01/17) PGS Response (24/01/17)	**04/01/17:** CSIRO provided a summary of research activities being undertaken in the GAB in addition to other research organisations involved in the GAB Research Program which also includes SARDI, Flinders University and University of Adelaide. CSIRO has also recently started a large---scale genetic tagging program in the GAB, funded by the CCSBT. The program aims to provide a Fishery independent estimate of absolute abundance of age 2 fish, to be used in the CCSBT management procedure and stock assessments. The method, known as gene---tagging, is a mark--- recapture method similar to conventional tagging but uses the unique genetic fingerprint from a small tissue sample collected from individual fish as the "tag" to firstly identify the fish on capture and subsequent release and then to identify a fish If it is recaptured. Initial tagging (collection of tissue samples from live fish with subsequent release) occurs in the GAB in late summer with tagging operations in 2017 scheduled for March and April. Re---sampling of fish occurs via commercially caught fish a year later across the fishing season (December---March). There is a real risk that the behaviour of juvenile SBT may be significantly altered during seismic operations. This may result in the: • Timing of migration into and out of the GAB • Proportion of the total juvenile population that SBT enter the GAB and/or • Surfacing behaviour of SBT while in the GAB. The area of the proposed seismic survey borders the southern end of several transects of the aerial survey in the eastern GAB. If the timing of seismic survey was to coincide with the timing of the aerial survey and any of the above changes in SBT behaviour were to occur, this would potentially impact on the index of abundance obtained from the fishery independent aerial survey and the gene---tagging abundance estimates and/or ability to find and tag fish. In addition, disruption to purse seine fishing operations would impact on the 'fishery dependent' index of abundance (from the commercial spotters). Finally, changes in behaviour and disruption of fishing activities will impact on the sampling operations for the gene---tagging study. Our strong preference is for the seismic survey to be undertaken at a time outside the November to March period of SBT migration into, and residence period within, the GAB. We are particularly concerned that there is a risk (both real and perceived) that the aerial survey and gene---tagging study results would be compromised by the seismic operations and that this could seriously undermine the confidence in the use of these indices in the monitoring and management of the stock at a very important juncture for CCSBT and the Australian fishery.	**24/01/17:** Survey for Season 1 has now been deferred to April 1 to May 31, so no impacts to activity are anticipated. With respect to Season 2, PGS will defer the Duntroon survey commencement to March 1, 2018 if similar CSIRO studies are being undertaken. PGS requires the operational flexibility of 3 months for the survey. PGS considers that there must be some accommodation within survey design to accommodate unforeseen conditions which prevent the survey from being undertaken and has requested these details. The revision to start dates for the survey for 2017 and 2018 is not anticipated to impact upon the total juvenile SBT population entering the GAB and affecting the survey results. Based upon the work of Popper et al (2014), behavioural impacts to fish types such as the SBT, might be expected within kilometres of the operational array. This localised disturbance is not expected to cause substantial displacement of stock. Spatial buffers applied to pontoons will limit impacts to the SBT in pontoons. *This information was conveyed to CSIRO in Record 13I.*		Record 13 C Record 13 D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Scientific Organisation which undertakes marine research in waters of the survey area	CSIRO Email 03/02/17 PGS Response (08/02/17) PGS Response email (21/02/17)	**03/02/17:** CSIRO request to provide information on all seismic activity that has gone on in the past post 2012 – specifically requested the PGS Springboard MC 3D MSS 2014 metadata on energy source, size and operation.	Relevant Information provided to CSIRO as requested (email 21/02/17). Clarified that Springboard survey was Ceduna Survey.	NA	Record 13E
		PGS Email (28/04/17) CSIRO Response (28/04/17)	**28/04/17**: PGS provided advice that the Duntroon survey would not proceed this season and will resubmit the EP to cover the period January 1 to May 31 next season. PGS will provide further updates. Would appreciate once the SBT survey is known. **28/04/17:** CSIRO appreciates the update. The final decision on the Aerial Survey and future gene-tagging activities will be made at the CCSBT Commission meeting in October this year; although we will have an indication after the Scientific Committee in September. CSIRO will be happy to advise you as soon as we have any substantive indication	Not Applicable	NA	Record 13F
		PGS Email (04/07/17)	**04/07/17:** PGS update requesting feedback on research, possible ways to mitigate impacts from surveys and to advise that the Duntroon survey was targeting Q1/Q2 2018 in the GAB for the Duntroon survey. No response received.	NA	NA	Record 13G
		PGS Email and Letter (11/09/17) Read Receipt (11/09/17) CSIRO Email (20/09/17) PGS Email (20/10/17)	**11/09/17:** PGS provided updated Duntroon survey details to the CSIRO. **20/09/17:** CSIRO advised that they provide a formal response ASAP. They had just attended the CCSBT Scientific Committee Meeting. No further response has been provided.	Not Applicable	PGS has provided information to CSIRO which provides details on why localised avoidance effects of SBT is expected (Record 13I).	Record 13H Record 13I
		PGS Update Letter (21/1/18) CSIRO Responses (22/01/18) CSIRO Response Email (24/01/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **22/01/18**: CSIRO thanks PGS for sending through the update on the status of the Duntroon survey. **24/01/18:** Thanks for the update. I will consult with my colleagues directly involved in the current GAB SBT projects ([CONTACT], [CONTACT] and [CONTACT]) and get back to you with any issues and our comments	No issues or concerns raised.		Record 13J Record 13K Record 13L
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback provided	NA	Record 13M
		PGS Reminder Email (15/10/18)	**15/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds	No feedback to date	NA	Record 13N

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Scientific Organisation which undertakes marine research in waters of the survey area	PGS Email Enquiry (6/11/18)	**6/11/18**: Email and information provision to CSIRO to provide assistance in feedback for the control measures adopted for the gulper shark.	No response to date	NA	Record 13O
Department of Environment, Water and Natural Resources (DEWNR) now Department of Environment and Water (DEW)	South Australian Environmental Department	PGS Letter (13/11/16) DEWNR email advising of change in Contact (14/11/16) DEWNR Email (14/11/16) (Record 14A)	**14/11/16:** Email advising of new DEWNR contact. Response to PGS letter will be forthcoming shortly (Record 14A). Advised that the survey was well away from SA waters and did not consider the activity to impact directly on the SA environment. Encouraged PGS to complete survey before May when the southern right whale commences migration to minimise risk to individuals which aggregate in SA water between May and November. Supported PGSs adoption of the EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales and its use of other measures to minimise the impact of your operations on other species and the environment.	**14/11/16:** PGS notes the feedback associated with the migration of the southern right whale in May and this impact has been considered within the Environment Plan (**Section 6.2.3.7**). PGS considers that it is necessary that the survey window extend into the May timeframe to allow for survey objectives to be met. All necessary controls to prevent interference will be adopted if present in the survey area as per EPBC Policy Statement 2.1 requirements. Based upon acoustic modelling, the southern right whale may exhibit minor deviations in migratory pathways due to sound however as the Duntroon survey is in open waters, this is not expected to create a barrier to their movement to the coastline. Acoustic modelling also identified that while present on the coastline in May, residual sound levels will not impede coastal calving or migration activities. PGS considers that the location of the Duntroon survey area and controls adopted should not significantly impact upon the southern right whale in coastal aggregations. *This response was provided to DEWNR in Record 14C.*	PGS acknowledged position with respect to southern right whales.	Record 14 Record 14AA Record 14A
		PGS Email and Letter (14/09/17) DEWNR Email Receipt (18/09/17) DEWNR Email (28/09/17) PGS (19/10/17) & DEWNR Email (20/10/17)	14/09/17: PGS information on the Duntroon survey provided to DEWNR. 28/09/17: DEWNR advises: Thank you for the opportunity to provide further comment. You have addressed as best you can the matters of concern to DEWNR. I have no further comment currently. 19/10/17: Further information sent on coastal aggregations by PGS. 20/10/17: DEWNR identifies that issue has been closed-out.	Not Applicable	PGS provided feedback on the modelling and impact assessment to advise that no significant impacts on coastal aggregations were expected.	Record 14B Record 14C
		PGS Update Letter (21/1/18) DEWNR (22/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. 22/1/18: DEWNR has no further comments. Thank-you for update	No issues or concerns raised.	NA	Record 14D
		PGS Update Letter (23/07/18)	**23/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No issues or concerns raised	NA	Record 14E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Department of Environment, Water and Natural Resources (DEWNR) now Department of Environment and Water (DEW)	South Australian Environmental Department	PGS Reminder Email (1/10/18) DEW Response (8/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds. **09/10/18:** DEW response identifies that notification arrangements are acceptable to them	No feedback provided.	NA	Record 14F
Department of Defence Science and Technology (DSTO)	Research Organisation	PGS Letter (13/11/16) Delivery receipt (13/11/16) PGS Resend (23/12/16)	No response provided.	No issues or concerns raised	NA	Record 15 Record 15A Record 15B
Department of Transport & Infrastructure (SA) (now Department of Planning, Transport and Infrastructure (DPTI))	State Combat Authority for oil spill response for vessels	PGS Letter (13/12/16) DTPI Read Receipt (Record 16A) DTPI Confirmation Receipt (13/12/16) DTPI Confirmation Receipt (23/12/16)	No response provided.	No issues or concerns raised	NA	Record 16 Record 16A Record 16B Record 16C
		PGS Email and Letter (5/10/17) DPTI email (09/10/17)	5/10/17: Provision of Duntroon Survey Information Update together with initial consultation material requested by DPTI in their August Consultation Guidance. 09/10/17: Advice provided by DPTI in response to Survey Information includes: • Marine Operations in DPTI have no comments to this proposed seismic survey in the GAB. • As all areas of survey as indicated in your plan are in Commonwealth waters, I assume that the Federal Hydrographer would publish a National Notice to Mariners. However, if you wish for DPTI to also publishes a State Notice to Mariners please let me know. If you could provide updates on mobilisation and demobilisation that would be good.	No adverse claims or objections. PGS does not consider that the activity, given the distance from shore warrants a State NTM and will not apply. PGS will include in Table 9-3 (Summary of Notification/ Consultation Triggers) relevant notification requirements.	NA	Record 16D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Department of Transport & Infrastructure (SA) (now Department of Planning, Transport and Infrastructure (DPTI))	State Combat Authority for oil spill response for vessels	Email DPTI (12/10/17)	12/10/17: Feedback on information update for Duntroon Survey and advised: • Oil Spill planning noted. DPTI also request early notification in the event of an oil spill; • The scientific monitoring contacts as requested are the SA Environmental Protection Agency: [PHONE] (either [CONTACT] or [CONTACT] as this is they're on call contact phone) • DPTI understand PGS is also consulting with other agencies such as DPC (Energy Resources area) too • As discussed, please take this and their comments as the DPTI response to your letter.	No adverse claims or objections. Information has been added to the oil spill response section of the EP (Section 7.7.23. – Initial Actions) and to Table 9-3 (Summary of Notification/Consultation Triggers)	Not Applicable	Record 16D
		PGS Update Letter (21/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 16E
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 16F
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 16G
Department of State Development (SA)	State Authority promoting development	PGS Letter (13/12/16) SDS Response (14/11/16) PGS Email response (14/11/16) PGS Email Response (14/11/16) (Record 17A)	**14/11/16:** DSD requested a meeting with PGS in association with visit to Port Lincoln and sought clarification of a standalone EP apart from Bight Petroleum's Lightning EP.	PGS clarified that EP would be standalone. Purpose of the reference was to provide stakeholders with idea of controls early in consultation.	PGS provided information (Record 17A)	Record 17 Record 17A

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Department of State Development (SA)	State Authority promoting development	PGS/DSD Meeting (21/11/16) (Record 17B)	**21/11/16:** Meeting to provide outline of proposed seismic plans over a two-season period commencing March 2017, with first season timing in line with previously approved Bight Petroleum EP • Seeking earlier start in EP for 2nd season, but that will be subject to stakeholder discussions; • DSD noted previous work done by Santos west of Kangaroo Island where significant numbers of Blue Whales were spotted using aerial surveys; • DSD had meetings with KI Council in the past where KI Council's concerns about exploration were relayed; • Discussed the complexities of the recently released FRDC paper on Scallops and Lobsters; ○ Relevant for meeting with SARLAC this afternoon; ○ PGS advised that they probably wouldn't argue the merits of that research at this point as need to review it in detail; ○ PGS to focus on hearing concerns at this stage, and seeing what issues are raised; • PGS advised stakeholder meeting schedule ○ Port Lincoln this week with a focus on ASBTIA and other fishers ○ Next week will visit Kangaroo Island • DSD to provide details of some past interested stakeholders by email so that PGS can check if they have been/are being consulted; • PGS described past discussions with ASBTIA as being positive despite significant difference of opinion on start date for the previous Ceduna MC3D; • Efforts were taken to see where PGS could assist industry/ local area and this would be continued ○ Previously provided useful data to SARDI, CSIRO and ASBTIA including raw sounder data, pelagic sampling, temperature and salinity data and 3D derived bathy; ○ Also trained and hired local MFOs. • DSD very supportive of project but keen to see PGS consider any local concerns DSD happy to arrange inter department meeting if deemed useful at an appropriate time should project proceed.	PGS has reviewed available data provided and obtained names of additional people requiring consultation. This includes: • [CONTACT](KI Futures Authority) • [CONTACT] (Tourism Operator) • [CONTACT] (Tourism Operator)	Meeting minutes were agreed between parties. PGS advised that DSD would be kept updated on progress.	Record 17B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Department of State Development (SA) (Department is now administered under Department of Premier and Cabinet and now Department of Energy & Mining)	State Authority promoting development	DSD Letter (09/12/16)	**09/12/16:** Department is supportive of the project but is keen PGS considers any local concerns particularly around the fishing industry and Kangaroo Island community interests. • Consultation with fishing interests is particularly important considering the recent FRDC report. • DSD is interested in feedback on meetings with KI stakeholders and Port Lincoln Stakeholders. • DSD would be happy to facilitate meetings with other agencies if required.	Verbal Feedback was provided to [CONTACT] by PGS by telephone in early December.	Verbal advice	Record 17C
		PGS/DSD Telephone Conversation (25/01/17) & (27/01/17)	**25/01/17:** [redacted] (DSD) advised that [CONTACT] has retired, and new contact was [CONTACT]. [redacted] also requested shapefiles for surveys offshore SA. PGS committed to providing shapefiles for the previous Ceduna 3DMC survey. **27/01/17:** [CONTACT](DSD) was provided with an update on activity and contact details.	No adverse claims or objections	NA	Record 17D
		PGS/DSD Meeting (08/03/17)	**08/03/17:** Met with SA DSD – [CONTACT], [CONTACT], [CONTACT] - Updated DSD on Duntroon submission, and stakeholder consultation - Confirmed that PGS would provide DSD with Nav. data from the Ceduna MC3D	No adverse claims or objections	NA	Record 17E
		PGS Email and Letter (01/09/17) DSD Letter (30 September 2017)	**01/09/17:** Updated consultation material sent to the DSD on the Duntroon Survey. **30/09/17:** DSD ([CONTACT]) provided the following response: • DSD aware that a similar letter sent to [CONTACT] (Executive Director of Energy Resource Division within DPC) and is pleased to know PGS is liaising with him Aware that PGS has carried out previous seismic surveys in the GAB without any significant environmental incident. On the basis that engagement processes and operational management will be undertaken for the Duntroon surveys, He is happy at this state to leave further comment and feedback to [CONTACT] and his team.	No issues, claims or objections raised,	Not Applicable	Record 17F

<table>
<tr><th>Stakeholder</th><th>Relevance to Activity (& 'interests')</th><th>Information Provided (Date, Method)</th><th>Summary of Response</th><th>Assessment of Merits of Adverse Claim/Objection</th><th>Operator's response to each objection/claim</th><th>Record No: Full Text of Communications with Relevant Person</th></tr>
<tr><td>Department of State Development (SA)

(Department is now administered under Department of Premier and Cabinet and now Department of Energy & Mining)</td><td>State Authority promoting development</td><td>PGS Email (01/09/2017)
DPC Email (04/09/2017)
PGS Email (06/08/17)
DPC Email (15/09/17)
PGS Email (19/09/17)
DPC Email (20/09/17)
DPC Email (26/09/17)
PGS Email (26/09/17)</td><td>01/09/17: PGS email and letter to provide DPC with updated survey information.
04/09/17: DPC requests a list of stakeholders which have been consulted on the project and advising of the point of contact for the seismic survey.
06/09/17: PGS provides updated stakeholder listing
15/09/17: DPC advises of additional stakeholders to be contacted:
The SA Government and the Energy Resources Division (ERD) recognise and acknowledge that NOPSEMA hold the responsibility to assess PGS's Environmental Plan in accordance with the OPGGS Act and associated Environment Regulations, but we very much appreciate the steps that PGS is taking to keep us informed of your plans.
DPC would like to supply the following feedback and suggestions:
We have some high-level feedback on the names of a couple of the SA Government Departments:
a) The "Department of Transport and Infrastructure" should be replaced with Department of Planning, Transport and Infrastructure
b) The Energy Resources Division ("ERD" – headed by Barry Goldstein) now sit within the Department of the Premier and Cabinet, so this department should be either be an additional stakeholder or could replace the Department for State Development in the list

For the remainder of the list, we would suggest that PGS considers expanding the list of stakeholders to include the following:
• the Environment Protection Authority (SA)
• Cetacean Ecology, Behaviour and Evolution Lab (Flinders University)
• Great Australian Bight Right Whale Study
• Appropriate additional fishery stakeholders and ENGO's; of note would be the SA Oyster Growers Association and the Great Australian Bight Alliance
• All operators in the GAB, to ensure and continue the consistent messaging that is being developed e.g. through the Great Australian Bight Exploration website [WEBSITE]

We would appreciate it if you would continue to keep us informed as your plans develop, and we wish PGS a safe and successful acquisition programme in the Bight.</td><td>PGS assessed and provided the following feedback on additional stakeholders:
1. a) Noted on DPTI; thanks
b) I should have been aware of this one given visits; we'll change DSD to DPC

2. a) SA EPA – noted, and we will send them an invitation to comment;
b) Cetacean Ecology, Behaviour and Evolution Lab (Flinders University) - noted, and we will send them an invitation to comment
c) Great Australian Bight Right Whale Study – will invite comment from [CONTACT] - [EMAIL]
d) Noted:
e) re SAOGA we'll send an invitation to [CONTACT]
f) re GAB alliance, they are a very loosely affiliated group rather than a coherent organization, so we have included key members, Sea Shepherd and Wilderness Society

e) Agreed that it is important that we maintain consistent messaging. I have been routinely joining the GAB group meetings and providing updates on our consultation.

We'll certainly keep you up to date, and I appreciate the support. In the meantime, if you ever need a specific update, please feel free to drop me a line or give me a call</td><td>Email of the commitments provided to DPC (as shown in the assessments column).</td><td>Record 17G</td></tr>
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Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Department of State Development (SA) (Department is now administered under Department of Premier and Cabinet and now Department of Energy & Mining)	State Authority promoting development	DPC Email (25/09/17) PGS Email (26/09/17)	**25/09/17**: DPC provides details of the following: The DPC Environment Team is circulating to tenement holders in the Great Australian Bight a copy of DPTI's Offshore Petroleum Industry Guidance Note. It aims to inform petroleum titleholders on the South Australian emergency management arrangements in respect to Marine Oil Pollution emergencies in State waters, their obligations under those arrangements and DPTI's expectations. As previously discussed, the Energy Resources Division notes that your planned operations are in Commonwealth-administered waters but, as outlined in the note "*This Guidance Note applies to all offshore petroleum activities with the potential to cause a Pollution Emergency in SA State waters……. These activities may occur in shallow coastal or deep oceanic environments in State or Commonwealth waters. This Guidance Note is relevant to the consultation requirements of both relevant State and Australian Government offshore petroleum legislation*" and hence I have attached a copy for your information. As an additional aid to titleholders, DPC has also summarised the respective roles of relevant South Australian Government agencies in relation to offshore oil spill response and planning within the attached word document. While not an exhaustive list, it does provide the key agencies, their respective roles and key contacts at each agency for consultation.	PGS will utilise the information and contacts to establish spill requirements in state waters and contact DPTI. Contacts have been made with other departments on the consultation listing except SAPOL. This agency will not be contacted as they oversee DPTI response. PGS will tactically respond to a spill so DPTI is the relevant agency for consultation purposes.	PGS advises DPC documents are very useful.	Record 17H
		PGS Email (04/10/17) DPC Email (04/10/17)	**04/10/17**: PGS Email to obtain contact details for reportable incidents. DPC response: Thanks for forwarding this query through. [CONTACT] is currently on extended leave to retirement and as such that email address is no longer suitable. Approvals and compliance for petroleum activities are managed by the Engineering Operations Branch. All reportable incidents should be sent through to [EMAIL]	No issues claims or objections. Information has been placed in Table 9-3 (Summary of notifications/Consultation Triggers)	NA	Record 17I
		PGS Update Letter (21/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.		Record 17J
		DPC Telephone Call (16/03/18) PGS Response (16/03/18)	**16/03/18:** DPC request to provide update on Duntroon survey plans together with the Zip File for survey. **16/03/18:** PGS response with information.	No issues or concerns raised	NA	Record 17K

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Department of State Development (SA) (Department is now administered under Department of Premier and Cabinet and now Department of Energy & Mining)	State Authority promoting development	PGS Letter Update (18/07/18) DEM Response Email (18/07/18) PGS Email (01/08/18)	**18/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **18/07/18:** DEM response – meeting is booked for 31st July with PGS **01/08/18:** PGS provision of shape files for the Duntroon survey (confidential)	No Issues of concerns raised	NA	Record 17L Record 17M Record 17N
		PGS Reminder Email (1/10/18) DPC Response email (8/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds. **9/10/18:** DEM response indicating: We assume that, if required, the current version of the Environment Plan already allows for a 2nd season of acquisition in CY2020, and that the notification periods you mention below for 2020 are consistent with those proposed within the EP for the CY2019 acquisition season. Could you please confirm these assumptions: The Department for Energy and Mining (DEM) recognise that the proposed survey will lie in Commonwealth waters and that the relevant statutory approval authority is NOPSEMA, rather than with the South Australian Government. We therefore offer only comment on the proposed milestones. DEM suggest that, in addition to the notifications you mention, stakeholders are notified • as soon as possible after the completion of the CY2019 acquisition period, to confirm whether the survey has either (i) definitely been completed in full, or (ii) has any chance of continuing into a 2nd (CY2020) acquisition season (with an estimated final decision-date being provided) • as soon as possible once a final decision has been made, even if that decision is that a 2nd acquisition season is not required.	Information associated with the EP covering two years is correct. PGS will include in stakeholder consultation (Section 9 – Table 9.1 & Table 9.3) the requirement to: • as soon as possible after the completion of the CY2019 acquisition period, to confirm whether the survey has either (i) definitely been completed in full, or (ii) has any chance of continuing into a 2nd (CY2020) acquisition season (with an estimated final decision-date being provided) • as soon as possible once a final decision has been made, even if that decision is that a 2nd acquisition season is not required.	NA	Record 17O
South Australian Research and Development Institute (SARDI)	South Australian Research Body	PGS Letter (12/11/16) PGS Resend (28/11/16)	No response provided.	No issues or concerns raised	NA	Record 18 Record 18 A
		PGS Email and Letter (08/09/17) SARDI Delivery Receipt (08/09/17)	08/09/17: PGS update information the Duntroon survey sent to SARDI	No issues or concerns raised	NA	Record 18B

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South Australian Research and Development Institute (SARDI)	South Australian Research Body	PGS Email 17/10/17 SARDI Email (19/10/17)	17/10/17: Request for availability of real time monitoring/forecasting tool to act as a predictor of upwelling conditions 19/10/17: Provision of website for forecasting tool	NA	NA	Record 18BA
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.		Record 18C
		PGS Letter Update (19/07/18)	**19/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **20/07/18:** Request to be taken off the mailing list as PIRSA gets the emails and response can be made at a departmental level.	SARDI has been removed from the mailing list	SARDI advised that PIRSA will continue to be updated on the project.	Record 18D Record 18E
		PGS Email (8/06/18) PGS Email (17/10/18) SARDI Email & Telephone Call (19/10/18) PGS Email (21/10/18) SARDI Response (5/11/18)	**8/6/18**: Email requesting use of forecasting tool and confirmation that the start of upwelling conditions commences in December. **18/10/18:** PGS information provided to SARDI on proposed monitoring/detection regime for upwelling in the KI Pool. **18/10/18:** [CONTACT] to call re detection program. **19/10/18:** Following our discussions today I note that you will not need our services until November 2019. In this case, we have ample time to agree on the precise reports you will need and get a contract in place. I will be in touch in the new year and will send the review paper on upwelling next week. **21/10/18:** PGS sought clarification of the following items to inform the EP from SARDI (answers provided appear in red): • The upwelling west of Kangaroo Island predominates during the period December 15 to March 10 – as you mentioned there always seems to be an upwelling event around March 3. YES • This is not an exclusive period with the possibility of upwellings occurring during the surrounding months (November, April) in the area. (YES but unlikely) • The upwelling west of Kangaroo Island is influenced by the Bonney upwelling. NO, but they occur around the same time	NA	NA	Record 18BA
Sub-Partners	Commercial Group proposing to install submarine cable in Duntroon survey area	PGS Email (301/12/16)	No response provided to date	No issues or concerns raised	NA	Record 19

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Sustainable Shark Fishing Inc.	Shark Fishing Industry Body	PGS Letter (13/11/16) Delivery Receipt (13/11/16) PGS Resend (28/12/16)	No response provided.	No issues or concerns raised	NA	Record 20 Record 20A Record 20B
		PGS Email & Letter (08/09/17) SSF Delivery Receipt (08/09/17)	**08/09/17:** PGS Letter providing update to Duntroon survey. *No response provided*	No issues or concerns raised	NA	Record 20C
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 20D
		PGS Update Letter (23/07/18)	**23/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 20E
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 20F
Kangaroo Island Council	Land Council adjacent to Duntroon survey area	PGS Letter (13/11/16) Delivery Receipt (13/11/16) PGS Email (15/11/16) (Record 21A)	**15/11/16:** PGS arranging meeting time with Kangaroo Island Council. Verbally the KI Council Mayor advises that the following organisations should be contacted: • KI Wild Migration • KI Eco watch • KI NRM Board (Natural Resources) • KI Dolphin Watch	NA	NA	Record 21 Record 21AA Record 21A Record 21AB

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Kangaroo Island Council	Land Council adjacent to Duntroon survey area	PGS/KI Council Meeting (30/11/16) (Record 22B)	**30/11/16:** PGS gave an overview of the project and advised project was not yet firm and was dependent upon receiving sufficient underwriting from oil companies.
			KIC advised that, while acknowledging the need for ongoing resource development, there were serious concerns within KI regarding oil exploration:
			• Serious concerns regarding impacts of large-scale oil spills, KI had invested heavily in its clean and green credentials (acknowledged by PGS).
			• Both PGS & KIC agreed on the importance of transparency in the EP preparation process, and ongoing operations. PGS acknowledged that there was some mistrust of the industry; to help alleviate concerns PGS is happy to:
			  ◦ Provide copy of EP upon submission to NOPSEMA;
			  ◦ Invite a KI representative to act in the capacity of Marine Fauna Observer; PGS to provide necessary training (offered in the spirit of transparency). KIC thought [redacted] to be a good candidate (PGS to check with [redacted])
			• [CONTACT] also raised concerns about seismic impacts on marine mammals. PGS advised they would use MFOs and Passive Acoustic Monitoring (PAM), and assessments of risks along with an outline of control measures to mitigate impact and risks would be contained within the EP.
			• [CONTACT] queried awareness of the recently issued FRDC paper on seismic impacts on Lobster and Scallops. PGS advised of its awareness of the paper and had discussions with SARLAC. The paper would be reviewed within the Duntroon EP.
			• While local concerns were understood, PGS appreciated the positive spirit in which the meeting was held.
				Meeting Minutes Agreed.
				
				Future actions noted and included within EP (Section 9).
					Meeting Minutes Agreed	Record 21B

		PGS Update Email (31/01/17)	**31/01/17:** Update to EP submission and revised date of commencement in 2017 to April 1, 2017.	No feedback provided.	NA	Record 21C
		PGS Email (09/03/17)	**09/03/17:** Arrangements to provide KI Council with copy of EP KI Council did not respond to this request.	No feedback provided.	NA	Record 21D
		PGS Email (20/04/17)	**20/04/17:** PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No response claims or objections raised.	NA	Record 21E
		PGS Email and Letter (08/09/17) Read Receipt (08/09/17)	**08/09/17:** PGS Information Update provided for Duntroon survey No response received to date	No feedback provided.	NA	Record 21F

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Kangaroo Island Council	Land Council adjacent to Duntroon survey area	KI Council Email (25/10/17) PGS Response Email (03/11/17)	**25/10/17:** Email requesting a copy of the EP submitted to NOPSEMA	Dropbox provision of the EP Provided.	NA	Record 21G
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 21H
		PGS Update Letter (20/07/18)	**20/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 21I
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 21J
Federal Member for Grey	Federal electorate adjacent to Duntroon Survey Area	PGS Letter (13/11/16) Delivery Receipt (13/11/16)	No response provided.	No issues or claims raised.	NA	Record 22
		PGS Email and Letter (01/09/17)	01/09/17: PGS information update provided on Duntroon survey	No issues or claims raised to date	NA	Record 22A
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 22B
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback provided	NA	Record 22C
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 22D
Federal Member for Mayo	Federal electorate adjacent to Duntroon Survey Area	PGS Letter (13/11/16) Recipient Receipt (13/11/16) (Record 23A) PGS email (08/12/16)	**08/12/16:** Email to arrange meeting with member for Mayo between 4th – 12th January. No response to date. Meeting not held.	No issues or claims raised to date	NA	Record 23 Record 23A
		PGS Email (28/04/17) Mayo response (28/04/17)	**28/04/17:** PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates. 28/04/17: Mayo response – email receipt.	No claims or objections raised.	NA	Record 23B

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Federal Member for Mayo	Federal electorate adjacent to Duntroon Survey Area	PGS Email and Letter (01/09/17) Read Receipt (01/09/17)	**01/09/17**: PGS information update provided on Duntroon survey	No issues or claims raised to date	NA	Record 23C
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 23D
		PGS Letter Update (17/07/18) Automatic Reply (17/7/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **18/07/18:** It is with great sadness that I have resigned as the Member for Mayo due to the High Court's clear ruling on citizenship matters. I am so sorry to put my community through a by-election. The High Court's ruling came as a great shock, as I have always believed I took all reasonable steps to renounce my entitlement to dual citizenship before the 2016 election. Although I have resigned, the Mayo electorate office will remain open until the by-election. If you require assistance, please do not hesitate to call the Mayo electorate office during office hours on [PHONE], or contact the Constituent Manager, [CONTACT], at [EMAIL].	No Issues or Concerns raised.	NA	Record 23E Record 23F
State Member for Finniss	State electorate adjacent to Duntroon Survey Area	PGS Email (11/11/16) PGS Letter (13/11/16) Email Delivery Receipt (13/11/16) Finniss Response (15/11/16) Meeting (PGS/Finniss) (29/11/16)	**15/11/16:** Meeting time set for 29th November. **29/11/16:** Briefing provided to [CONTACT] Meeting Record: I gave [CONTACT]a brief overview of the project and possible timing. [CONTACT] stated that he was supportive of the project and wished us well.	No claims or objections raised.	NA	Record 24 Record 24A Record 24B Record 24C Record 24D

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State Member for Finniss (Con't)	State electorate adjacent to Duntroon Survey Area	PGS Email (08/03/17) Finniss Email Response (09/03/17)	08/03/17: PGS feedback to advise that the: • The consultation went quite well overall • The environment plan has only just been submitted to NOPSEMA (Feb 27); submission was delayed for commercial reasons as project funding had become uncertain • PGS still hopes to acquire some seismic data this season, but this would be subject to approvals, vessel availability and commercial factors. Earliest start would be mid-April. • The EP has been submitted to also cover next season (earliest start Jan 1, 2018) Meeting could not be arranged. No meeting held	Not Applicable	NA	Record 24 DAA
		PGS Email (28/04/17) Finniss response (28/04/17)	28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates. 28/04/17: Finniss response – appreciated being updated.	No claims or objections raised.	NA	Record 24DA
		PGS Email and Letter (01/09/17) Read Receipt (01/09/17)	01/09/17: PGS information update provided on Duntroon survey	No claims or objections raised.	NA	Record 24E
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date.	NA	Record 24F
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 24G
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 24H
State Member for Flinders	State electorate adjacent to Duntroon Survey Area	PGS Letter (13/11/16) Flinders Receipt (14/11/16) (Record 25A)	**14/11/16**: Confirmation email from Member of Flinders of suitable timing for a meeting associated with the survey. **25/11/16:** Meeting with PGS. <u>Meeting Minutes</u>: I met [CONTACT], State Member for Flinders, on Nov 25, 2016 and provided a project briefing. [CONTACT] was supportive of exploration in the Bight and requested that we consult with the Port Lincoln based fishing industry as per the previous project in the Bight. [CONTACT] raised no concerns about the project.	No claims or objections raised.	NA	Record 25 Record 25A Record 25B Record 25BA
		PGS Email and Letter (01/09/17) Read Receipt (01/09/17)	01/09/17: PGS information update provided on Duntroon survey	No claims or objections raised.	NA	Record 25C
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date	NA	Record 25D

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State Member for Flinders	State electorate adjacent to Duntroon Survey Area	PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback provided	NA	Record 25E
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 25F
State Member for Goyder (now State Member for Narungga – Fraser Ellis)	State electorate adjacent to Duntroon Survey Area	PGS Letter (13/11/16) Delivery Receipt (13/11/16) Member Email (18/11/16) (Record 26A) Meeting (PGS/Member Assistant) (29/11/16)	**18/11/16:** Meeting time set for 29th November. **29/11/16:** Meeting held with PGS. Meeting Minutes: [CONTACT] assistant was in attendance during the briefing with [CONTACT]. No concerns were raised, and she provided no comments. No business card was received, and I omitted to record her name in my notes (Record 26B).	No claims or objections raised.	NA	Record 26 Record 26AA Record 26A Record 26B Record 26BB
		PGS Email (28/04/17) Goyder Response (28/04/17)	**28/04/17**: PGS provided advice that the Duntroon survey would not proceed this season and will resubmit the EP to cover the period January 1 to May 31 next season. PGS will provide further updates. **02/05/17:** Goyder appreciates the update.	Not Applicable	NA	Record 26BA
		PGS Email and Letter (01/09/17) Read Receipt (01/09/17)	01/09/17: PGS information update provided on Duntroon survey *No Response Provided*	No issues or concerns raised	NA	Record 26C
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date	NA	Record 26D
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 26E
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 26F
Shipping Australia	Commercial Shipping Interests in the survey area	PGS Letter (13/11/16) Email Delivery Receipt (14/11/16)	No response provided.	No issues or concerns raised	NA	Record 27
Australian Marine Conservation Society	eNGO	PGS Letter (14/11/16) Email Delivery Receipt (14/11/16) PGS Resend (28/11/16)	No feedback provided.	No claims or objections raised.	NA	Record 28 Record 28A Record 28B

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Blue Whale Study (BWS)	Research Group interested in Blue Whales	PGS letter (14/11/16) BWS Read Receipt (14/11/16) PGS Resend (28/12/16) Blue Whale Email (28/12/16)	**28/12/16:** Feedback provided identified that in certain seasons the vicinity of the shelf break west of Kangaroo Island is a feeding habitat for blue whales and is difficult to predict. It is possible the survey may encounter multiple whales. Whale diversity is also high including sperm, pilot and beaked whales, but blue whales present the greatest risk as call frequencies are like the acoustic array and may be disturbed. Disturbance could displace whales from feeding areas where krill is present and alternate food sources may not be available. They may be reluctant to leave the area once found. Would like to be kept on the information list to see how the survey is going.	PGS acknowledges the information which BWS has provided and the EP has considered all the whales identified in email. PGS has selected the January to May period to minimise as far as possible the encounter with blue whales. Controls have also been established which mitigate against displacement from feeding grounds (i.e. buffer of 3 km, support vessel look ahead, low visibility operations in areas where foraging whales are not present). PGS is more than happy to keep BWS advised of the progress of the survey.	28/12/16: PGS responded by acknowledging comments made regarding the whales which may be encountered in the survey area and advised that BWS would be kept appraised of the survey.	Record 29 Record 29A Record 29B Record 29C
		PGS Email (28/04/17) BWS Response (02/05/17)	**28/04/17**: PGS provided advice that the Duntroon survey would not proceed this season and will resubmit the EP to cover the period January 1 to May 31 next season. PGS will provide further updates. **28/04/17BWS** appreciates the update.	Not Applicable	NA	Record 29CA
		PGS Email and Letter (08/09/2017)	**08/09/17:** PGS update information on the Duntroon survey *No response received to date.*	No claims or objections raised.	NA	Record 29D
		BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	**20/10/17:** BWS letter contained the following concerns**:** 1. Periods of peak environmental sensitivity The letter states that the seismic survey will take place during January-May 2018, a period 'selected to avoid peak periods where environmental sensitivities are present in the region', and to avoid winter conditions. It is understandable to wish to avoid winter conditions, but the assertion that environmental sensitivities are not present during January-May simply does not stand up. Shelf break and associated secondary upwelling is a well-known and major feature of this region, with upwelling commonly occurring from November to April1. The PGS stakeholder letter identifies as a key sensitivity the Kangaroo Island and western Eyre Peninsula upwellings. This is an incorrect interpretation of upwelling in the EGAB. While surface upwelling appears off south-west Kangaroo Island and western Eyre Peninsula, these are secondary features of what is known as the 'Kangaroo Island pool', a large pool of upwelled nutrient-rich water from shelf-break upwelling south of Kangaroo Island that is carried alongshore and inshore by prevailing currents and bathymetry. The November–April upwelling season is the period of peak productivity in the southern Australian region and coincides with increased abundance in the southern Australian region of pygmy blue whales and of their prey, the krill *Nyctiphanes australis*, throughout the region.	The following forms the assessment of merit of the concerns raised. <u>Survey activities coinciding with periods of peak sensitivity/productivity in the eastern GAB:</u> PGS, in information provided on the 8th September, was seeking to convey that there were many sensitivities present within and surrounding the Duntroon survey area with differing temporal and spatial considerations in the survey period (January to May). It was not inferring that eastern GAB sensitivities were not present during the January to May period and the Duntroon Environment Plan (EP) certainly does not reflect this. PGS also appreciates BWS's clarification provided regarding the Kangaroo Island Pool and secondary surface upwellings. On reflection, PGS should have utilised the correct terminology for the Key Ecological Feature (KEF) – *Kangaroo Island Pool, canyons and adjacent shelf-break & Eyre Peninsula upwelling* - in describing the feature and its associated sensitivities. The information you quote from McClatchie et al (2006) has been utilised within the Duntroon EP to describe the mechanism which creates the upwelling conditions, although it is noted that secondary surface upwelling events are also influenced by 'upwelling favourable' south-easterly wind regimes.	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)		Middleton & Bye (2007) identify these upwelling favourable events to occur between December and March, although *coastal* upwellings have been reported during November-April (Van Ruth, 2009)4. Recent discussions with CSIRO (J. Middleton, pers. com, October 2017) reconfirmed that most upwellings occur within the period mid-December to mid-March. PGS recognises that regional environmental sensitivities (e.g. blue whales, high productivity fisheries) during this period lie *on the continental shelf* or *at the shelf break* and are directly associated with the Kangaroo Island Pool upwelling and these secondary surface upwelling events. PGS has taken a precautionary approach with respect to this KEF and reduced the Duntroon survey timeframe to March 1-May 31, 2018 to limit the temporal overlap with periods which have a higher likelihood of KEF upwelling/productivity. For March, spatial controls are adopted by commencing MC3D survey activities in the deeper off-shelf areas of the EPP-41/42 MC3D survey polygon **OR** MC2D survey activities in EPP-46, a low-density survey which does not spatially overlap the Kangaroo Island Pool or the areas which show secondary surface upwellings. Given this temporal and spatial buffer, PGS considers that the Duntroon survey will not significantly impact upon the KEF or areas of high productivity. PGS considers that the survey timeframe - March 1 to May 31 – is the minimum required to complete the Duntroon survey scope. The survey cannot be shifted into the June/July timeframe due to unsuitable survey weather conditions and vessel safety considerations. PGS considers on a temporal and spatial basis the controls adopted to prevent impacts to the KEF to be as low as reasonably practicable (ALARP).	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

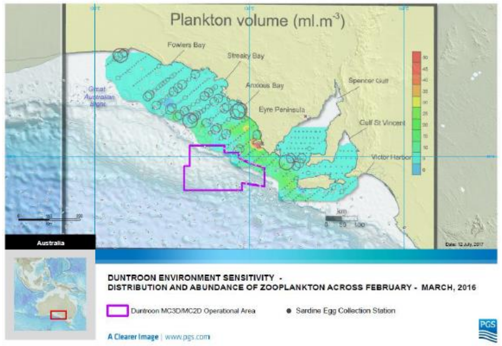
Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	It is true that sightings of blue whales in the EGAB by BWS have occurred mainly in the month of December (2003 and 2005). During December 2003 high densities of blue whales were feeding on very large surface swarms of krill very close to the Duntroon MC3D survey area. At such times blue whales were more common in the EGAB than in the neighbouring Bonney Upwelling region, suggesting that under certain conditions the region is important feeding habitat for blue whales. A diversity of other cetacean species have also been observed in the EGAB by the Blue Whale Study during January to May, including fin, minke, sperm, pilot, killer and Shepherd's beaked whales, and Risso's, common and bottlenose dolphins. Almost nothing is known of the ecology and movements of these species in this region. Seasonal productivity here is also strongly linked to the highly productive sardine, anchovy and southern Bluefin tuna fisheries.	Blue whale sighting data: PGS has collated all available public and industry data on cetacean presence, including the pygmy blue whale, from cetacean surveys undertaken in the eastern GAB and observation results from previous marine seismic survey (MSS). This includes both the PGS Ceduna MSS (Nov 2011 – May 2012) and TGS Nerites MSS (Jan-Jun 2014) surveys; the IFAW Survey (April-May 2013); and both papers which you authored/co-authored5 6. Recorded data supports the presence of pygmy blue whales in November -December with isolated sightings in May. PGS understands the potential for the pygmy blue whale and the other whale species to be present in the survey area during the survey period (March to May). Accordingly, the acoustic impact assessment within the Duntroon EP addresses impacts to all cetacean species which may be present (including those identified in your correspondence) and adopts controls to prevent and mitigate impacts.	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	2. Blue whale buffer PGS states that during seismic acquisition there will be an 8km buffer around the seismic vessel, so presumably shutdown will occur if blue whales are sighted within this range. This buffer is much wider than is normally applied by the industry to pygmy blue whales, is this likely to become standard practice off southern Australia? However, I would like to know how blue whales will be detected and identified at this extreme range. Will scout vessels or aircraft close with them to confirm species identification?	Application of blue whale buffer during seismic acquisition: PGS would like to clarify that the spatial buffer between the acoustic source and pygmy blue whales quoted applies to foraging whales only to prevent displacement from biologically important areas. This spatial buffer does not apply to non-foraging whale species. This distance is based upon acoustic modelling performed by JASCO Applied Sciences for the Duntroon survey area and a sound pressure level (SPL) of 160 dB re 1µPa as recommended by the National Marine Fisheries Service (NMFS) (2013)7 to prevent behavioural disturbance from impulsive sounds to marine mammals. Across the differing seabed features of the Duntroon survey area, the following distances to this SPL threshold have been predicted: • Continental shelf: 7.5 km; • Continental slope: 9.2 km; and • Deep water: 5.8 km. Accordingly, the spatial buffer adopted between the acoustic source and foraging whales for the Duntroon survey is 10 km to prevent displacement of foraging whales from BIAs. This spatial buffer is applicable to the Duntroon survey only. PGS proposes the following to detect the presence of foraging whales. This uses a combination of aerial and vessel observation techniques: • Approximately 3 days prior to survey commencement an aerial survey will be undertaken to determine whale presence and activity type (i.e. foraging or migrating) in the survey area. • PGS may undertake additional aerial surveys during survey operations if the observed whale numbers are higher than expected and additional spatial data is required to supplement vessel-based surveillance; • At least one MFO will be present on each survey vessel to detect for the presence of whales and their activity type. Vessel crew members will also assist in observation activities;	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	(Refer Item Above)	• If foraging whales are detected within the BIA: ○ During daylight hours two vessels (scout/supply) will undertake surveillance at distances of ~ 7 km on either side of the survey vessel to inform the survey vessel of foraging whales and manage spatial separation; ○ Four hours prior to darkness, a vessel will scout the area scheduled for night acquisition activities to confirm whale presence. If foraging whales are encountered the survey vessel will move to an alternate acquisition line maintaining a 10 km spatial buffer to the foraging pod or if no such options for relocation exist night operations will not be undertaken.	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	3. Plankton A particular emphasis of the PGS letter is a response to McCauley *et al.* (2017). Attachment 1 challenges McCauley *et al.*'s findings, relying heavily on Richardson *et al.* (2017), but this document is not cited. Is this the report by CSIRO's Oceans and Atmosphere Business Office? This should have been made clear. McCauley *et al.* (2017) were criticised by Richardson *et al.* (2017) and by IAGC on the grounds that their sample size was small and they only measured effects out to 1.2km. However, as McCauley *et al.* point out, previously the range of effect on zooplankton was thought to be of the order of only 10m or so, nowhere near 1.2km. This is a startling disparity that begs the question: why has industry not already commissioned such research if they are concerned about adverse effects? IAGC has stated "*the project falls short of what would be needed to provide a convincing case for adverse effects from geophysical survey operations".* If industry is sceptical of these findings, why not provide the resources to enable a study that would provide a more convincing case one way or the other? As McCauley *et al.* pointed out, 3D surveys could have the potential to affect zooplankton communities across a wide area over weeks or months. If true, this should be of major concern to both the marine science community and the offshore industry. CSIRO modelling suggests that while 'local impacts' on zooplankton might be significant, 'on a regional scale impacts would be minimal'. They added that their modelling results should be applied with caution to other regions. Indeed, the North West Shelf is a very different region to the EGAB, which is regarded as much more productive. Krill is known to have a very patchy distribution, often occurring in productive 'hotspots'8, a feature of the EGAB during the upwelling season9. Indeed, the shelf break in the EGAB is likely to be a focal area for krill hotspots, as has been observed during BWS aerial surveys. So local impacts could be significant on a regional scale if krill aggregations overlap with seismic surveys, as could occur along the shelf break. An attempt has been made by PGS to mitigate effects on zooplankton by planning seismic operations during daytime, on the basis that krill carry out vertical migration to the surface at night and return to deeper water during daytime. However, *Nyctiphanes australis* is one of few krill species that commonly forms surface swarms during daytime10,11 and has been observed in close proximity to operating seismic vessels during BWS aerial surveys, both in the EGAB and elsewhere.	Potential seismic impacts to krill aggregation: PGS apologises for not providing the citation for Richardson et al. (2017)8. The report was compiled by the CSIRO Oceans and Atmosphere Division and the link to the document is https://publications.csiro.au/rpr/download?pid=csiro:EP175084&dsid=DS1. PGS would like to confirm that the offshore oil and gas industry is concerned with the disparity of plankton mortality results between McCauley et al. (2017) and numerous prior studies which have directly assessed sound impacts on plankton to understand this disparity. The following studies have been initiated: • The Australian Institute of Marine Science (AIMS) has secured approximately $12M of funding from Quadrant Energy through a Good Standing Agreement to undertake research into the impacts of seismic testing. One of four themes to be studied includes establishing the effects of seismic testing on plankton. The program commenced on 1 July 2017. • For the Duntroon survey, a joint PGS-CSIRO Research proposal is currently being scoped by CSIRO to evaluate the effect of seismic operations on organisms immediately around the survey. This is based on an earlier PGS-CSIRO collaboration in 2014/15 which provided bioacoustics data on schools and scattering data during active and inactive seismic operations. This methodology has the potential to provide information on nekton (20cm-100cm) and micro-nekton communities (small fish, crustaceans 2-20 cm) relative to the environment and seismic operations. • PGS is also aware that the Government of Canada, as part of the Environmental Studies Research Fund (ESRF), has recently called for proposals by scientific organisations to undertake studies into the effects of seismic sound on commercial fish, invertebrates and other species at risk (including plankton). The offshore oil and gas industry is also working on the marine vibroseis technology as an alternative to airguns. This technology has the potential to reduce most of the risks associated with the use of airguns, however this emerging technology is unavailable on a commercial basis to PGS.	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	**(As per Issue above)**	BWS has identified that: • McCauley et al. have identified that '*3D surveys have the potential to affect zooplankton communities across a wide area over weeks or months*'; and • '*CSIRO modelling suggests that while local impacts on zooplankton might be significant 'on a regional scale impacts would be minimal'. They added that their modelling results should be applied with caution to other regions and the NWS is a very different region to the eastern GAB which is regarded as more productive*'. PGS provides for BWS's information (below), the distribution and abundance of zooplankton during February-March 2016 collated as part of the annual sardine egg collation survey together with the Duntroon operational area boundary. PGS notes that there is minimal overlap between the Duntroon survey area and continental shelf, and the overlap area does not contain high productivity surface upwellings. PGS agrees that the eastern GAB is more productive the NWS, however this enhanced productivity is intermittent during upwelling periods and is present in certain locations (i.e. continental shelf and shelf break). As per the explanation provided in Item 1, PGS, in limiting the Duntroon survey timeframe to March 1 -May 31 this reduces the temporal overlap with periods considered as having a higher probability of intermittent upwelling (i.e. December to February). For March, spatial controls are adopted by commencing MC3D survey activities in the deeper off-shelf areas of the EPP-41/42 MC3D survey polygon **OR** MC2D survey activities in EPP-46, a low-density survey which does not spatially overlap the Kangaroo Island Pool or the areas which show secondary surface upwellings. Given this temporal and spatial buffer, PGS considers that the Duntroon survey will not significantly impact upon areas of high productivity (i.e. zooplankton/krill).	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

Stakeholder	Relevance to Activity (& ‘interests’)	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator’s response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	(As per issue above)	 PGS appreciates the information provided on the vertical migration characteristics of krill, *Nyctiphanes australis*, however would like to clarify with BWS that PGS has not attempted to mitigate the effects on zooplankton by planning seismic operations during daytime hours only. As provided in the letter dated 8th September 2017 this control suggested by Richardson et al, 2017 is not considered effective as the “*seismic signal does not attenuate sufficiently with depth (design parameter not considered relevant*)’. However, PGS has adopted the following controls identified by Richardson et al, (2017) to limit the impacts to plankton: • The Duntroon surveys will be undertaken in the March – May period where the observed surface circulation in the eastern GAB is larger than the November-February period; • Surveys conducted in regions off the shelf edge are likely to have less absolute impact as zooplankton biomass is generally lower offshore. Most of the Duntroon operational area lies in offshore waters (~78%) which should have less absolute impacts on plankton stock. • Undertake activity in seasons with lower zooplankton biomass should ensure there is less absolute impact. The timeframe and spatial buffers imposed on the Duntroon survey has been selected to prevent impacts during upwelling events.	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Letter (20/10/17) PGS Response (13/11/17) BWS Email Acknowledgement (14/11/17)	Finally, it may be a naïve question, but if a 150 cu in airgun can conceivably cause krill mortality at the range stated by McCauley *et al.* (2017), what would a 3000 cu in commercial array be capable of?	PGS also would like to address the following query raised by BWS – *if a 150-cui airgun can conceivably cause krill mortality at the range stated by McCauley et al. (2017), what would a 3000-cui commercial array be capable of?* The source array utilised in the McCauley et al (2017) field study utilised the 150 in3 array in shallow water to simulate sound exposures expected during deeper water acquisition. This study was primarily focussed around impacts to scallops and lobsters with a very limited (2 day) study of impacts to plankton. The Richardson et al. (2017) (CSIRO) review was based on McCauley et al. (2017) work and extrapolated impacts from the 150in3 airgun to an array of ~3,000 in3 similar to the array proposed by PGS.	Stakeholder provided with assessment as contained in the assessment of merits column.	Record 29E Record 29F
		PGS Update Letter (21/1/18) BWS Response (22/01/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **22/01/18:** BWS will take a good look at the content.	No claims or objections raised.	NA	Record 29G
		PGS Email (19/06/18) BWS Response (25/06/18)	**19/06/18 (PGS):** PGS email to discuss detection monitoring for blue whale during the November timeframe. Information provided includes: Thank-you for your time yesterday to discuss possible ways of monitoring environmental conditions in and around the Kangaroo Island upwelling with a view to detecting conditions favourable for blue whale foraging. As discussed yesterday, PGS are moving the Duntroon MSS timeframe from March to May 2019 to September to November 2019. This is to avoid upwelling conditions as far as possible which lead to foraging blue whales in the biologically important area (BIA) to the south/west of Eyre Peninsula and Kangaroo Island. Discussion with John Middleton (SARDI) and review of the upwelling scientific literature identified that upwelling conditions prevail in the area between December and March, however there is a possibility of upwelling conditions during November. As PGS would like to prevent seismic interaction with foraging blue whales, PGS would like to, particularly in the November timeframe, monitor environmental parameters so that upwelling-related conditions are identified with a view to halting the survey if blue whales are detected coincident with these foraging conditions.	No further information forthcoming to date.	NA	Record 29G

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	PGS Email (19/06/18) BWS Response (25/06/18)	Recognising that more detail is required around the environmental monitoring parameters; definition of the numerical 'range' of individual parameters of interest; the interaction of individual parameters; lead times to establish 'favourable upwelling conditions'; and an assessment methodology which is independent and verifiable, I am currently looking at the following monitoring and detection framework for the Kangaroo Island Pool upwelling (preliminary only – seeking feedback): • Environmental parameters: o Wind direction and speed (recognising the SE wind component contributing to the upwelling) (from BOM); o Sea bottom temperatures (SBT) within the upwelling area/foraging BIA (SARDI http://pir.sa.gov.au/research/esa_marine/sarom); o Sea surface temperatures (SST) in the upwelling area/foraging BIA (SARDI http://pir.sa.gov.au/research/esa_marine/sarom); o Sea surface chlorophyll (SSC) in the upwelling area/foraging BIA (perhaps IMOS Site https://portal.aodn.org.au/search); • According to a structured assessment methodology which identifies conditions suitable for upwelling & foraging, if conditions are triggered - deploy aerial surveillance to verify if blue whales are present in the BIA; • If presence is detected, survey will be halted. If presence is not detected, aerial surveillance would continue until blue whale encounter in the BIA was detected – at that time the survey would be halted. I would appreciate your initial feedback of this skeleton framework, the parameters monitored and your opinion on the effectiveness of this methodology and aerial surveillance as a platform for blue whale detection during the commencement of upwelling conditions. **25/06/18 (BWS) Response:** Sorry I haven't responded yet, was caught up with other things and have had little time. Will try to get back to you in the next couple of days, cheers [CONTACT].	No further information forthcoming to date.	NA	Record 29G
		PGS Update Letter (24/09/18)	**24/09/18 (PGS):** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. This also included a copy of the revised modelling and the monitoring and detection methodology for blue whales during November.	No response received to date.	NA	Record 29H
		PGS Reminder Email (3/10/18)	**3/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 29I

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Blue Whale Study (BWS)	Research Group interested in Blue Whales	BWS Response Email (15/10/18)	**15/10/18:** Thanks for your update on the Duntroon survey proposal. I'm sorry about the long delay in replying. I won't comment on the acoustical analyses in that comprehensive report but have a few minor comments on the letter itself. I appreciate that you have addressed our concern about the survey timing by shifting to the September-November period. That period is much less likely to have an impact on foraging pygmy blue whales, though we can't rule out their appearance in October or November. We have sometimes sighted them off Portland during these months in the recent past. I also appreciate the approach you are taking to monitor the onset of upwelling-favourable conditions using wind stress and SST. I wasn't aware that SARDI still had access to a sea bottom temperature logger but if so that data would only be available when the logger was serviced. As you noted, sea surface chlorophyll-a would also be a useful measure but most upwelling in this region is sub-surface, so chl-a imagery would not be much help. Remember that krill can still be present in the system even before upwelling is established at the start of a season, and we have noted whales feeding before the upwelling season itself has commenced. The letter notes that should upwelling-favourable conditions occur, aerial monitoring would commence. Please keep us in mind when considering this work, as Blue Whale Study has considerable expertise in this field, having pioneered blue whale aerial surveys in the Bight.	PGS has done an extensive literature search to identify the seasonal distribution of pygmy blue whales along the southern coastline of Australia. The season September to November was selected to avoid pygmy blue whale presence and in particular foraging pygmy blue whales. PGS is now seeking to verify this anecdotal information provided by BWS. Accordingly PGS has requested BWS to supply further information with regard to: • Sighting data for pygmy blue whales 'in the recent past' off Portland during October; • Activity (i.e. migrating, foraging) for pygmy blue whales sighted in October off Portland; • Data supporting 'foraging activity' prior to upwelling and the location of the foraging activity in that instance. PGS also provided data with respect to the SARDI monitoring stations: SARDI monitors the ocean conditions in the Otway through the Southern Australian Regional Ocean Model (SAROM) at 34 SAROM site stations around the southern shelves (refer http://pir.sa.gov.au/research/esa_marine/sarom). This provides hind-cast, now-cast and forecasts for ocean conditions along the southern shelves. SARDI have advised that they will be able to monitor the water conditions and identify upwelling events through this model. Thanks once again for your feedback it is always appreciated and would be great if you If you have additional information you could supply on the pygmy blue whale sightings/activity.	Information contained in Record 29I	Record 29I
Conservation Council of SA	eNGO	PGS Letter (14/11/16) CCSA Read Receipt (14/11/16) PGS Resend (28/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 30 Record 30A Record 30B
International Fund for Animal Welfare (IFAW)	eNGO	PGS Letter (14/11/16) IFAW Read Receipt (13/11/16) (Record 31A) PGS Resend (28/12/16) IFAW Automatic Reply (28/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 31 Record 31A Record 31B Record 31C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Kangaroo Island Dolphin Watch	Conservation/ Ecotourism Business on Kangaroo Island	PGS Letter (14/11/16) KI Dolphin Watch Response (20/11/16) PGS Email (21/11/16) (Record 32A)	**20/11/16:** Response identified the following: • Three separate submissions made regarding the Bight Petroleum survey. Contact KI Dolphin Watch if they cannot be accessed. • Organisation has had ongoing discussion with NOPSEMA about impacts of anthropogenic sound; • Enquired if PAM was still being adopted.	PGS will request link to previous comments made by KI Dolphin Watch. PAM is still being assessed and an answer should be able to be provided at a future meeting to be held.	PGS would appreciate the link or send us those three KI Dolphin Watch submissions. Regarding PAM, this is under review along with all aspects of the EP, but it is expected that confirmation will be made during visit to Kangaroo Island in next week.	Record 32 Record 32A
		KI Dolphin Watch Email (24/11/16) PGS Email (24/11/16) (Record 32B)	**24/11/16:** KI Dolphin Watch provided links to previous submissions made regarding seismic in the GAB. Opposition to plans was related to the safety of cetaceans and their habitat. Until this can be assured KI Dolphin watch will continue to remain opposed to seismic surveys. The use of PAM is a base level requirement which Bight agreed to. This should remain the same with the Duntroon survey given the species likely to be encountered.	PGS agree to use of PAM. Response to general issues raised in previous Bight Petroleum and CGG survey will be assessed and a response provided.	NA	Record 32B

Kangaroo Island Dolphin Watch	Conservation/ Ecotourism Business on Kangaroo Island	KI Dolphin Watch (24/11/16)
		
		PGS Response (24/11/16) (Record 32B)
		
		PGS/KI Dolphin Watch Meeting (30/11/16)
			30/11/16: Key outcomes of KI Dolphin Watch meeting discussing the survey:
			• KI Dolphin Watch felt it was very important PAM was employed on the survey
			• KI Dolphin Watch wanted seismic companies to operate to the highest standards in terms of mitigating sound
			• PGS suggested to provide transparency in operations that KI Dolphin watch may wish to join the vessel in the capacity of a MFO. KI Dolphin Watch indicated they appreciated this initiative and suggested a young graduate. PGS agreed.
			• PGS agreed to provide the following data from the survey to the community from the survey:
			  ○ MFO and PAM Reports
			  ○ Water Temperature and salinity data as recorded
			  ○ Bathymetric data for 3D seismic (may take 9-12 months to obtain after seismic survey is completed).
				Meeting Minutes agreed between parties.	NA	Record 32C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Kangaroo Island Dolphin Watch (Con't)	Conservation/ Ecotourism Business on Kangaroo Island	PGS Email & Letter (04/01/17)	**04/01/17:** PGS letter responding to the KI Dolphin Watch impacts assessment issues which were sent in the KI Dolphin watch email on 24/11/16. Key issues identified within that material included: 1. The ecological importance of the Kangaroo Island Pool and Canyon system is an upwelling of enormous significance to migratory species including endangered species under the EPBC Act; 2. The assertion that there is "no significant evidence of lethal and sub-lethal impacts" or seismic exploration carried out in the natural environment with acoustic pulses (Physiological, behavioural, masking); 3. The assertion that there is "no significant evidence of lethal and sub-lethal impacts" or seismic exploration carried out in the natural environment with acoustic pulses (Foraging impacts); 4. The assertion that there is "no significant evidence of lethal and sub-lethal impacts" or seismic exploration carried out in the natural environment with acoustic pulses (avoidance and coastal breeding, prey displacement); 5. Entanglements/Marine Debris 6. Climate variability and Potential Impacts PGS considers all issues within this information have been assessed in the impact assessment within the EP.	PGS provides the following assessment: 1. PGS has assessed all listed species referenced in KI Dolphin watch comments on the Bight Petroleum referral submission and recognises its overlap with a portion of the Kangaroo Island Pool. Survey timeframes have been selected to avoid peak periods of presence but recognises the species may still be present. PAM will be used as a mitigation tool on the survey. 2. PGS will use an array with sound source of output equivalent to or less than the 3090 in^3. PGS recognises thresholds which protect whales from physiological impact as detailed in the EPBC Policy Statement 2.1 requirements adopting all relevant shutdown and power-down distances. PGS also recognises that marine sound can cause behavioural impacts and mask sounds, with wavelengths increasing and becoming less of a quick pulse. Masking at short distances due to the pulse nature is significant for the pulse but not for the duration in-between. At longer distances the modulated sound spectrum is expected to contribute to increased ambient marine noise for the duration of the survey. 3. Reduced foraging and abandonment of habitats has been observed with foraging behaviours disrupted (avoidance) when exposed to airguns. This has been observed in bowhead whales and perhaps in sperm whales. PGS has adopted controls to prevent foraging impacts. 4. PGS has assessed for avoidance behaviours which may extend to15 km (continental shelf) and 40 km (deeper) from the operational array based on CMST modelling. There are no areas where sound may restrict migration or deter species from adjacent coastlines. Marginal increase is not expected to significantly affect the metabolic demands of individuals who have migrated from the Southern Ocean. Given the attenuation of sound across the continental shelf residual sound levels in calving areas are not expected to be cause behavioural impacts. PGS has assessed the displacement effects for prey species in proximity to the source. As fish and squid are sound sensitive localised avoidance around vessel is probable, but on a temporary basis as the survey vessel is in constant movement. 5. Vessels will adopt MARPOL discharge requirements to bring risk marine debris entering the environment to low. 6. Recognising climate change variability, PGS has assumed all EPBC-listed species will be present.	NA	Record 32D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Kangaroo Island Dolphin Watch (Con't)	Conservation/ Ecotourism Business on Kangaroo Island	KI Dolphin Watch (17/01/17) PGS Response Email (19/01/17)	17/01/17: Feedback on MFO position for the survey. 19/01/17: PGS acknowledgement of position	NA	NA	Record 32D
		PGS Email (28/02/17) KI Dolphin Watch Email (02/03/17) PGS Email (02/03/17) KI Dolphin Watch Email (09/03/17) KI Dolphin Watch (07/04/17) PGS Email (20/04/17)	28/02/17: PGS advise that EP had been submitted to NOPSEMA with earliest start time April 1, 2017. Next season possible start Jan 1, 2018. 02/03/17: KI Dolphin Watch will look at the EP when time permits. 02/03/17: PGS indicates that a full EP can be provided if needed. 09/03/17: KI Dolphin watch requests full EP (& is sent) 07/04/17: Appreciates EP sent through providing the following feedback: • Thanks very much for sending the EP through. It makes interesting reading and obviously reflects our concerns. • It is a very comprehensive document and seems to have been developed in the right "spirit" with an understanding and acceptance that there will be some impacts and attempts has been made to mitigate to a high degree. Only one comment regarding indicators of stress in cetaceans .... they are not always obvious, as demonstrated clearly in the study by Rolland et al in the Bay of Fundy following the 9/11 attacks. The cessation of shipping traffic resulted in a marked drop in stress hormone levels in the whales. So, what we see is not always what we are getting. It is an interesting perspective which your people may like to take on board. 20/04/17: PGS advises that feedback from NOPSEMA identifies further work is needed on the EP and there are no plans to now acquire this season. The revised EP will only cover the 2018 season. 21/04/17: Ki Dolphin Watch appreciated being kept updated and looked forward to hearing how things progress and to let them know if any assistance was needed.	No concerns or objections were raised. Information provided only. Stress indicators are noted as a result of sound exposure. Rolland study is comparative with vessel (continuous sound). Assessment literature will use sound impacts associated with seismic operations.	NA	Record 32 E
		PGS Email (20/04/17) Survey Update KI Dolphin Watch Email (05/05/17) PGS Email (06/05/17)	20/04/17: PGS email to advise that the Duntroon survey would not be proceeding in 2017 but scheduled for 1Q/2Q 2018. 05/05/17: KI Dolphin Watch appreciated advice on change KI Dolphin Watch also provided an article about seismic testing on fish in case PGS was not aware of it. 06/05/17: PGS advised that the article had been considered and provided feedback on marine vibroseis – an upcoming technology.	PGS considered this study as part of the EP collation however the observations were undertaken on an opportunistic basis (i.e. no proper study design). The Woodside study on the Maxima 3D survey on reef fish is considered to be a more scientifically robust study.	NA	Record 32 F Record 32G
		KI Dolphin Watch (26/06/17) PGS Email (26/06/17) KI Dolphin Watch (28/06/17)	28/06/17: KI Dolphin Watch Please find attached an article regarding recent research findings related to seismic testing for consideration – Widely used marine seismic air gun operations negatively impact zooplankton (Nature Ecology and Evolution).	PGS will assess publication and consider the new data in the Duntroon EP. *Note further assessment is provided in PGS Correspondence (08/09/17) (below)*	Email correspondence confirming action (26/06/17)	Record 32 H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Kangaroo Island Dolphin Watch (Con't)	Conservation/ Ecotourism Business on Kangaroo Island	PGS Letter (08/09/17) KI Dolphin Watch Response (12/09/17)	08/09/17: PGS update for the Duntroon survey activity provided to KI Dolphin watch. Response summary follows: • Thanks also for the letter outlining the changes to the proposed surveys and changes made to the time frames and operations. We are assuming all other conditions including the use of PAM technologies etc. as previously agreed are still an integral part of the plan. • The discussions around Rob McCauley's paper make very interesting reading but do seem to work on the premise used so readily in the US .... that there is an acceptable level of "loss" which may have unknown impacts. We would of course prefer a platform of "do no harm" but understand the somewhat more pragmatic approach of the industry. We look forward to receiving the modelling and will liaise with Margi and Geoff accordingly.	PGS considers that an acceptable loss if one which does not prevent or damages ecosystem functioning. The level of impact is below natural mortality levels and hence unlikely to be significant on a plankton or ecosystem basis (Record 32I).	PGS acknowledged response.	Record 32I
		PGS Email (03/11/17) KIDW Email (09/11/17) PGS Email (09/11/17)	03/11/17: Email providing link to Dropbox to download the EP. 09/11/17: KIDW advise they will review and provide comment ASAP.	07/11/17: PGS advise that purpose if for transparency but always happy to get feedback,	Email response containing assessment of merit details.	Record 32I
		PGS Update Letter (21/1/18) KIDW Email Response (25/01/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. 25/01/18: Thanks for the update regarding the proposed programme and also for the information regarding [CONTACT]. His family have moved off the island and we haven't had contact with [CONTACT] for some time. We hope he is still keen to take up the option, but if not, we have some alternatives ready to take up the offer. Good luck with everything you are trying to do in terms of moving towards less invasive technologies. Your desire to progress this is greatly appreciated and could well lead to you positioning your organisation as world leaders as you know.	PGS will monitor MFO position.	NA	Record 32J Record 32K Record 32L

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Kangaroo Island Dolphin Watch (Con't)	Conservation/ Ecotourism Business on Kangaroo Island	PGS Update Letter (20/07/18) KIDW Response (23/07/18)	**20/07/18 (PGS):** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **23/07/18 (KIDW):** Thank you very much for the update with respect to PGS's planned Duntroon Multi-Client two-dimensional (MC2D) and Multi-Client three-dimensional (MC3D) Marine Seismic Surveys (MSS) ('Duntroon Survey') in the eastern Great Australian Bight (GAB). We will keep you and the regulator, NOPSEMA, abreast of emerging science re anthropogenic threats to the marine environment and to Cetaceans in particular. As you are aware this is an area of emerging new understandings.	PGS is happy to receive updates from KIDW on cetacean impacts from anthropogenic sound.	NA	Record 32M Record 32N
		PGS Reminder Email (1/10/18) KIDW Response (11/10/18) PGS Confirmation Email (15/10/18)	**1/10/18 (PGS):** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds. **11/10/18 (KIDW):** Thanks for your email. Our sincere apologies for taking some time to reply. The information you have set out is very clear and concise and I would simply make the comment regarding the time parameters in that the September 1to November 30 time frame, obviously seeking to avoid "Peak" whale season, may have some issues if next season follows the same pattern as this season in that there are still whales and calves in Encounter Bay as we speak. The same may well happen elsewhere. The expected risk of interactions may not be as low as expected given what we are seeing. All else in terms of notification milestones seems appropriate. Is it still PGS intent to have a nominated MFO from our organisation, trained and employed by PGS but acting independently, participate and similarly will PGS provide all data obtained to KI/VH Dolphin Watch as previously agreed with [CONTACT] when he was acting on behalf of PGS?	PGS appreciates feedback on the SRWs still present in Encounter Bay (east of KI) in early November. All assessments made in the Duntroon EP recognise the presence of SR whales along the coastline and undertaking migration away from the coastline. PGS still retains within the Duntroon EP an MFO from KIDW to participate in the Duntroon survey. Survey report provision as agreed with [CONTACT]is a firm commitment with KIDW.	Response contained in Record 32O	Record 32O
Kangaroo Island Eco-action	Conservation/ Ecotourism Business on Kangaroo Island	PGS Letter (14/11/16) PGS/KI Eco watch Telephone Conversation (01/12/16)	**01/12/16:** Eco-watch is against any exploration in the GAB as they do not consider it is the appropriate environment (i.e. not against exploration in general) KI Eco-watch was aware of the cetacean shutdown zones and wanted to be confident that there would be strict adherence to standard whale mitigation procedures.	PGS agrees that appropriate mitigations (including standard controls) will be put in place and will be followed.	PGS confirmed that appropriate mitigations would be put in place.	Record 33 Record 33A
Kangaroo Island Marine Action Group (KIMAG)	eNGO	PGS Letter (14/11/16)	No feedback provided.	No claims or objections raised.	NA	Record 34

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Wild Migration Limited (WML)	eNGO	PGS Letter (14/11/16) Telephone Conversation 30/11/16 (Record 35A) PGS/WML Telephone Conversation (30/11/16) (Record 35B)	**30/11/16:** Committed to the provision of: ○ Seismic source noise modelling ○ Provision of risk assessment section regarding Sea Lions once first iteration is prepared (followed by subsequent ones). Information is required prior to providing feedback. Additional items discussed: ○ PGS will endeavor to contact [CONTACT]direct with respect to possible impact to the rock lobster fishery ○ The project is not certain to proceed, as PGS would likely need sufficient industry funding prior to formally committing ○ PGS committed to Dolphin Watch [CONTACT] to train and place an MFO on board the vessel for a swing, with the candidate drawn from the local community, and ideally a graduate in a related field (demonstrates transparency in operations and implementing commitments in EP). WML may be interested in the [CONTACT] source suitable candidate.	Meeting minutes accepted between parties.	Meeting Minutes Accepted	Record 35 Record 35A Record 35B
		PGS Email (14/12/16)	**14/12/15:** PGS provided current section on Australian sea lion impacts contained within the EP to WML. Noting the following additional items: • Two sources are proposed – a 3090 in^3 and 3260 in^3 with a source timing of 7 seconds. The acoustic footprint for the larger array is smaller than the 3090 in^3 array due to the source element configuration. • Will not use specialised MFOs on chase boats. Crews of boats will be competent in carrying out observations and will work closely with the lead MFO.	N/A	Information Provided as written	Record 35BA

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Wild Migration Limited (WML)	eNGO	WML Response (16/12/16) PGS Email (23/12/16)	**16/12/16:** WML comments are as follows: 1. It is appropriate to provide the sound intensity over the full sound spectrum (o-p) and utilised for the EIA 2. NOAA's Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (2016) establishes that sound exposure level works well for marine mammals but not well for other marine species (crustaceans, bivalves, cephalopods, finned fish, etc.) because non-mammal marine species detect sound through particle motion (the organism resonating in sympathy with the surrounding sound waves) rather than through a tympanic mechanism as with marine mammals. A more informed measurement introduced to modelling is sound exposure level cumulative (SELcum) by which a time component is added to SEL enabling it to encompass all marine species. 3. Concern relates to the foraging of male and female sea lion during this time and the ability of lactating to females to sufficiently foraging to produce milk to care for pups. As such, we have always maintained that we are focused on the <u>impact of sound while animals are foraging</u>. You have rightly identified that the predicted breeding season for Seal Bay is September 2017 – January 2018. Equivalent information is available from researchers for the other pupping sites that are more acutely vulnerable to the proposal.	1. PGS considers that this is a valid position given the current modelling focusses on the low frequency area of the spectrum. 2. PGS considers that given the immediate foraging area of the Australian sea lion additional modelling adopting recognised NOAA PTS and TTS thresholds for pinnipeds is appropriate. SEL reading suitable for cetaceans as it conforms with EPBC Policy Guideline 2.1 requirements. 3. PGS acknowledge WML interest in the Australian sea Lion. PGS does not consider that the additional information on breeding at different locations will provide any additional basis on which to assess risk. As the species in asynchronous in breeding cycle, breeding will occur all year through (basis of EP). No further information is considered warranted.		Record 35C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Wild Migration Limited (WML) (Con't)	eNGO	WML Response (16/12/16) PGS Email (23/12/16)	• We appreciate the provision of the map where you have identified an overlap in the foraging area but are unsure how you have arrived at your overlap assessment of the Duntroon OA, given that the attachments do not provide modelling of sound dispersion throughout the area. The Bight Petroleum modelling that was released portrays an incomplete bandwidth profile and does not represent the full extent of noise propagation. This is crucial information to have omitted. The modelling also focused on three points within the Bright Petroleum lease area (PI, P2 and P3), not the full area the Duntroon OA proposes to survey. <u>Given these omissions and incomplete information we are not convinced by your assessment of impact to Australian sea lions.</u> • In most respects, noise-induced threshold shifts in pinnipeds follow trends like those observed in odontocete cetaceans. Unique to pinnipeds are their vibrissae (whiskers), which are well supplied with nerves, blood vessels and muscles, functioning as a highly sensitive hydrodynamic receptor system (Miersch *et al*, 2011). Vibrissae have been shown to be sufficiently sensitive to low frequency waterborne vibrations to be able to detect even the subtle movements of fish and other aquatic organisms (Renouf, 1979, Hanke *et al*, 2012, Shatz and Groot, 2013). Ongoing masking through ensonification may impede the sensitivity of vibrissae and the animal's ability to forage. • Seismic also change responses to fish and squid behaviour. Any changes to prey fields, induced by a man-made noise sources, will impact fauna higher up the food chain. • Assessment should consider that routine deep-divers, that dive to or below the deep sound channels, may be exposed to higher sound levels than would be predicted based on simple propagation models. Assessment should also consider convergence zones which may result in areas with higher sound levels at greater in areas with higher sound levels at greater ranges. • It is important that assessment of impact for pinnipeds considers both the physiological impact (temporary threshold shift and permanent threshold shift) as well as the very real possibility of masking, causing both behavioural responses and making less prey available. The Modelling of P1, P2 and P3, with its incomplete information is insufficient. Full professional modelling of the entire area to be surveyed, is required	4. PGS acknowledge the limitations with respect to the modelling with regard to Australian sea lions and will initiate further modelling to make a full assessment. 5. PGS considers that there is only potential for localized masking around the acoustic array given the preferred hearing frequency of pinnipeds. High frequency components will be received as pulses not continuous and potentially masks only a portion of the pulse timeframe. Absorption of the high frequency component of the sound spectrum occurs over a short distance. A full assessment will be made when modelling is obtained. 6. PGS has recognized that localized displacement may occur, however it will be temporary in any one location given the movement of the vessel. 7. PGS has assessed potential impacts to deep-diving species and placed controls around deep diving species such as sperm whales to ensure that impacts are mitigated to ALARP. This will be reviewed in light of any additional modelling received. 8. PGS commits to additional modelling.	Response to WML to indicate PGS agreement for additional modelling and awaiting project go-ahead before committing funds. Once sanctioned PGS will provide details of the modelling intended	Record 35D
		PGS Email (30/12/16)	**30/12/16**: Provision of next revision of the pinniped section of the EP based upon WML feedback	No response received to date.	NA	Record 35E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Wild Migration Limited (WML) (Con't)	eNGO	Wild Migration Limited email (02/01/17) PGS email response (24/01/17) WML Email (27/01/17)	**02/01/17:** Feedback from WML that the Harris Reference associated with cessation of feeding was not an observed outcome of the study. Cessation of feeding is a possible outcome based upon seals hauling out or avoiding the ensonified area. WML also identified use of the 160 dB re 1µPa RMS value (NFMS) to assess for behavioral impacts to sea lions within the modified EP text identifying that pulsive sound is not appropriate. **27/01/17:** WML accepted reasoning for the use of the NFMS metric.	**24/01/17:** PGS advised that the use of the 160 dB re 1µPa was the only appropriate value to be applied to assess to assess for behavioral impacts to pinnipeds. All other thresholds advised by WML for TTS and PTS in hearing have been adopted within the EP.		Record 35F
		PGS Email (28/02/17)	**28/02/17:** PGS advice that EP submitted. Earliest start date will be April 1, 2017. Expect the sound modelling to take approximately 4 weeks.	No issues of concerns raised.	NA	Record 35G
		PGS Email (28/04/17) WML Response Email (28/04/17) PGS Request Email (05/05/17)	**28/04/17:** Email to advise that the Duntroon survey would not proceed in 2017. The EP will be resubmitted for the period January 1 to May 31, 2018. **28/04/17:** WML appreciated being posted **05/05/17:** PGS requested names of researchers with information on pupping sites (no answer provided, subsequently found in literature)	No issues of concerns raised	NA	Record 35H
		PGS Email/Letter (14/09/17) Email Receipt (14/09/17) PGS Email (11/10/17)	**14/09/17:** Correspondence sent included an update on Duntroon survey scope; Acoustic Modelling Report, Assessment section on pinnipeds within EP and summary of recent plankton papers; **11/10/17:** Prompt to WML to determine if there was any feedback.	Not Applicable	Not Applicable	Record 35I

		PGS/WML Telephone Conversation (12/10/17)	**12/10/17:** WML feedback on the information provided (modelling and pinniped assessment section of EP) for review: This included:
			• WML clearly maintain a position of no oil and gas exploration in the Bight
			• However,
			    • WML are happy with the transparent consultation process;
			    • Pleased PGS was prepared to do new modelling to consider issues raised, and share the results;
			    • It's clear how the modelling has advised the survey design;
			    • WML understands that while there is no perfect time for the survey, PGS has taken into consideration all the recognised conflicting sensitivities;
			    • WML appreciate that PGS didn't restrict review of impacts to pinnipeds to just the "haul out" areas, but considered their range, their prey and masking.
			• On the provision that the sound modelling is included in the EP submission, you will be making no objections to the proposed project proceeding.
			PGS will send WML a copy of the full EP soon after submission to NOPSEMA, with just the individual correspondence removed for privacy reasons.
				No adverse claims or objections.
				
				PGS will provide a full EP to WML soon after submission.
					Not Applicable	Record 35J

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Wild Migration Limited (WML)	eNGO	PGS Email (03/11/17) WML Email (07/11/17) PGS Email (07/11/17) WML Email (21/11/17) PGS Response (21/11/17)	**03/11/17:** Email to advise of Dropbox details for obtaining a copy of the EP submitted to NOPSEMA **07/11/17:** Email advising that WML are looking forward to reading the EP and supplying comment if interested. **21/11/17:** WML request for drop-box link	07/11/17: PGS advise they are always happy to receive feedback 21/11/17: PGS resends link.	NA	Record 35K Record 35L
		PGS Update Letter (23/1/18)	**23/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 35M
		PGS Update Letter (24/09/18)	**19/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Due to WML interest in acoustic modelling, the revised modelling report was provided and additional controls relevant to sea lions (i.e. start-up delay/shutdown procedures) provided.	No response provided to date	NA	Record 35N
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 35O
PEW Environmental Group	eNGO	PGS Letter (14/11/16) PGS Resend (28/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 36 Record 36A
Whale and Dolphin Conservation Society (WDCS)	eNGO	PGS Letter (14/11/16) WDCS Receipt (14/11/16) (Record 37A) PGS Resend (28/12/16) WDCS Read Receipt (28/12/16) WDCS Response (29/12/16)	**29/12/16:** Query on the setting of dates for the 2017 survey when the Environment Plan for Karoon is not yet approved. Does this indicate the Bight lease will be carried out in 2017?	PGS clarified that the survey and EP will cover both areas with a target date of March 1, 2017 to commence. This could be in the Karoon, Bight or both areas.	Information provided back to WDCS (Record 37D)	Record 37 Record 37A Record 37B Record 37C Record 37D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Whale and Dolphin Conservation Society (WDCS)	eNGO	PGS Email (28/04/17)	28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No response, claims or objections raised.	NA	Record 37E
		WDCS Email Response (10/09/17) PGS Email and Letter (19/09/17) WDCS Email Response (19/09/17)	19/09/17: Letter to provide WDCS with an update to the Duntroon survey activities. No response provided to date.	Not Applicable	NA	Record 37F
		PGS Update Letter (21/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 37G
		PGS Update Letter (19/7/18)	**19/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 37H
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 37I
District Council of Lower Eyre Peninsula (DCLEP)	Adjacent council on coastline adjacent to survey area.	PGS Letter (14/11/16) DCLEP Delivery Receipt (Record 38A) PGS Resend (28/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 38 Record 38A Record 38B
		PGS Email and Letter (01/09/17)	01/09/17: PGS information update provided on Duntroon survey No response provided.	No claims or objections raised.	NA	Record 38C
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 38D
		PGS Letter Update (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 38E
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 38F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
City of Port Lincoln	Adjacent council on coastline adjacent to survey area.	PGS Letter (14/11/16) Reader Receipt (14/11/16) (Record 39A & 39B) City of Port Lincoln Email (20/11/16) (Record 39C)	**14/11/16:** City of Port Lincoln happy to meet to discuss program. **20/11/16:** Councillors will be made aware of the planned surveys. If the project proceeds, city would be keen to maximise the port and land-based activities in Port Lincoln. Requested liaison with relevant fishing sector organisations in the southern Eyre peninsula about the proposal and address any concerns they have. Please to receive notifications as outlined in the letter. Would like to be kept updated on the progress of the EP and approvals and the pre-survey program generally.	All points are noted. Liaison with fishery organisations is proceeding.	PGS Response: Thanks for the email, and all points noted. A general fisheries meeting is being organized by ASBTIA for this Thursday and will include other fisheries. If any are unavailable, we will follow up accordingly.	Record 39 Record 39A Record 39B Record 39C
		PGS/City of Port Lincoln Meeting (23/11/16) (Record 39D)	**23/11/16**: PGS gave an overview of plans and timing in line with notification. PLCC would like to see local opportunities maximised (use of local vessels). PGS advised that it was unlikely to mobilise helicopter emergency support for this project. Crew changes would be though Port Lincoln every 5-6 weeks and some refuelling was likely. PGS will look at a local chase boat if suitable vessel available and commercial terms cab be reached. PLCC supportive of project, however needed to work cooperatively with the fishing industry. PGS advised that meeting would be held with ASBTIA next day PGS advised that key commitments made by Bight Petroleum regarding working with the fishing sector and addressing relevant concerns (as per their EP that is in public domain) would be honored, although discussions would be held on whether a longer operational window could be opened in the 2nd season. PL noted that recent media coverage, national environmental advocacy group action, increased local awareness and some fishing/aquaculture sector concerns, together with BP's recent withdrawal from its exploration program, had escalated interest and possibly created more polarized community views regarding oil and gas exploration and related activities – and planning for the Duntroon Seismic project should be in that context of increased community awareness and interest Both PGS and PL discussed the general issue of trust and transparency in the planning and operations of the oil and gas sector, and how it could be improved • PGS advised how, in its work on another project, it had posted the-EP onto a stakeholder accessible website, with good results • PGS happy to provide full version of EP upon request but would remove individual correspondence and agreements for privacy reasons.	PGS continues to consult with local fisheries (refer separate entries).	Meeting Minutes accepted	Record 39D

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
City of Port Lincoln	Adjacent council on coastline adjacent to survey area.	PGS Email (28/04/17) PLCC (28/04/17)	**28/04/17**: PGS provided advice that the Duntroon survey would not proceed this season and will resubmit the EP to cover the period January 1 to May 31 next season. PGS will provide further updates. **28/04/17:** PLCC appreciates the update.	Not Applicable	NA	Record 39CA Record 39CB
		PGS Email and Letter (01/09/17) Read Receipt (01/09/17)	01/09/17: PGS information update provided on Duntroon survey	No claims or objections raised.	NA	Record 39D
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 39E
		PGS Letter Update (17/07/18) PGS Follow-up Email (26/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No issues raised from letter received.	NA	Record 39F
		PLCC/PGS Meeting (2/08/18)	**02/08/18:** Meeting Notes are as follows: Thanks for meeting with [CONTACT] and I this morning, it was nice to meet you and discuss our proposed activities and also gain an understanding for the motive behind the special council meeting later this month. As discussed, the below YouTube video is very informative about the zero impact of seismic on site attached fish communities in the Scott Reef off the Northwest Shelf. https://m.youtube.com/watch?v=f3XztyNbceA Also included is a link to the Australian Institute of Marine Science (AIMS) page outlining the long-standing relationship of monitoring the Scott reef environment. https://www.aims.gov.au/woodside Please don't hesitate to be in touch should you have any questions on the above or our Proposed Duntroon activities.	No issues or concerns raised	NA	Record 39G

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Regional Development Australia Whyalla and Eyre Peninsula (DAWEP)	Adjacent Coastline Regional Development Authority	PGS letter (14/11/16) DAWEP Delivery Receipt (Record 40A) DAWEP Email Response (14/11/16) (Record 40B) PGS/DAWEP Meeting (23/11/16) (Record 40C)	**14/11/16:** Email to confirm meeting timeframes **23/11/16:** At meeting PGS gave overview of plans for survey and DAWEP was supportive. PGS's previous project assisted with upgrades to jetty (refuelling) and airport (helicopter hangar) along with some local training and employment. PGS advised that it was unlikely to mobilise helicopter emergency support for this project. Crew changes would be though Port Lincoln every 5-6 weeks and some refuelling was likely. DAWEP advised that PGS needs to work cooperatively with the fishing industry. PGS advised that a meeting was being held next day with ASBTIA next day and key commitments regarding survey timing (as per Bight Petroleum EP) would be honoured although discussions would be held on whether a longer operational window could be opened in the second season. PGS advised that the project would be dependent on vessel availability, approvals and commitments for funding from oil industry.	PGS continues to consult with the fishing industry (refer separate entries)	Meeting Minutes agreed.	Record 40 Record 40A Record 40B Record 40C
		PGS Email (28/04/17)	28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No response claims or objections raised.	NA	Record 40D
		PGS Letter (01/09/17) EPLGA/RDAWEP Letter (12/09/17)	**12/09/17:** EPLGA and RDAWEP provided the following response to the Duntroon Survey information update: Thank you for forwarding detailed and extensive information on the proposed Duntroon Multiclient three-dimensional and two-dimensional Marine Seismic Surveys within the Commonwealth waters of South Australia, and specifically in the Great Australian Bight The Eyre Peninsula Local Government Association [EPLGA] and Regional Development Australia Whyalla and Eyre Peninsula Inc. [RDAWEP] work in collaboration in achieving positive economic outcomes for the Eyre Peninsula in addition to ensuring all measures are undertaken to protect the diverse industries of the region The EPLGA and RDAWEP supports the proposal by PGS Pty Ltd to conduct the seismic surveys under the conditions as stated in your correspondence, to obtain qualified data for the relevant stakeholders, whilst ensuring minimum impact on environmental sensitivities. We look forward to receiving regular updates as the survey advances, including notification: • on the acceptance of the Duntroon Survey Environment Plan; • of the pending commencement of the survey 5-10 days prior to initiation of activity; • Of the completion of the survey around 10 days after vessel demobilisation from the area.	PGS acknowledges the requests made within the letter and will advise the EPLGA and RDAWEP at the notification triggers identified (contained in EP Table 9-3)	Acknowledged Receipt	Record 40E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Regional Development Australia Whyalla and Eyre Peninsula (DAWEP)	Adjacent Coastline Regional Development Authority	PGS Update Letter (20/1/18) RDAWEP Response (22/01/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **22/1/18:** Appreciates the update	No claims or objections raised.	NA	Record 40F
		PGS Update Letter (19/07/18)	**19/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 40G
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 40 H
Greenpeace	eNGO	PGS Letter (15/11/16)	No feedback provided.	No claims or objections raised.	NA	Record 41

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
The Wilderness Society (TWS)	eNGO	PGS letter (15/11/16) Wilderness Society Letter (05/12/16)	**05/12/16:** TWS does not support exploration for oil and gas extraction in the GAB and is concerned that seismic activity is intended to facilitate such exploration. TWS has a strong interest in: o Fully understanding the potential impacts and risks of the seismic surveying activities proposed; o The detailed environmental assessments on which any EP has been based; and o Consulting with you to minimise the impacts and risk to ALARP and acceptable levels (if it is possible to minimise them to this standard). TWS notes that the intended survey period nominally avoids the main periods in which significant whale activity occurs, but whales are present outside these periods. Importantly these periods of significance are varying with climate change, so presence will also change. In addition, there are many other endangered and vulnerable species, together with commercial species present in the intended survey period. It is noted that the EP is based on the Bight EP. Matters in this EP provide grounds for concern, particularly against the stated background: 1. "Little is known about the sound levels at which damage or physical injury occurs in cetaceans" 2. Literature indicates that high acoustic sound levels (i.e. SPL above 230dB re 1μPa) might be expected to cause injury to cetaceans; 3. Potential impacts range from physiological damage, temporary or permanent shifts in hearing thresholds; associated interference with species acoustic signals or behavioural changes (avoidance activities) (McCauley, 1994; McCauley et al. 2000) 4. It is not known whether to low encounter rates (with whales) is due to the whales not being in the area or due to avoidance of acoustic sources and that 5. Damage to &/or behavioural changes to marine fauna (cetaceans, turtles) and behavioural changes to pinnipeds carries a medium level of inherent risk. Considered together with many other studies, including an investigation by the Tasmanian and Curtin Universities that showed significant inherent and residual damage to lobsters and scallops, and such instances as the reported death of 24,000 tonnes of scallops following seismic testing in the Bass Strait, there are clearly substantive concerns with any proposal to conduct seismic survey in the GAB. Further information is required on these proposals together with the studies on which your environmental and social impact assessment has been based for TWS to participate in consultation. TWS are also interested in the intended consultation process.	PGS considers that TWS has the basis of the impact and risk assessment given the Bight Petroleum EP (& Request for further written information) which is publicly available and the basis of the assessment. PGS is very happy at the acknowledgement by TWS that the temporal period avoids periods of peak cetacean presences and acknowledges that whales will be present in the area and will adopt the EPBC Policy Statement 2.1 – interaction between offshore seismic and whales to ensure impacts are mitigated to as low as reasonably practicable. PGS has no objections to providing the additional references used relating to acoustic sound. Assessment of merit (items 1-3). Most quotations are not provided in the context of the original EP. On this basis, PGS seeks to confirm the basis of impact will be against criteria issued in the EPBC Policy Statement 2.1 requirements to prevent damage to whales and other recognised standards (as appropriate). Assessment of merit (Item 4): PGS considers that it is not unreasonable for an observation study to reflect uncertainties and is like scientific studies which discuss study limitations. Assessment of merit (Item 5): Inherent impact and risk allows for baseline conditions to be established from which controls are adopted to eliminate or mitigate the impacts or risks to as low as reasonably practicable. In this instance the residual impact is the most appropriate level of impact which is relevant to the assessment. PGS also acknowledge the recent FRDC research paper and is liaising with the commercial fishing industry on this. PGS notes that there is not an active scallop fishery in the GAB. Crustaceans and other invertebrates will be assessed as part of the EP collation.	Response is provided in Record 42B.	Record 42 Record 42A Record 42B
		PGS/WS Telephone Conversation (23/01/17)	**23/01/17:** [CONTACT] called from the Wilderness Society for an update which was provided by PGS. PGS confirmed that they would keep them advised on what was happening about the survey.	NA	NA	Record 42C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
The Wilderness Society (TWS)	eNGO	PGS Email (28/02/17)	**28/02/17:** PGS advice that the EP had been submitted to NOPSEMA. Earliest start date is now April 1, 2017. Next season earliest possible start date is January 1. No response provided.	Not Applicable	NA	Record 42D

		TWS/PGS Meeting Record (18/3/17)	Meeting outcomes included the following:
			• [CONTACT] provided an overview of the seismic business models – Multiclient vs Contract – and the titles that apply to a Multiclient project – SPAs and AAs from NOPTA
			• [CONTACT] and PO respectfully acknowledged that the two parties were unlikely to agree on whether seismic should proceed in the GAB
			  ○ The Wilderness Society position on that is very clear- they want to see no exploration in the GAB at all, and their position is as follows:
			    ▪ They want no "industrialization" of the Bight
			    ▪ The GAB has a unique eco system, and numerous species found nowhere else
			    ▪ Species such as the Southern Right Whale are endangered, and possibly more affected by anthropogenic noise than certain other cetaceans
			• [CONTACT] noted his respect for this position, and the work done by groups such as the Wilderness Society in maintaining strong environmental advocacy
			• While PGS will still respond to market demand driven by the Commonwealth position on where acreage should be released, it will nevertheless strive to demonstrate transparency in its activities
			  ○ For example, as a result of consultation in Kangaroo Island, PGS has committed to:
			    ▪ Additional sound modelling with respect to Sea Lions
			    ▪ Training of an MFO nominated from a KI interest group, so that a KI representative can see that PGS "does what it says it will do"
			• [CONTACT] requested a copy of the submitted EP for use by a small group of select members involved in the GAB
			  ○ [CONTACT]confirmed this will be provided, but with stakeholder correspondence removed as a respect for privacy
			  ○ [CONTACT] was appreciative of this, noting that many (note that the provision of the EP is in good faith with the expectation that no elements will be used out of context)
			• [CONTACT] and [CONTACT] then went on to have some very good and interesting broad discussions on the oil and gas industry, not directly related to this project, and agreed to keep in touch.
				PGS will ensure the assessment of impacts to the SRW and ecosystem is included within the EP.
				
				The Duntroon EP will be provided to TWS.
					EP provided as link to TWS via drop-box on 22/03/17.	Record 42E
						Record 42F

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The Wilderness Society (TWS)	eNGO	PGS Email (28/04/17)	28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No response claims or objections raised.	NA	Record 42F
		TWS Email (13/07/17) PGS Response Email (13/07/17) PGS Email and Letter (08/09/17) PGS Email log of Telephone Conversation (04/10/17)	**13/07/17:** TWS raised concern regarding the recent issue of the McCauley Paper and plankton with serious implications for a whale nursery in the GAB. **08/09/17:** PGS Update on the Duntroon survey and assessment of plankton impact on GAB. **04/10/17:** TWS advised it would respond to the information sent in September by the end of the week.	PGS has assessed plankton impacts associated with the Duntroon activity. Based on accepted scientific thresholds for plankton, impacts are expected to be below natural mortality rates for plankton species. Not-withstanding this, the McCauley paper has been considered in the design of the Duntroon survey to minimise impacts to plankton. This includes: • Limiting survey activities on the continental shelf in the months where there is a higher likelihood of upwelling (i.e. survey will not commence until March with deeper parts of the acquisition area acquired first); • If foraging whales are present at the shelf break a spatial buffer will be implemented to protect he whales and the plankton	PGS provided feedback on the plankton impact assessment for the Duntroon survey.	Record 42G Record 42H
		TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	**9/10/17:** TWS raised concerns regarding the following issues and concerns: **1.** The intended survey period will be between January 1 and May 31, 2018 and will be undertaken on a 24hour basis for up to 150 days. Further, there will be very limited periods of time when the acoustic array is not operational. Your letter suggests that the preferred timeframes for the surveys 'nominally' avoid the main periods in which significant whale activity generally occurs. As TWS have previously advised, whales are known to be present in the Great Australian Bight (**GAB**) survey area outside these periods	The duration of the Duntroon has been reduced to the period March 1 to May 31 (92 Days). This timeframe limits the potential for overlap with upwelling conditions and higher productivity periods (including whale foraging). PGS will either commence with MC2D survey acquisition, a low intensity survey located to the west of the Kangaroo Island Upwelling, or MC3D survey in the deeper off-shelf waters to minimise spatial overlap in March with the continental shelf. PGS acknowledges and has recognised in the Duntroon EP that cetaceans are present outside the peak periods nominated in literature and adopts the requirements of EPBC Policy Statement 2.1 to manage whale interactions.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	**2.** PGS acknowledge that the survey coincides, both in timing and location, with the foraging activities of the pygmy blue whale and the commencement in May of the migration of the southern right whale through the survey area to coastal breeding grounds. We note that the *Conservation Management Plan for the Southern Right Whale (SEWPC, 2012)* and the management practices in the Seismic Guidelines (*EPBC Policy Statement 2.1)* advise that seismic surveys should be undertaken outside BIAs at biologically important times. To reduce the impact of the survey to ALARP, the time for the survey should not be extended to May 2018, to avoid disturbance of the migration of the southern right whale to breeding grounds.	The Duntroon survey area overlaps two whale BIAs, the pygmy blue foraging (abundant food source) and sperm whale (foraging) BIAs. The survey area does not overlap southern right whale (SRW) BIAs as defined by the National Conservation Values Atlas (DoEE, 2017) and no survey activities will be taken within the SRW BIA. The EPBC Policy Statement 2.1 provides for survey activity which is coincident with BIAs however requires implementation of additional (Part B) requirements to prevent impacts. PGS agrees with the temporal separation of survey activities with BIAs as far as possible. For the pygmy blue whale BIA, temporally PGS has delayed the start of the survey to March 1 and will acquire data in areas away from upwelling potential areas. This also limits impacts to the pygmy blue whale (if present). If the pygmy blue whale is present, a spatial buffer of 10 km will be placed between the operating array and the foraging whales to prevent disturbance and displacement. Additional EPBC Policy Statement 2.1 Part B controls are implemented to minimise impacts to ALARP. Recognising the requirement to minimise impacts to southern right whales migrating to the coastline in May, PGS has utilised acoustic modelling to understand possible impacts to the species during migration, coastal migrations and while calving in State waters. Given the survey's distance from shore and the limited distances where sound impacts are above 160 dB re 1µPa (SPL) (i.e. the NMFS (2013) behavioural impact threshold for whales), insignificant impacts are expected to the SRW by survey operations.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)
			3. We remain concerned that the measures proposed by PGS to mitigate the impacts of the survey activities upon the protected and listed species, the whales and pinnipeds within the BIAs, are not adequate to reduce the impacts to ALARP. In this regard, we note that no proper evaluation of the control measures relied upon to reduce the environmental impact has been provided in the PGS EP. The EP does not explain how the '3km observation zone' or the 'operational buffers' referred to in your letter of 8 September 2017 will be maintained.	PGS commissioned additional 'species specific' acoustic modelling and has reassessed control requirements considering this information. There are many spatial (or operational) buffers adopted between survey activities and sensitivities which may be present. Controls have been assessed which are practical and protect the species. Vessel will assist in maintained operational buffers. The 3 km observation zone is a standard requirement of the EPBC Policy Statement 2.1 (Part A) requirements.		

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	**4.** It is noted that the 2 MFOs on the survey vessel designated to the observation of whales in the survey location (as required under *EPBC Policy Statement 2.1*), appear to also be responsible for monitoring other species, including dolphins, porpoises, pinnipeds and seabirds. The engagement of only 2 MFOs for the observation of all protected species, including seabirds and to ensure the implementation of power down and shutdowns zones upon sighting of whales, does not comply with the requirements of the *EPBC*. In this regard, we note that the use of additional MFOs on support vessels as an additional control measure to mitigate the environmental impacts of the survey has been considered but not adopted by PGS.	Controls have been reassessed as part of the Duntroon EP update informed by additional modelling. PGS advises that MFOs on-board vessels will monitor for marine fauna. Any sightings of birds will be incidental and secondary to the in-water species. One MFO will also be utilised on each of the support/chase vessels. PGS notes that the EPBC Policy Guidelines 2.1 do not prescribe the number of MFOs which are required on each of the vessel. PGS has adopted these controls as part of minimising impacts and risks and in-turn complying with the requirements of the EPBC Act, regulations and associated policies and guidelines.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)
			5. The EP also does not propose any controls that will be employed to mitigate impacts if pinnipeds are sighted near the seismic vessel during the survey.	The Duntroon EP updated for more recent modelling identifies thresholds for PTS/TTS impacts to otariid pinnipeds are not reached. You are correct that no protocols for shutdown will be implemented if pinnipeds are within a certain range of the operating array. This does not change in the updated EP. All pinniped sightings will be recorded.		
			6. Further, the allocation of such limited resources is not adequate to monitor and record sightings of the protected and threatened species in the operational area and to ensure compliance with environmental performance outcomes as required under regulation 14(3) of the *Offshore Petroleum Greenhouse Gas (Environment) Regulations* 2009. The PGS EP does not provide for the monitoring of the Australian sea lion activity or sound intensity levels within the sea lion habitat. We also note that PGS does not intend to undertake any additional baseline surveys to establish the presence of blue pygmy whales in the operational area during January to May nor to record this data during the period of the survey, notwithstanding the fact that '*surveys have shown that relative abundance in this area is highly variable both between and within season* '(EP p.71, DoE 2015).	As above, PGS will record sightings of Australian sea lions. PGS does not propose, based on acoustic modelling to monitor sea lion activity or sound intensities within the Australia sea lion habitat. Modelling identified that even on the closest acquisition line to the male and female foraging BIA, TTS thresholds were not reached within the BIA. PGS considers the male and female foraging habitat utilised by lactating females is important. PGS has modified the survey design to provide for an 8 km spatial buffer between the operating array and the BIA border to limit sound levels which may cause behavioural displacement. PGS has adjusted the survey design to accommodate this requirement. Equally for the pygmy blue whale, PGS does not consider that additional baseline will serve to define the temporal movements of the pygmy blue whale which responds in most part to the irregular upwellings which occur along the SA coastline. PGS has designed the survey to account for blue whale presence which is prudent if there is uncertainty or significant variation in their movement patterns. Cetacean monitoring during the survey will be operationally focussed to minimise impacts to cetaceans only.		

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	7. TWS SA previously raised concerns regarding the reliance by PGS on the Bight Petroleum Lightning 3D MSS EP (21/3/14) the statements that: • 'little is known about the sound levels at which hearing damage or physical injury occurs in cetaceans'; • 'literature indicates that high acoustic sound levels (i.e. Sound levels above 230 dB re 1Pa) might be expected to cause injury to cetaceans'; • 'potential impacts may range from physiological damage ...; temporary or permanent shifts in hearing thresholds; associated interference with species acoustic signals; or behavioral changes (i.e. avoidance activities) (McCauley, 1994; McCauley et al., 2000)'; • Damage to &/or behavioural changes to marine fauna (Cetaceans, Turtles) and behavioural changes to Pinnipeds carries a medium level of inherent risk.	PGS has substantially re-written the Duntroon EP to align with more recent NOPSEMA standards and this information has been updated for recent studies. The acoustic section has been peer-reviewed by JASCO Applied Sciences. PGS would like to advise TWS, that NOPSEMA requires an assessment of the *inherent* impact or risk (i.e. with no controls or control failure) of an environmental hazard. This is to establish what the maximum credible consequence might be. To establish the *residual* impact or risk controls are applied. This impact or risk is then representative of the impact or risk present during the activity.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)
			8. Regarding the potential impact of seismic activity upon pinnipeds, PGS has relied upon a number of studies and literature not provided to TWS SA and not readily available for review (in particular, McCauley 1994). On the basis of the inconclusive studies, PGS has concluded that by using soft-start/ramp up procedures the impacts on pinnipeds 'will not be significant' and it is not proposed to implement shutdown or low power zones. In regard to avoidance reactions to airguns, the EP relies upon a study by Thompson et al 1998, to support the proposition that seals returned to pre-trial behaviours within 2 hours of the end of airgun exposure experiments (cited in Gordon et al 2003 *Paper: A Review of the Effects of Seismic Surveys on Marine Mammals,* Marine Technology Society Journal Winter 2003/04 Volume 37, Number 4 2004).	PGS will provide updated material in acoustic section of the EP to be forwarded to you.		

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	9. The EP does not consider the conclusions based on the review of a large number of studies in the Paper by Gordon et al, as follows: *p.26 In six out of eight trials with harbor seals, the animals exhibited strong avoidance behavior, swimming rapidly away from the source. Similar avoidance responses were documented during all trials with grey seals: they changed from making foraging dives to v- shaped transiting dives and moved away from the source. Some seals hauled out (possibly to avoid the noise); those that remained in the water seemed to have returned to pre-trial behavior within two hours of the guns falling silent. The authors comment that responses to more powerful commercial arrays might be expected to be more extreme, longer lasting, and to occur at greater ranges. These represent some of the most detailed and dramatic short-term responses to air guns observed from any marine mammal.* *p.30 Of potentially greater concern is the possibility that alone, or in combination with other factors, air gun noise will have less dramatic chronic effects such as: excluding marine mammals from important areas at significant times, interfering with their migrations and movements, contribute to overall habitat degradation, disruption of biologically significant behaviours, and increased levels of stress. Although such effects appear less severe than direct mortality or injury, they affect many more individuals and extend over significant periods of time. Cumulative effects could result in the reduction of reproductive rates, which are generally very low in marine mammals, and increases in mortality. Chronic problems of this kind are a legitimate conservation concern, but they are difficult to manage within existing frameworks.*	PGS has included the relevant studies provided by Gordon et al. 2003. PGS prefers to identify the science which was observed rather than provide speculative commentary provided by authors (e.g. the authors <u>commented</u> that responses to more powerful commercial arrays <u>might</u> be expected to be <u>more extreme</u>, longer lasting and to occur at greater ranges'). PGS considers that it has provided the relevant scientific detail from the paper.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)
			10. The *South West Marine Bioregional Plans* direct that "*actions with a real chance or possibility of increasing the ambient noise levels within female [Australian sea lion] foraging areas to a level that might result in site avoidance or other physiological or behavioural responses*" have a high risk of a significant impact on this species. Accordingly, the survey should be restricted to avoid BIAs, particularly waters surrounding breeding colonies and foraging areas of the Australian sea lion.	PGS has included in the design of the survey a spatial buffer between the operational array and the BIA boundary to prevent behavioural disturbance to foraging female sea lions.		

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	**11.** As PGS is aware, TWS and also the Kangaroo Island Community remain concerned to ensure that adequate control measures are implemented to ensure that the acoustic impact upon protected species, in particular the Australian sea lion are reduced to ALARP. We note that PGS appear to have consulted with the Kangaroo Island Community in relation to these issues, but the same level of detailed consultation has not been afforded to TWS. In this regard, I note that TWS were advised by PGS in March 2017 that as a result of this consultation with the Kangaroo Island Community PGS had committed to further acoustic modelling in relation to the Australian sea lion. TWS has not been provided with the report relating to this additional modelling.	PGS has provided the acoustic modelling report to TWN on 9th October 2017.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)
			12. The high-level impact assessment and limited mitigation and control measures outlined in the PGS EP are primarily focussed upon the immediate environmental impacts of the survey, such as vessel collision and disturbance, on a limited range of whale species and commercial tuna, anchovy and sardine values. It does not appear that PGS have taken a holistic ecosystem approach to assessing the impacts of the survey on the environmental sensitivities of the GAB, nor the long-term or cumulative impacts of the ongoing and numerous surveys in proximity to the operational area. Nor have PGS provided a response to the request from TWS for information regarding the impacts on other commercial species raised in our previous letter (e.g. scallops or lobsters) and the assessment of impacts on these classes of species within the ecosystem and food chains of the GAB (i.e. impacts on non-commercial species of this type). Any further information and detail as to all mitigation measures proposed that you can provide for the purpose of assessment of the impacts on the environmental values of the GAB would be appreciated.	The revised EP (to be provided) provides for a more holistic ecosystem assessment approach particularly with the assessment of acoustic sound. This considers direct and indirect impacts and effects on ecosystem functioning. Acoustic modelling has considered cumulative impacts to species within individual species sections in the EP. Section 6.2.3.10 discusses cumulative sound impact from multiple PGS surveys and possible cumulative impacts from adjacent third-party surveys. Impacts to commercial fish and invertebrate fisheries are provided in Section 6.2.3.4 and Section 6.2.3.2 respectively. PGS advises that there is no commercial scallop fishery that operates in the Duntroon OA.		

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	13. TWS appreciate that PGS have provided some response to the concerns we have raised regarding recent scientific findings that indicate seismic surveys may have significant impacts on plankton. It appears from your response and cited work from CSIRO on behalf of APPEA that credible assessments of the likely impact on plankton and upwelling events in the GAB do not exist. This is very concerning and it must be stressed that the GAB is a very different ecosystem to the North West Shelf. It is clear that there is potential for significant detrimental impact on plankton and there is no credible scientific analysis of the nature and extent of the impact on plankton, but equally importantly, on the ecosystem values (including not only cetacean food chains but also commercial fisheries) relevant to the GAB. In view of the limited evidence available regarding the impact of seismic surveys on plankton, the precautionary principle dictates that at a minimum: Relevant experts should be transparently consulted to assess the potential impact of disruption to plankton populations during and outside upwelling events on all aspects of the GABs ecological values, including threatened and migratory species, to determine if seismic survey activities in the GAB present unacceptable risks to the environment If risks are determined to be acceptable, in order to minimize impacts to ALARP there should be no seismic survey activities undertaken in the GAB during seasons (with buffer) during which upwelling activity may be expected to occur If the survey proceeds, independent scientific research should be commissioned to assess the survey's impact on plankton (and any follow-on impacts on ecological values in the GAB) during the proposed survey and results should be provided to all stakeholders	PGS has utilised independent third-party expert modelling and scientifically recognised mortality thresholds to assess potential impacts to plankton from Duntroon survey activities. This assessment has identified that the impact to plankton from survey operations is localised and not significant when compared with natural mortality rates within plankton populations (~10-50% per day). The CSIRO study was undertaken as a *screening assessment* using assumed conditions for a typical 3D MSS but also adopting the findings of the recent McCauley et al., (2017) research for plankton mortality. McCauley et al. (2017) findings are significantly different from numerous prior studies which have directly assessed sound mortality to plankton. The provision of the study synopsis as consultation material was, on a transparent basis, providing an assessment of impacts using McCauley et al.'s (2017) findings under NWS conditions. As such, the results are very "worst case". The major findings of the CSIRO simulation found the 3D MSS activity could have a substantial impact on zooplankton populations on a local scale within or close to the survey area; however, on a regional scale the impacts were minimal. Recovery within the survey area and within 15 km of the survey area occurred within 3 days of survey completion. The relatively quick recovery was due to the fast growth rates of zooplankton and the dispersal and mixing of zooplankton from both inside and outside the impacted region (Richardson et al. 2017). CSIRO warns against directly applying the results of the study *quantitatively* to other regions with different oceanographic conditions. However, there are many insights in the paper which inform survey design and limit impacts to plankton. Factors relevant to the Duntroon survey includes: surveys conducted in regions with more dynamic ocean circulation are likely to have less net impact on zooplankton (applies to Duntroon); surveys conducted in regions off the shelf edge are likely to have lower less absolute impacts on zooplankton (75% of Duntroon survey Is in deep water); and undertaking surveys in seasons with lower zooplankton biomass will reduce impacts (avoid spatial overlap with upwelling areas) (Richardson et al. 2017). These insights have informed the Duntroon survey design to minimise seismic impacts on zooplankton.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	**(As per issue above)**	While the NWS results cannot be adopted *quantitatively* for the Duntroon survey, the study identifies plankton impacts are localised within, or near, the survey area. It also shows that the plankton recovery time is rapid. While the oceanography in the Duntroon survey area differs from the NWS (i.e. GAB ocean conditions are much more dynamic and sea temperature is cooler) which may serve to decrease the level of plankton biomass removal but increase recovery times, undertaking additional modelling for GAB conditions is not expected to alter the general findings of the screening study. PGS does not see merit in undertaking a similar study for the GAB currently. PGS does see merit in confirming the plankton findings of McCauley et al (2017) which is expected to be undertaken by the Australian Institute of Marine Science (AIMS). CSIRO identified shortcomings with the McCauley et al, (2017) survey design and results and repeatability of the results must be completed as a priority.	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)

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The Wilderness Society (TWS)	eNGO	TWS Correspondence (email and Letter) (9/10/17) PGS Response (18/10/17)	13. In view of the limited evidence available regarding the impact of seismic surveys on plankton, the precautionary principle dictates that at a minimum: • Relevant experts should be transparently consulted to assess the potential impact of disruption to plankton populations during and outside upwelling events on all aspects of the GABs ecological values, including threatened and migratory species, to determine if seismic survey activities in the GAB present unacceptable risks to the environment • If risks are determined to be acceptable, in order to minimize impacts to ALARP there should be no seismic survey activities undertaken in the GAB during seasons (with buffer) during which upwelling activity may be expected to occur • If the survey proceeds, independent scientific research should be commissioned to assess the survey's impact on plankton (and any follow-on impacts on ecological values in the GAB) during the proposed survey and results should be provided to all stakeholders.	<u>Upwelling Conditions (Precautionary Measures)</u>: PGS will undertake the Duntroon survey during the period March 1 to May 31, 2018. This timeframe avoids the peak periods for upwelling (November/December) and January/February where current and wind conditions are favourable for upwelling events. While upwellings are possible within March, PGS will undertake acquisition activities in the MC2D area west of the Kangaroo Island Pool with small overlap of the shelf OR acquire data in deep water off the continental shelf to minimise potential for spatial overlap with the continental shelf. It is noted that upwelled areas are present on the continental shelf only and for some areas of upwelling (i.e. west of Eyre Peninsula) there is no overlap with the Duntroon survey area. Recognising that upwellings within the Kangaroo Island Pool can also lead to foraging by blue whales along the shelf-break, if foraging activity is encountered a 10 km spatial buffer will be placed between the acoustic array and the foraging whales. This also protects the plankton in that location. On this basis, PGS has temporally and spatially avoided impacts to upwellings *should they occur*. PGS has determined, based upon recognised mortality thresholds impacts are localised, temporary and not significant when compared with natural mortality rates in plankton populations (~10-50% per day). PGS has engaged JASCO Applied Sciences to independently model and review written assessments. As above, PGS has restricted the Duntroon survey timeframe (1 March to 31 May) avoiding most of the upwelling period. Spatial separation controls have also been adopted for the March timeframe. PGS does not agree with the statement that <u>no seismic surveys</u> should be undertaken in the GAB (very large area) during seasons (with buffer) during which upwelling activity may be expected to occur. This unnecessarily limits regional development in the area, and as shown, alternate measures can be adopted to achieve the same outcomes. A joint PGS-CSIRO Research proposal is currently being scoped by CSIRO to evaluate the effect of seismic operations on organisms in the survey. This is based on an earlier collaboration in 2014/15 which provided bioacoustics data on schools and scattering data during active and inactive seismic operations. This methodology has the potential to provide information on nekton (20cm-100cm) and micro-nekton communities (small fish, crustaceans 2-20 cm) relative to the environment and seismic operations	Refer to Record 42K Note the updated Duntroon EP will be forwarded to TWS.	Record 42K Record 42J (Acoustic Modelling)
		PGS Email (9/10/17)	**9/10/17:** Provision of the Duntroon Survey Acoustic Modelling Report	Not Applicable	Not Applicable	Record 42 J

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	**02/11/17:** TWS Letter detailing the following: Your letter of 18 October 2017 refers to but does not attach a copy of the revised Duntroon Survey Environment Plan (***Duntroon EP***) for our consideration. We would appreciate receiving a copy of the revised Duntroon EP so that we may provide further input in regard to the issues we have raised in relation to the seismic survey. You state that the Duntroon EP provides for a *more holistic ecosystem assessment approach*. TWS SA requires a reasonable opportunity to review the revised EP and consider how the issues previously raised by TWS SA have been addressed and the identified impacts on the environmental sensitivities of the GAB mitigated and managed	Duntroon EP provided to TWS (refer entries below)	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J
			1. It is noted the intended survey period is now to be limited to between 1 March 2017 and May 31, 2018, now 92 days, and will be undertaken on a 24-hour daily basis. The deferral of the commencement of the Duntroon survey until March is acknowledged to mitigate the impacts of the survey activity. TWS SA notes however, that the survey still coincides, both in timing and location, with the Biologically Important Areas (**BIAs**) for foraging activities of the pygmy blue whale and the commencement in May of the migration of the southern right whale through the survey area to coastal breeding grounds. We are unclear why PGS is of the view that timing cannot be constrained to avoid such important areas or migration/foraging times or on what basis conducting seismic in these areas during this time is considered acceptable in terms of impacts on listed species	In undertaking petroleum activities different controls are adopted to prevent or mitigate impacts to environmental sensitivities present. Avoidance through temporal or spatial buffers are preferred where possible. PGS is uncertain whether TWS is aware, based upon information within the National Conservation Values Atlas (DoEE), the BIA for the blue whale within the Kangaroo Island Pool is listed as present from November to May. Migration of the southern right whale and its presence on the southern Australian coastline is between May and October. Accordingly, there is no 'time constraint' which can be applied which can accommodate all sensitivities present in the area. PGS utilises the objectives and management action criteria for relevant threats (e.g. noise) listed within the respective conservation management plans and conservation advices for threatened species which may be present in the survey area to determine if impacts after controls are adopted are acceptable. PGS considers the controls which have been adopted meet the management actions within these conservation management documents to protect these threatened species.		

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	2. PGS note that the Duntroon survey area also overlaps with the biologically significant Kangaroo Island Upwelling identified as occurring between December and March (Middleton & Bye (2007)). TWS SA would like to understand the measures PGS intends to adopt to detect the presence of additional aggregations of fishes, seabirds, seals or other organisms in the event of an upwelling in the survey area and to mitigate the impacts of the activity on the pelagic habitat to ALARP and acceptable levels.	PGS considers that it has provided details in Item 1 of PGS correspondence dated 18th October which addresses the spatial and temporal measures adopted to prevent coincident survey and upwelling activities. *PGS provides this information again below*: PGS has limited the Duntroon survey to the period March 1 to May 31 (92 Days). This timeframe limits the potential for overlap with upwelling conditions and higher productivity periods (including whale foraging). In the March timeframe when upwelling is possible, PGS will either commence the MC2D survey acquisition, a lower density survey located to the west of the Kangaroo Island Pool and not overlapping any secondary surface upwelling areas which lie closer to the coastline OR the MC3D survey in the deeper off-shelf waters to minimize any potential spatial overlap in March with the continental shelf. On the basis that PGS is temporally and spatially avoiding these areas during periods where upwellings are likely, detection of fish, seals and other organisms is not seen as providing any benefit.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	3. It is anticipated that pygmy blue whales would be present during the upwelling. PGS has not indicated what measures are to be taken to identify the presence of the blue whales prior to commencing the survey and start up or during any period there is evidence of an upwelling event. The PGS response (section 2) states that if pygmy blue whales are present a spatial buffer of 10 km will be placed between the operating array and the foraging whales. Further information is required by TWS SA to understand how this control will be implemented and in what circumstances the survey will be shut down to minimize the impact of the survey in the BIA on the foraging blue pygmy whales to acceptable levels. In this regard, would PGS please confirm what aerial surveys are to be undertaken prior to commencing the survey activity and during any upwelling to identify the presence of both the blue pygmy and also the migrating southern right whale (***SRW***).	PGS provides the following information with respect to detection and application of measures to prevent displacement of foraging blue whales. This uses a combination of aerial and vessel observation techniques: • Subject to availability, approximately 3 days prior to survey commencement an aerial survey will be undertaken to determine whale presence and activity type (i.e. foraging or migrating) in the survey area. • PGS may undertake additional aerial surveys during survey operations if the observed whale numbers are higher than expected and additional spatial data is required to supplement vessel-based surveillance; • At least one MFO will be present on each survey vessel to detect for the presence of whales and their activity type. Vessel crew members will also assist in observation activities; • If foraging whales are detected within the BIA: a. During daylight hours two vessels (scout/supply) will undertake surveillance at distances of ~ 7 km on either side of the survey vessel to inform the survey vessel of foraging whales and manage spatial separation of 10 km between the operating array and the foraging pod; b. Four hours prior to darkness, a vessel will scout the area scheduled for night acquisition activities to confirm whale presence. If foraging whales are encountered the survey vessel will move to an alternate acquisition line maintaining a 10 km spatial buffer to the foraging pod or if no such options for relocation exist night operations will not be undertaken (adaptive management).	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	4. Further, how will soft start and shut downs be implemented to mitigate the impacts upon the foraging blue whales and migrating SRWs, particularly in regard to permanent or temporary disturbance.	As per #3 if foraging whales are detected or known to be within the BIA, PGS will adopt a spatial buffer of 10 km* to the foraging pods. This distance has been determined from information contained within the acoustic modelling report for a sound pressure level (SPL) of 160 dB re 1µPa adopted from the National Marine Fisheries Service (2013) *Marine Mammals: Interim Sound Threshold Guidance* for preventing behavioral disturbances in marine mammals (i.e. foraging). It is noted that by adopting this 'behavioral' sound threshold and maintaining the associated spatial buffer (noting this is a lower sound threshold than sound levels leading to permanent or temporary threshold shifts (PTS/TTS) in hearing) shutdowns of the operating array are not required. If a foraging pod is identified which will fall within the 10 km operational buffer, PGS will undertake adaptive management as described in #3. Soft-start procedures will be adopted at the commencement of any acoustic operation and after shut-downs in accordance with the requirements of EPBC Policy Statement 2.1 (PGS refers you to this document for details). Where foraging whales have not been detected, visual observation to 3km+ will be undertaken for at least 30 minutes prior to acoustic source start-up and gradual initiation of the array elements will occur over 30 minutes. Where foraging whales have been detected visual observation will be increased to 45 minutes. With respect to shut down and power down zones: • Where non-foraging whales have been detected, the low power zone will be set at 2 km and array shutdown at 500m; • Where foraging whales have been detected, the low power zone will be increased to 3 km and array shutdown at 500m. These additional measures adopted due to foraging whale presence have been included on a precautionary basis. ** This distance is based upon the Duntroon acoustic modelling results for the continental slop area (9.2 km) which is the maximum radius from the operational array for all modelling locations (i.e. continental shelf, continental slope and deep water).*	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	5. PGS concedes that the sound exposure levels (***SELs***) exceed the levels for the behavioral impact threshold for whales (PGS response p.2). Notwithstanding the PGS assertion that the impact is insignificant given the distance of the survey from the shore, the time period for the survey should not be extended to May 2018, to avoid disturbance of the migration of the southern right whale to breeding grounds and the calving period.	PGS would like to clarify that behavioral impact thresholds for whales have been reported in sound pressure levels (SPLs) and not sound exposure levels (SELs). PGS has assessed possible impacts to the southern right whale during migration (oceanic and coastal) and whilst present on the adjacent South Australian coastline utilizing information contained within the JASCO Applied Science modelling report. A summary is provided below: <u>Injury Thresholds</u>: • For low frequency (LF) cetaceans (i.e. southern right whale), sound exposures which could lead to PTS might be experienced within a maximum horizontal distance from the a fully operational array of 0.74 km. This is a 24-hr. cumulative metric (SEL24hr) based on the assumption that an animal is constantly exposed to these noise levels at a fixed position relative to the vessel and represents an unlikely worst-case scenario. More realistically, cetaceans would not stay in the same location or same range for 24 hrs. • Another complementary sound metric on a per-pulse basis (not cumulative) is also used to assess for PTS (based on Peak pressure). These radii are limited to a horizontal distance of 30 m from the operating array. *The Duntroon survey in implementing a 500 m shutdown zone, a 2 km low-power zone (for migratory whales) and 3 km low-power zone (if foraging whales are identified in the BIA) around the operational array protects LF cetaceans against PTS/TTS injury and implements EPBC Policy Guidelines 2.1 requirements.* <u>Behavioural thresholds</u>: PGS has adopted the NMFS (2013) sound thresholds for behavioural disturbance from impulsive sounds (160 dB re 1µPa SPL). Modelling predicts that cetaceans may exhibit avoidance behaviours at distances up to 9.2 km (max) from the operational array. This may cause migrating southern right whales to marginally deviate on their migratory pathway, but this is not considered significant. The Duntroon survey is 50 km from shore and does not block or create barriers to migration. <u>Shoreline sound levels (calving and coastal migrations):</u> Given the minimum distance of the survey from the SA coastline (51 km), sound levels within the southern right whale buffer BIA are approximately 120- 130 dB re 1µPa SPL, below the threshold for behavioral change. On this basis calving and coastal migration is not expected to be impacted.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	**6.** PGS concedes that the sound exposure levels (***SELs***) exceed the levels for the behavioral impact threshold for whales (PGS response p.2). Notwithstanding the PGS assertion that the impact is insignificant given the distance of the survey from the shore, the time period for the survey should not be extended to May 2018, to avoid disturbance of the migration of the southern right whale to breeding grounds and the calving period.	Shoreline Masking: • Southern right whale 'calls' are an up-sweep at 50-200 Hz for long-distance contact and to bring groups together. A down call, at a frequency of 100-200 Hz, may be used to maintain acoustic but not physical contact. Source levels for the whale have been estimated between 172-187 dB re 1µPa @ 1m. Other sounds include mixtures of amplitude and frequency modulation all with the major energy at 50 – 1000 Hz. Webster and Dawson (2011) in field studies to understand the vocal repertoire of southern right whales in New Zealand waters established that the majority of calls from the species were up-calls with an average peak frequency of 127 Hz (SD +34.71, range: 61-208 Hz) with an average peak frequency of all calls of 156 Hz (SD+ 168.04, Range: 37 – 1599 Hz). The average call duration was 0.74s (SD = 0.32, range: 0.18-2.15s). 1. o Acoustic modelling from the closest site to the coast predicts sound levels in coastal areas to be ~ 120 – 130 dB re 1µPa (SPL). Measured ambient sound levels at the Head of the Bight in 50 m over approximately a six-month period had a median of 98 dB re 1µPa (broadband SPL, 3 to 3180 Hz). The impulses propagating across the continental shelf from the survey are expected to only contain low frequency components. If the geo-acoustics close to the coast are similar to those in Bass Strait as reported in Duncan and Garilov (2012) and Erbe et al. (2015), then potentially the pulses will contain no frequencies higher than approximately 40 Hz, which is below the typical frequency band of southern right whales. It is difficult to estimate impacts due to seismic impulses of low amplitude and frequencies below the typical vocalisation range of the whale. No significant impacts are expected from airgun impulses at emerging southern right whale aggregation sites at adjacent coastal areas.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	**6.** In response to the request from TWS SA, on 9 October 2107, PGS provided a copy of the Jasco Applied Sciences *Duntroon Marine Seismic Survey* Acoustic modelling report dated 12 September 2017 (***acoustic report***). The report contains a large amount of technical information and modelling data and very limited analysis of the data. Accordingly, TWS SA has not had reasonable opportunity to consider and obtain expert opinion in relation to the report. In so far as TWS SA is able to interpret the report, it would appear that the report indicates that air gun sounds exceed both the SEL criteria under the *EPBC Act Policy Statement 2.1* (DEWHA 2008) and also the sound pressure level (***SPL***) threshold under the *United States National Marine Fisheries Service* (NMFS; 2013) for cetaceans and some pinnipeds. Would you please confirm whether this is in fact the case and also whether these thresholds will be exceeded during the survey activities in areas that overlap the BIAs.	PGS does not understand the TWS statement '*it would appear that the report indicates that air gun sounds exceed the SEL criteria under the EPBC Act Policy Statement 2.1 (DEWHA 2008)*'. Guidance provided within the EPBC Policy Statement 2.1 determines the low power zone radius based upon whether each shot exceeds 160 dB re 1µPa2.s for 95% of the seismic shots at 1 km. As per the information contained within the JASCO Applied Sciences modelling report, the Duntroon acoustic array exceeds this criterion and adopts a low-power zone of 2 km. This is completely acceptable under the EPBC Policy Guidelines. PGS has adopted the NMFS (2013) threshold of 160 dB re 1µPa (SPL) for behavioural disturbance to marine mammals if this is the SPL which TWS refers to. As per previous entries (#4) PGS has utilised acoustic modelling results to determine the buffer distance required between the acoustic array and foraging whales (in the BIA) so the sound level received by the foraging whale does not exceed this behavioural threshold.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	7. The fact that the survey is to be conducted in BIAs and will continue unabated for 90 days would suggest that the acoustic impact on the behavior of cetaceans and pinnipeds may be significant. The acoustic report and the PGS response does not appear to consider the cumulative effect of the survey being conducted 24 hours a day over 90 days and what mitigation measures, including shut downs, need to be implemented to reduce the impacts to ALARP. A more detailed response, particularly in relation to the mitigation measures to be implemented, will be provided once TWS SA has a reasonable opportunity to obtain expert advice in relation to the acoustic report	PGS would like to make the following points associated with TWS interpretation of the Duntroon survey: 2. The Duntroon survey will not be conducted in BIAs for a period of 90 days. Only a portion of the Duntroon operational area overlaps BIAs. For example, the majority of the MC2D survey area is not located within any BIA; 3. There will be no shooting during line turns, whale shutdown periods and any maintenance downtime; 4. The Duntroon acoustic report provides details on predicted cumulative effects of the survey on marine species. Please refer to the JASCO Applied Science modelling report (Section 4.3) which is devoted to cumulative sound impacts on cetaceans, pinnipeds and fish. 5. BIAs are established because the habitat is significant for the survival of a species and attributed to a certain activity (i.e. foraging, calving, migration). PGS has identified these BIAs, within and adjacent to the Duntroon operational area, determined possible impacts and where necessary identified controls to prevent these activities being disturbed (e.g. spatial buffer of 10 km to prevent behavioral impacts to foraging whales). On this basis, PGS considers that it is disingenuous to describe sound impacts as 'continuing unabated for 90 days. This activity should not be confused with areas which are coincident with major shipping channels and traversed by large vessels emitting constant significant sound (~ 200 dB re 1μPa at hull) continually disturbing the same habitat. Unlike commercial shipping lanes the Duntroon survey vessel is in constant movement across a large area.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	8. PGS has not adequately addressed the concerns of TWS SA that the measures proposed to mitigate the impacts of the survey activities upon the protected and listed species, in particular the whales and pinnipeds within the BIAs, are not adequate to reduce the impacts to ALARP or acceptable levels. PGS still do not explain how the spatial buffers will be maintained, nor any assessment of whether such measures are effective to preclude behavioral disturbance, for example, the 8km spatial buffer from the foraging habitat utilized by lactating female Australian sea lions. We also note that PGS does not intend to monitor sea lion activity and that cetacean modelling '*will be operationally focussed to minimise impacts to cetaceans only*'. Accordingly, PGS will not be in a position to measure the impact of the Duntroon survey and the cumulative impact of a number of surveys it has conducted in the GAB on the pelagic habitat and environmental sensitivities of the area.	<u>Control Measures (Spatial buffer maintenance, behavioral disturbance assessment):</u> PGS has provided details in #4 as to the derivation of the 10 km spatial buffer for foraging whales and in #14 the 8 km buffer to prevent behavioral disturbances to the foraging female Australian sea lion. PGS has identified in #3 how spatial buffers will be maintained for foraging whale species and in #14 how spatial buffers will be maintained to prevent behavioral impacts to foraging female sea lions. PGS also adopts EPBC Policy Statement 2.1 (Part A) requirements supplemented by a number of Part B requirements as controls to prevent and mitigate impacts to sound sensitive marine species. <u>Monitoring and measurement</u>: PGS understands that TWS refers to cetacean monitoring and not cetacean modelling. PGS clarifies that it will observe fauna during survey activities. Operational monitoring, particularly for cetaceans, is important during survey activities as it is a control, should cetaceans be encountered, to reduce potential impacts through power-down and shutdown activities. PGS in the development of the Duntroon survey EP has conservatively assessed possible impacts (including cumulative impacts) to environmental and social sensitivities present. In many cases PGS has elected to prevent impacts by implementing temporal and spatial controls to eliminate possible impacts. These form the basis of controls which meet the required environmental outcomes (e.g. no residual sound levels from survey activities which would cause behavioural or physiological impacts to foraging female sea lions through the adoption of an 8 km spatial buffer to BIA) and are demonstrated to be both ALARP and acceptable with respect to available conservation documentation. Delivering these *measurable* environmental outcomes allows PGS to measure the impact of the Duntroon survey on environmental sensitivities within the survey area. *PGS does not agree that it is not in a position to measure the impacts from the Duntroon survey.*	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	9. PGS state in its response (section 7) that it has revised the Duntroon EP to align with '*more recent NOPSEMA standards and this information has been updated for recent studies*'. Would PGS please identify the NOPSEMA standards and studies it has relied upon. In regard to the long-term and cumulative effects of noise on marine biodiversity, it does not appear that PGS has considered the report of Weilgart, L. (2013) *A review of the impacts of seismic air gun surveys on marine life*, submitted to the Expert Workshop on Underwater Noise and its Impacts on Marine and Coastal Biodiversity, 25-27 February 2014.	PGS believes that TWS has misinterpreted this statement. It should be read that the Duntroon EP has been revised to align with: 6. More recent NOPSEMA standards (i.e. guidelines); and 7. Information contained within the EP has been updated for more recent scientific studies. The NOPSEMA guidelines can be accessed at the following location https://www.nopsema.gov.au/environmental-management/environment-resources/ The Weilgart (2013) paper has been reviewed as part of the Duntroon EP (Revision 1). All species identified as affected by acoustic sound in that paper have been assessed within Revision 1. PGS does not consider that this paper reviews the *long-term and cumulative effects of noise on marine biodiversity* as described by TWS but looks at the different types of impacts which can be experienced by marine species from acoustic sound.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	10. Further, no reference is made in your response or the acoustic report to the UN Convention on Migratory Species – *Marine Noise Guidelines* UNEP/CMS/COP12/Doc.24.2.2 25 May 2017 and the modules on species and impact from the Technical Support Information (B.1-12, C and D) referred to therein. It is also unclear whether PGS has considered the *Offshore Cetacean Aerial Surveys in The Great Australian Bight 2015-16* Final Report to Sardi 30 August 2016 and the data collected from the aerial surveys of cetaceans undertaken in 2015-16. This recent research and data is important to any consideration of whether the mitigation measures proposed by PGS will reduce the impact of the seismic survey to ALARP or acceptable levels	PGS understands that the *Guidelines on Environmental Impact Assessment for marine-generating activities* in accordance with UNEP/CMS/COP12/Doc.24.2.2 25 and associated *Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for marine Noise-generating Activities* have most recently been discussed in Manila, Philippines on 23-27 October 2017, after the submission of the current Duntroon EP (Revision 1) to NOPSEMA. Not-withstanding this, PGS has had the benefit of other stakeholder input regarding supporting documents to these guidelines (i.e. Prideaux, G., and Prideaux, M. (2015) 'Environmental Impact Assessment guidelines for offshore petroleum exploration seismic surveys', Impact Assessment and Project Appraisal (Online 12/2015)) on which to base the Duntroon impact assessment. PGS's review of the *Marine Noise Guidelines* UNEP/CMS/COP12/Doc.24.2.2 25 May 2017 and the supporting technical modules identify that the Duntroon EP has adopted the relevant sound thresholds for the marine species which might be present in the survey area and the impact assessments for species have been conducted across the range of physiological and behavioral impacts identified in the guidelines. PGS has reviewed and utilised information contained in the *Offshore Cetacean Aerial Surveys in The Great Australian Bight 2015-16* Final Report to SARDI 30 August 2016 within the Duntroon EP (Revision 1). PGS highlights to TWS that the surveys contained in this report did not identify any pygmy blue whales within the eastern GAB or south of Kangaroo Island. All pygmy blue whales observed were in the Bonney upwelling area between Portland and Robe (to be expected at this time of year given the reliability of the Bonney upwelling).	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J
			11. TWS SA appreciates that the Duntroon EP is intended to establish measures to mitigate the impacts and risks of the activity. It is however important that the EP demonstrates that the mitigation and management measures will reduce the inherent risks to ALARP and acceptable levels. In light of the uncertainty as to the impacts of the SELs over the prolonged period of the activity on the behavior of the marine fauna, the precautionary principle dictates that the mitigation measures demonstrate how those inherent risks will be effectively mitigated and managed, with appropriate systems to measure the impacts against baseline data.	PGS agrees that the Duntroon EP needs to demonstrate mitigation and management measures to reduce the inherent impacts associated with acoustic sound to ALARP and acceptable levels. The principles of Ecologically Sustainable Development (ESD), incorporating the precautionary principle form part of the acceptability criteria for the EP. However, in accordance with the EPBC Act the precautionary principle is applied if there is a threat of serious or irreversible damage. The Duntroon EP is currently with NOPSEMA for assessment against these requirements.		

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	12. TWS SA notes that PGS now intends to use one MFO on support vessels as an additional control measure to mitigate the environmental impacts of the survey. No details have been provided as to whether the MFOs are professional observers, trained for this particular activity, with experience in whale observation and distance estimating. It is also unclear how the MFOs on a support vessel will be able to continuously monitor any whale sighted from the survey vessel.	PGS provides the following information with respect to MFOs engaged for the Duntroon survey: 8. MFOs will be trained in whale identification and behavior, distance estimation and can make accurate observations of whales in Australian waters; 9. One experienced MFO (> 2 years' experience) will be present on the survey vessel if with a trained but inexperienced second MFO. Otherwise MFOs will have a minimum of 6 months experience; 10. The MFO present on the support/chase vessel will be supported by crew members competent in whale observation, distance estimation and reporting; 11. The MFOs will induct survey and support vessel crews to ensure they are aware of the EPBC Policy Statement 2.1 requirements and methodologies to undertake visual assessment for marine fauna species.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	13. Further, the PGS response does not indicate that any controls will be employed to mitigate impacts if pinnipeds are sighted near the seismic vessel during the survey. In so far as the PGS response (section 4) states that controls have been '*reassessed as part of the Duntroon EP update informed by additional modelling*', would PGS please advise TWS SA of the risks identified by the 'modelling' and the 'controls' to be implemented to mitigate that risk.	The Duntroon operational area overlaps the male sea lion foraging BIA by 7,135 km2 which represents 2.4% of the BIA area available to the male sea lion. The north-eastern corner of the Duntroon operational area has a small overlap with the male and female foraging BIA. It is to be noted that the Duntroon operational area includes a 10 km vessel turning area (buffer) outside data acquisition areas. PGS has utilized the information contained in the Duntroon sound modelling report to understand the potential sound impacts to otariid pinnipeds. Sound thresholds adopted to interpret the modelling report were based on the recently issued NMFS (2016) - *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts* (NOAA Technical Memorandum NMFS-OPR-55) and involved assessment for both PTS and TTS on a cumulative SEL over 24 hours (SEL24hr) and sound pressure levels measured on a peak (PK) basis. The acoustic modelling identified that on the SEL24hr metric PTS and TTS were not exceeded at any distance for otariid pinnipeds from the operating array based upon NOAA Technical Guidance (NMFS, 2016). Based upon the PK sound metric otariid pinnipeds might be exposed to sound level sufficient to cause PTS/TTS in very close proximity to the operational array (i.e. at distances < 20 m from the acoustic source or within the aperture of the array). Given these results, based upon the PK metric (only), pinnipeds may be exposed to sound levels sufficient to cause physical damage if the acoustic source starts suddenly at full power with pinnipeds in very close proximity. In circumstances where arrays are already operating (i.e. during survey line acquisition) it is expected that individual animals would implement avoidance measures before entering these close ranges at which physical damage might occur. Standard control measures for sound sensitive species adopted during seismic operations (e.g. soft-starts) will allow individual pinnipeds to move away and minimize potential exposure to sound levels which might result in physical damage. On this basis, soft-start procedures are considered an important control for pinniped protection, however as modelling predicts no PTS or TTS impacts to otariid pinnipeds except in very close proximity to an operational array (based upon PK metrics) no shutdown or low power zones as defined in the EPBC Policy Statement 2.1 are proposed for pinnipeds. .	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)		Given the location of the Duntroon operational area (include vessel turning buffer), and the very small area affected by PK sound levels where PTS/TTS might occur (i.e. at the array aperture) only male sea lions would be expected to be in proximity to areas where the array is operating	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J
			14. The response of PGS (section10) does not adequately address the *South West Marine Bioregional Plans* direction that "*actions with a real chance or possibility of increasing the ambient noise levels within female [Australian sea lion] foraging areas to a level that might result in site avoidance or other physiological or behavioral responses*" have a high risk of a significant impact on this species. PGS has not demonstrated how the 'spatial buffer' will be maintained and that this control measure will be adequate to avoid disturbance of female Australian sea lions in their foraging habitat. In view of the inherent risks, TWS SA considers that the survey should be restricted to avoid BIAs, particularly waters surrounding breeding colonies and foraging areas of the Australian sea lion.	The information relating to sea lion BIA spatial overlap in #13 is relevant to this item. As previously mentioned, PGS has utilized information contained in the Duntroon sound modelling report to understand the potential sound impacts to otariid pinnipeds particularly to foraging female sea lions. During a seismic survey, a new portion of sound energy is introduced with each pulse of the air gun array. The Duntroon acoustic modelling considered the total acoustic energy which the Australian sea lion was subjected to over 24 hrs. from MC3D seismic operations in EPP-41/42. This consisted of two representative survey lines in the northern section of the EPP-41/42 MC3D polygon in proximity to the sea lion BIAs. The EPP-41/42 survey area has the greatest spatial overlap and proximity to foraging BIA of all three Duntroon surveys. Five fixed locations were identified either at the nearest boundary of, or within, the adjacent male and female foraging BIA to assess the maximum weighted SEL24hr for the species (refer Duntroon modelling Report Figure 1). Modelling predicted that the maximum weighted SEL24hr to sea lions in the BIA of 152.6 dB re 1μPa^2.s. This field sampling location was on the boundary of the male and female Australian sea lion BIA and exposed to the broadside aspect to the array while the seismic vessel traversed Lines 1 and 2 as shown in Duntroon acoustic modelling report (Figure 1). The received levels at both sampling locations on the 100 m isobath were almost identical (SEL24hr of 146.4 and 146.3 dB re 1μPa2.s) well below both PTS and TTS criterion. The maximum level at the sampling location on the BIA boundary in the direction of Kangaroo Island was 146.0 dB re 1μPa^2.s. Results for all locations are provided in the Duntroon acoustic modelling report (Table 28). It should be noted that modelling is conservative and assumes the animal is stationary for 24 hrs. to accumulate this exposure. More realistically a marine mammal does not stay in the same location for 24 hours and these results represent an unlikely worst-case scenario.		

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	14. The response of PGS (section10) does not adequately address the *South West Marine Bioregional Plans* direction that "*actions with a real chance or possibility of increasing the ambient noise levels within female [Australian sea lion] foraging areas to a level that might result in site avoidance or other physiological or behavioral responses*" have a high risk of a significant impact on this species. PGS has not demonstrated how the 'spatial buffer' will be maintained and that this control measure will be adequate to avoid disturbance of female Australian sea lions in their foraging habitat. In view of the inherent risks, TWS SA considers that the survey should be restricted to avoid BIAs, particularly waters surrounding breeding colonies and foraging areas of the Australian sea lion.	The acoustic modelling report also assessed the potential for behavioural impacts in the adjacent male and female foraging BIA. The Duntroon acoustic modelling report adopted a SPL of 160 dB re 1µPa from the National Marine Fisheries Service (2013) *Marine Mammals: Interim Sound Threshold Guidance* for preventing behavioural disturbances in marine mammals (i.e. foraging). Note again this is a lower sound threshold than that leading to PTS/TTS impacts. For the continental shelf environment, ensonification above 160 dB re 1µPa SPL might occur 7.7 km from the operating array. On this basis, to prevent behavioural impacts to foraging sea lions in the male and female BIA, PGS will implement a spatial buffer of 8 km between the operating acoustic array and boundary of the female and male sea lion BIA. On this basis, any behavioural impacts to female sea lions would be expected to be incidental only. Accordingly, the MC3D survey polygon has been reduced at its north-eastern boundary so no data acquisition occurs within 8 km of the male and female foraging BIA boundary to prevent behavioral disturbances to foraging female sea lions. The survey vessel master will be supplied will all maps and GPS for exclusion zones that will be implemented during the survey including details of seasonal restrictions. PGS does not agree with the TWS viewpoint that the survey should be restricted to avoid all BIAs of the Australian sea lion when impacts can be managed through survey design. PGS notes the following: 12. By adopting this spatial buffer to the male and female foraging BIA, PGS has been able to meet the requirements of the South-west Marine Bioregional Plan by ensuring that the ambient noise levels received within female foraging areas from survey operations do not cause physiological or behavioral responses; 13. Within the male foraging BIA, the area ensonified at any one time above the 160 dB re 1µPa SPL is 120 km2 (max). This area represents 0.04% of the BIA available to foraging male sea lions. Given the localized and transient nature of the area affected at any one time, and the wide-spread foraging nature of pinnipeds, survey activities are not expected to have a significant effect on male sea lion foraging. • The Duntroon survey area does not intersect breeding colony BIAs for the Australian sea lion as defined in the National Conservation Values Atlas	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	15. PGS have responded further to the concerns raised by TWS SA regarding recent scientific findings that indicate seismic surveys may have significant impacts on plankton (section 12). It is also noted that in July 2017 PGS agreed with the CSIRO Oceans & Atmosphere Research (**CSIRO**) to undertake a project between July and December 2017 to '*evaluate the effects that seismic operations may be having on organisms in the area of seismic surveys'*. The Research Proposal further states: a. PGS has identified a need to '*establish a cost-effective environmental monitoring program'* for their seismic vessels; and b. One aspect of the monitoring is to '*evaluate the effects that seismic operations may be having on organisms in the area of seismic surveys and to optimize data collected from the surveys'*. The Research Proposal indicates that PGS and the CSIRO collected five months of bio-acoustic data during the Ceduna marine seismic survey in the summer of 2014-15. As part of the 2017 Research Project, PGS proposes to analyses the data to investigate the variations in the schools of aquatic organisms during seismic activity compared to the periods of no seismic activity. Analyses of the bio-acoustic data and reporting from the Project will assist in understanding the impacts of the seismic activity on the pelagic habitat and organisms in the area and also inform the mitigation and monitoring measures necessary to mitigate those impacts. As this information has been in the possession of PGS for over 18 months and preliminary reporting is due in December 2017, a precautionary approach would require this assessment to be included in the Duntroon EP. Further, the EP should outline the environmental monitoring proposed to be undertaken by PGS to further evaluate the effects of the seismic operations.	<u>Plankton</u>: PGS confirms that it has responded to the concerns raised by TWS on recent scientific findings that indicate seismic surveys may have significant impacts on plankton, however also identify that with control measures adopted by PGS, impacts to plankton will not be significant. PGS attaches at the base of this letter, the responses made to this previous inquiry (shown in blue). Research: PGS would like to clarify the information relating to further research: • Study 1: During the PGS Ceduna survey, a collaboration between PGS and CSIRO collected bioacoustics data during seismic operations. This desktop study is largely to determine 'what can be seen' from the data collected and will be a proof of concept to assess if Simrad echo sounders installed on seismic vessels can be used to monitor pelagic habitats during seismic surveys and is proposed as per the attached scope. The project will also make recommendations on how existing/new instrumentation could be used to optimize opportunistic environmental monitoring during surveys. Note the data was previously collected under the IMOS project purely as goodwill for scientific purposes. It has only recently been recognized that there may be this additional value in the data, hence the potential desktop study. • Study 2: A joint PGS-CSIRO Research proposal is currently being scoped by CSIRO to evaluate the effect of seismic operations on organisms in the area of the survey. PGS is independently in discussions with CSIRO about how we can potentially carry out plankton sampling during a survey under the Duntroon EP. The objective would be to look for impacts on plankton from the air guns. If CSIRO can design a procedure that PGS believe is achievable and cost effective within the capabilities of our normally fielded assets (along with some specialized items for the testing itself), hence PGS would commit to this study. As a consequence of a 'project go-ahead under an accepted EP' by a client, this assessment cannot be included in the Duntroon EP. Further, PGS cannot provide any further information on the nekton and micronekton study as PGS is awaiting the CSIRO scoping document and the results of the desktop assessment of the Ceduna scatter data.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J

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The Wilderness Society (TWS)	eNGO	TWS Email & letter 02/11/17 PGS Response (13/11/17)	16. PGS has also noted that there is significant uncertainty in the movement patterns of the blue pygmy whale and yet does not appear to have evaluated the data from the *Offshore Cetacean Aerial Surveys In The Great Australian Bight 2015-16* Final Report To Sardi 30 August 2016.	PGS has identified in previous correspondence its approach with respect to handling the 'uncertainty in movement patterns of the pygmy blue whale'. As per #10, PGS has assessed this document, Offshore Cetacean Aerial Surveys in the Great Australian Bight 2015-16 (Gill, 2016). Pygmy blue whales were not observed in the eastern GAB or south of Kangaroo Island during this survey. Pygmy blue whales were only observed in the Bonney upwelling between Portland and Robe (to be expected across the period surveyed) during the surveys.	Content of the assessment of merits has been sent to the stakeholder	Record 42K Record 42J
			17. Your response also notes CSIRO identified the need to address the shortcomings of the plankton studies of McCauley et al, including the survey design and results. In light of the significant uncertainties relating to these species and organisms in the survey area, all available data and the identified further studies need to be completed before designing the measures to mitigate the environmental impacts of the survey. The baseline data is also required to ensure that the monitoring and recording of the effects of the seismic operations on the organisms in the area are accurate and may also be relied upon to assess the cumulative impact of all proposed surveys in the GAB area	As PGS has previously identified, the CSIRO identified shortcomings with the McCauley et al, (2017) survey design, results and repeatability is being undertaken by the Australian Institute of Marine Science (AIMS) commencing in July 2017. As identified in PGS correspondence dated 18th October 2017 PGS has adopted a precautionary approach with respect to preventing impacts to plankton by adopting spatial and temporal controls. These measures have included limiting the Duntroon survey timeframe to prevent overlap with timeframes where upwellings (& high productivity) have a higher probability of occurring and for the March timeframe where upwelling is still possible, undertaking survey activities in the deeper areas of the EPP-41/42 MC3D survey area OR commence the MC2D survey in the west of the Duntroon operational area which does not overlap upwelling/high productivity areas. PGS does not understand TWS reference to 'baseline data' collation. For information, PGS would like to advise that 75% of the Duntroon survey area lies off the continental shelf in waters greater than 200m water depth. Van Ruth (2009) identified on a quantitative basis that plankton abundance in offshore waters is low compared with near-shore areas and annual plankton distribution and abundance undertaken by SARDI also supports this finding.		
		TWS Email (13/11/17)	**13/11/17:** Request by TWS to share EP with others on team.	PGS has no issues with this	Content provided in email	Record 42L
		TWS Email (14/11/17) PGS Response (15/11/17)	**14/11/17:** TWS advising that the EP contains extensive additional material and TWS will require at least 7-10 days to respond with expert input**.**	PGS has no issues with this.	Content provide in email	Record 42M

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)	**28/11/17:** TWS Letter detailing the following: The Wilderness Society of South Australia (***TWS SA***) acknowledges receipt of the further information provided on 13 November 2017 in relation to the Duntroon MC3D and MC2D seismic survey (***Duntroon Survey***) proposed by PGS Australia (***PGS***) in areas of the Great Australian Bight (***GAB***).	Noted	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q
			1. It is of considerable concern to TWS SA that PGS does not intend to implement all available measures to mitigate the direct, indirect and cumulative impact of the Duntroon Survey on cetaceans, pinnipeds and other aquatic species in the GAB, particularly the endangered Southern Right Whale (***SR Whale***) and Blue Whale and the vulnerable and rare Australian sea lion.	In accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009, Regulation 13(5) and the NOPSEMA Guidance on Environment Plan Content Requirements (N)4750-GN1344, Rev 3, April 2016) (Section 2.1.4 – ALARP & Acceptable Levels) PGS is adopting *all controls that reduces the risk to as low as reasonably practicable* (i.e. where the environmental benefits outweigh the cost) **and** to acceptable levels (i.e. the controls are effective in meeting the standards required of the community in preventing impacts to the sensitivity – e.g. those standards detailed in legislation, etc.). This test carries two components to it. Implementing all available measures is not the same. It infers that some of the measures adopted might not be effective in reducing impacts but will be included anyway. PGS does not consider that this approach has merit.		

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)	**2.** It is clear from the *SR Whale Conservation Management Plan* (**CMP**) that seismic activity is known to lead to avoidance behaviour and the risks are 'moderate to catastrophic'. Further, as the behavioural impacts of noise on the SR Whale are largely unknown, it is essential that a precautionary approach be adopted in respect of the measures to be implemented to reduce the impact of the Duntroon survey to ALARP. This also applies for the same reasons in relation to the Blue Whale and Australian sea lion	PGS would like to confirm that TWS is referring to the Conservation Management Plan for the Southern Right Whale – A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 2011-2021 (SEWPC, 2012)? If so, the reference to potential consequences associated with seismic operations is assessed as 'moderate' (refer Table 5 & Table 6) and as foot-noted on these tables - this ranking has been applied on a precautionary basis given the behavioural impacts of noise on southern right whales are largely unknown. PGS believes that they have provided a response to TWS associated with the impacts to the southern right whale – please refer to PGS Letter dated 18th October 2017 (Item 2) and 13th November (Item 5). The Duntroon survey area is not located in a biologically important area (BIA) for the species as it lies in open ocean – all BIAs lie in coastal waters where calving and coastal migrations occur (refer to Section 4.2 of the Conservation Plan). As per Section 5.1(E) Noise Interference - *As migratory movements to and from the calving grounds remain unknown, individuals may currently be exposed to noise interference from seismic surveys, however the risk of physical impacts is minimised by implementation of the practical measures outlined in the seismic guidelines (i.e. EPBC Policy Statement 2.1 requirements).* As identified in Section 6.2.3.8 of the Environment Plan, of which you have a copy, this policy statement has been adopted for the survey. In this section there has been a thorough assessment of sound impacts to coastal aggregation sites and no sound disturbance is predicted. PGS believes that with the control measures adopted as detailed in the EP, impacts to the southern right whale are ALARP and acceptable. PGS would direct you to this section for information.	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)	3. The response from PGS indicates that it has not aligned its environmental management strategy for the Duntroon Survey with the objectives of Southern Right Whale and Blue Whale *Conservation Management Plan* (**CMP**), nor the *South-west Marine Bioregional Plan*. Relevantly, the primary risk mitigation measure proposed by PGS is to use 'scout' vessels 7 km either side of the survey vessel in an attempt to maintain a 10 km 'spatial buffer zone' between the survey vessel and known areas of migrating SR Whales and foraging blue whales and sea lions. This measure appears to be intended to displace the whales and sea lions from the survey area and is relied upon in place of shut down of the survey upon observation of SR Whales or foraging Blue whales within the BIAs and in close proximity to the survey vessel. PGS concede that this may cause migrating SR Whales to deviate from their migration pathway (Attachment 1 item 5); also that for pinnipeds, '*it is expected that individual animals would implement avoidance measures'* (Attachment 1 item 13). PGS also relies upon being able to effectively maintain this 'spatial buffer zone' to justify the 'low risk' assessment on the basis that whales and sea lions will, as a result, be unlikely to enter or remain in the survey area for more than 24 hours. This approach would seem to be contrary to a conservation strategy of minimizing disturbance and the threat of site avoidance for vulnerable cetaceans and pinnipeds. Would PGS please provide evidence to support the likely effectiveness of this measure, as it is not one of the measures recommended in *EPBC Act Policy Statement 2.1.* Did PGS consult with the Department of Environment and Energy or any other cetacean or marine expert in developing these proposed control measures?	TWS's interpretation of the vessel placement 7 km from the operational array is not correct. As part of a request from NOPSEMA to assess the effectiveness of providing reliable spatial buffers for foraging whales PGS has revised the scope of the Duntroon survey as follows (as reflected in Figure 1 at the end of this attachment): • The Duntroon survey period has been reduced in timeframe between March 15 (earliest commencement) to May 31, 2019. • During March 15-31, PGS will acquire seismic in deeper waters only (1600m+) applying a buffer distance of 10 km to the blue whale up-welling related foraging BIA boundary to protect the pygmy blue (& other baleen whales) who may be foraging in the BIA during the period of higher probability of an upwelling occurring. The 10 km buffer provides a contingent distance to a blue whale foraging at the edge of the BIA, so it is not displaced from foraging. • During April/May, the likelihood of upwelling is much lower with an associated much lower potential for baleen whale foraging. If a blue whale foraging is encountered in the BIA, a surveillance vessel will be deployed to monitor the pod and the survey vessel will take corrective action to ensure the acoustic source is not operational within 10 km of the foraging pod. Aerial surveillance will also be considered to supplement vessel surveillance and provide information on whale presence and behaviour (i.e. foraging/migrating) in BIAs if whale numbers are higher than expected or if foraging related activities are observed to inform adaptive management measures. The decision as to whether one or two vessels will be used to monitor, and whether additional vessels are required to support operations, will depend on the location of the sightings, the number of foraging whales and assessment of the foraging areas relative to the proposed vessels forward track. The decision will be made by the MFO if an additional vessel is needed, and this additional vessel would be mobilised within 7 days of the event.	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)		By maintaining this spatial buffer, foraging whales will be protected from foraging displacement within the foraging BIA. This information is being submitted to NOPSEMA as part of the Request for Further Information (RFI) issued in November by NOPSEMA. As TWS would be aware, NOPSEMA have been delegated with assessing activities in Commonwealth waters in accordance with the EPBC Act 1999. As part of that process "*the facts and reasons for the impact and risk management choices must be made to allow independent judgement by NOPSEMA about whether it agrees that environmental impacts and risks will be reduce to ALARP and are of an acceptable level"* (Guidance on Environment Plan Content Requirements (N)4750-GN1344, Rev 3, April 2016) (Section 2.1.4 – ALARP & Acceptable Levels)). NOPSEMA determine whether the effectiveness of controls is adequate not the Department of Environment and Energy	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q
			4. The proposal to conduct aerial surveys prior to the Duntroon Survey is stated to be 'subject to availability', presumably in reference to suitable aircraft. Failure to conduct surveys prior to commencing the Duntroon Survey will mean that PGS will not identify and record the number of whales in and within close proximity to the survey area. This will also limit the ability of PGS to determine whether the number of whales in proximity to the survey area is 'higher than expected' and to adopt all measures to minimise disturbance of the whales. Conducting aerial surveys prior to commencing and during and after the Duntroon Survey, is also essential to establish baseline data against which the environmental performance outcomes proposed and implemented by PGS may be measured	PGS advises that the "weather dependent, subject to availability" relates to suitable flying conditions. Three days prior to MC3D commencement (located within the blue whale foraging BIA) aerial surveillance will be undertaken. Three days is considered a sufficient period in the GAB when one day is suitable for flying. Aerial surveillance support will be available for areas where encounter with foraging whales is possible (i.e. April/May on the shelf). Subject to availability has been removed.		
			5. PGS appears to have misconstrued the issues raised by TWS SA in regard to the reference to the '*recent NOPSEMA standards*' and '*recent studies'* relied upon by PGS to update the Duntroon EP. Although PGS has now referred to the NOPSEMA 'environment resources' webpage, it still remains unclear what recent NOPSEMA standards were relied upon by PGS in preparing the revised Duntroon EP. Nor has PGS identified the recent scientific studies that have informed the content of the revised Duntroon EP	NOPSEMA continue to update guidelines to reflect changes in community expectations and the science available with respect to impacts and risks. If PGS has now accessed the NOPSEMA website "resources" page, this is the standard that PGS must meet (content/process) to meet NOPSEMA's requirements. PGS is unaware of any additional standards or studies – although there are some limited 'reference cases' not related to seismic which are being prepared. PGS has provided an extensive list of studies which have been used to inform the impact assessment within the revised Duntroon EP. Please refer to references in individual sections and Section 10 (References).		

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)	**6.** It is unclear from the response from PGS, how, if at all, the control measures proposed in the Duntroon EP have been informed by the five months of bio-acoustic data collected by PGS and the CSIRO and during the Ceduna marine seismic survey in the summer of 2014-15. Further, PGS has not identified what, if any, analysis of the data has been undertaken to date to investigate the variations in the schools of aquatic organisms during seismic activity, compared to the periods of no seismic activity. Please explain the reference to the '*project go-ahead under an accepted EP*' and why this would mean that assessment of data previously collected by PGS '*cannot be included in the Duntroon EP'*.	This data was acquired by PGS for CSIRO under the IMOS Project (i.e. CSIRO data). This data was bioacoustics data for general environmental use and not specifically tied to seismic survey impacts. CSIRO have been using the data for their own purposes since acquisition. As an initiative, PGS has identified with CSIRO that the data might be useful in looking at the effects of seismic activities on the marine environment, however this requires a desktop study to determine if the data collected is useful and could be used for this purpose. It is not certain that useful outcomes will be obtained from this study. CSIRO and PGS have prepared a proposal to undertake this desktop study, however funding from PGS is reliant on having secured work under an accepted EP. Accordingly, the desktop cannot be undertaken until funding is secured and it is not guaranteed that the outcomes of the study will be useful in determining environmental impacts. On this basis, there are no outcomes to include in the EP as the desktop is an exploratory study into the use of the data.	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q
			7. PGS has not confirmed that it will gather the necessary data to address both the gaps in knowledge around the presence of cetaceans and their habitat use in the GAB before commencing the survey, nor during the survey and subsequent years to assess the impact of the survey upon their behaviour and habitat.	PGS has utilised all data available within the eastern GAB to understand the environment within the Duntroon survey area. Significant studies have been undertaken recently to increase the knowledge-base of marine resources. PGS recognises one item drives many other processes in the area - whether an upwelling is occurring which increases productivity, encourages baleen whales to forage, increases pelagic fish species and attracts apex predators to the region. Upwellings in the area are intermittent and unpredictable - not as reliable as other areas such as the Bonney Upwelling in the Otway Basin. Given this uncertainty, PGS has designed the controls within the Duntroon survey to either prevent spatial overlap of up-welling related areas when there is a higher potential for upwelling; or for the lower likelihood periods adopting controls to protect species from sound impacts if an upwelling occurs. This is prudent and precautionary. PGS will monitor, utilising MFOs from vessels and aerial surveillance (as required) the location of cetaceans and their behaviours in relation to the survey vessel during the survey. PGS believes there is little benefit (merit) in monitoring cetaceans prior to or in subsequent years as their behaviours rely upon upwelling conditions which might not be present.		

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)	8. The measures to detect and monitor the presence of whales both during the day and at night are limited and no information is provided to indicate that these measures have been peer reviewed or will be effective;	PGS has utilised day and night time detection methods form the EPBC Policy Statement 2.1. These measures have been extensively peer-reviewed and considered to be effective. Many conservation management plans (such as that for the southern right whale) call up these guidelines for mandatory use. PGS believes this comment does not hold merit.	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q
			9. There is no information as to consideration by PGS of the use of alternative survey technology, including low-noise and noise-free options, nor any explanation as to why the proposed technology for the Duntroon Survey was selected;	PGS advises that within the Duntroon survey Environment Plan (Section 6.2-Acoustic sound disturbance) an assessment of alternate technologies has been undertaken. *''PGS has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Duntroon survey. Other than eSource (a technology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to PGS and geophysical objectives of the survey may not be met resulting in large gaps of data. PGS would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration''.* The acoustic array size selected Is the minimum size which will achieve survey objectives.		

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)	10. PGS confusingly claim to have assessed the cumulative impact of the Duntroon Survey by reference to acoustic modelling based upon 24-hour exposure of marine species in the survey area and has not responded to issues raised by TWS SA as to the cumulative impact of the consecutive periods of the Duntroon survey together with previous surveys and the coincidental survey by TGS-Nopec Co Pty Ltd;	**Within EPP-41/42 & EPP-46 Areas:** Only one acquisition vessel will be used to complete the Duntroon survey scope. Immediate past seismic surveys undertaken within the Duntroon OA in EPP-41/42 was a 2D seismic survey by Santos in 2003. Surveys activities undertaken in EPP-46 (2D) are significantly older (~1990s). As such repeated seismic sound exposure resulting from cumulative past impacts from preceding surveys in EPP41/42 and EPP-46 are not considered to be significant. For EPP-46, the Duntroon MC2D and MC3D surveys will spatially overlap each other however with the reduced timeframes for acquisition this may not occur. Note that the MC2D survey is a lower density survey with lines separated by 5 km. There will only be very limited areas spaced over a wide grid which may be surveyed twice. Given this limited area of overlap cumulative impacts from these multiple surveys are not expected to be significant. **Third Party Surveys**: PGS has not been consulted about other third-party surveys which may occur in the eastern GAB and no other surveys have been submitted to NOPSEMA for the area at the same time as the Duntroon survey. The NOPSEMA website provides an overview of proposed seismic surveys that may occur at a future date. PGS is not aware of any firm plans for MSS to occur within the same timeframe and potentially within the Duntroon OA. PGS will continue to monitor the NOPSEMA website for potential spatial and temporal overlaps from third party MSS activity with the Duntroon OA, establish contact with titleholders where this overlap may occur and identify controls to prevent cumulative impacts. One measure PGS will implement in the event of simultaneous seismic operations is to offer and request sharing of cetacean observations with the other operational vessel. The intention is to gather as much information on cetacean distribution as practicable to assist with operational decision making on a daily basis.	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q

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The Wilderness Society (TWS)	eNGO	TWS Response (28/11/17) PGS Response (09/03/18)		Should any proposed seismic survey overlap the Duntroon OA, the survey vessels will ensure a minimum distance of 40 km is maintained between them during full seismic acquisition to minimise underwater noise interference that may affect seismic data quality as well as potential cumulative impacts on marine fauna. The Programmatic Environmental Assessment of Arctic Ocean OCS Seismic Surveys – 2006 established proactive measures for simultaneous seismic surveys with a minimum spacing of 24 km (15 nm) between seismic source vessels (BOEM 2014). More recently (27 February 2014), the Bureau of Ocean Energy Management (BOEM) published a final environmental review of geological and geophysical survey activities off the mid- and south Atlantic coast. The environmental impact statement from this review included a recommendation of a 40 km geographic separation distance between the acoustic sources of simultaneous seismic surveys. This will minimise the impacts to marine life by providing a 'corridor' between vessels that is below 160 dB re 1μPa SPL (*recognised behavioural limit for impulsive sound and significantly below thresholds which may cause injury to species*) and approaching ambient levels, such that marine fauna may pass through rather than traveling larger distances to go around the survey vessels.	Content of the assessment of merits has been sent to the stakeholder	Record 42N Record 42Q
			11. No commitment has been made to complete the Duntroon Survey activity prior to May 2018 and 2019, to avoid the SR Whale migration period	PGS cannot commit to this request by the TWS. The survey duration has been reduced as far as possible and the May timeframe is required to obtain seismic data. PGS has assessed possible alternatives, for example for PGS to split the Duntroon survey over multiple seasons. However, titleholders are required to undertake acquisition surveys within the timeframes committed to the Australian government or run the possibility of losing their petroleum title. In addition, acquisition over multiple seasons would incur additional mobilization/demobilization costs (estimated ~AUD6M). On this basis, splitting surveys over multiple seasons will not achieve the necessary objectives. As outlined in Item 2, PGS has assessed possible risks to migrating southern right whales during May and with the control measures adopted (in accordance with EPBC Policy Statement 2.1), the impacts to migrating southern right whales are assessed as SLIGHT, ALARP and acceptable in accordance with all conservation management plans, advices and legislation.		

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The Wilderness Society (TWS)	eNGO	PGS Email Response (11/12/17) TWS Response (15/12/17) PGS Response (18/12/17)	**11/12/17:** PGS thanked the TWS for the letter but advised that it was best to wait for NOPSEMA's response before discussing timeframes. Subsequent to receiving a request from NOPSEMA for further information I can advise that we are unlikely to respond to NOPSEMA prior to January 2. Given the additional time, I trust it is ok to wait for a complete response from TWS rather than respond to this initial letter (28/11/17)? 15/12/17: TWS requested a copy of the EP to be sent to Melbourne. Also requested a copy of the further information NOPSEMA requested.	18/12/17: PGS sends copy of the EP to Melbourne. Re NOPSEMA correspondence, our opinion is that we all want the best environmental outcomes, and the best way to achieve this is through each stakeholder looking at things independently.	Content provided in email	Record 42O
		TWS Email (15/01/18)	**15/01/18:** TWS can't recall whether you were having a break over summer and are back at work yet, but happy new year. Thanks for sending the USB of your EP through. I can confirm it has been received but is password protected. Is it possible to send through the password? Also, in relation to any further information you are providing NOPSEMA, is it possible to at least tell us what views you have formed and what has been changed in the EP based on the concerns raised by the Wilderness Society?	Information relating to significant changes in the EP as part of the RFFWI (e.g. controls, plankton literature) has been provided in TWS Letter Dated 09/03/18.		Record 42P Record 42Q
		TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (4/09/18) PGS Letter (25/09/18) (remaining Items)	**29/07/18 (PGS):** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **20/04/18 (TWS):** TWS Letter detailing the following concerns which were addressed in the PGS letter dated 29/07/18 and 25/09/18 (as follows):	Refer to assessment and response below.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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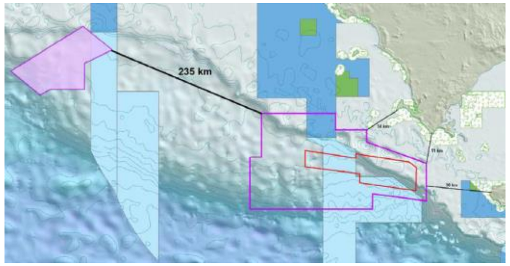
TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) PGS Letter (29/09/18) (remaining Items)	1. The Revised EP and the PGS letter provide details of the environmental impact and risk assessment of the Duntroon Survey. In evaluating the impacts and risks of the Duntroon Survey, internationally recognised risk assessment processes are appropriate to apply. Although PGS refers to literature to support the assertions in its environmental assessment, in many instances the method PGS has applied and the relevant assessment process is unclear. In this regard, we note that PGS has neither referred to, nor appears to have adopted, the framework of the Convention on Migratory Species Noise EIA Guidelines for Seismic Surveys (Air Gun and Alternative Technologies)1, including the modules E and G on species and impact from the CMS Noise EIA Guidelines Technical Support Information (CMS Guidelines). The CMS Guidelines have been adopted by Australia and provide the context for assessment of impacts of noise from seismic activity. Further, the Revised EP does not demonstrate compliance with many aspects of the CMS Guidelines, including: 1. PGS does not commit to conducting a review of the cumulative impact of the PGS Ceduna survey in 2014-15, the proposed MC2D and MC3D Duntroon Surveys and GX Technology Corporation survey in 2018; 2. It is unclear whether the sound modelling is based upon the equipment to be used in the actual survey and in the same seasonal conditions and weather location; There is an assumption in the environmental assessment that marine species will leave the area during the survey, thus minimising the impact – this is inappropriate for mobile species (cetaceans, pelagic fish) that might rely on the area as critical or foraging habitat; and 3. The assessment of the impact of the Duntroon Survey on species in the affected area has not been independently or peer reviewed.	<u>CMS Guidelines</u>: PGS would like to advise that the referenced CMS Noise Guidelines were brought to PGS's attention by its authors from Wild Migration Limited. This group, like TWS SA, has been provided with copies of the full Duntroon EP. While CMS Guidelines (Appendix E) discusses the types of marine generating noise [including seismic surveys and the equipment they use (please refer to the Duntroon EP (Section 2) for equivalency], Appendix G discusses the broad principles of EIAs. To this end: • PGS has provided transparency in the information which has been submitted to the regulator by providing a full copy (excluding privacy provisions) to parties requesting the EP. This has included a description of the noise generated, a description of the surrounding environment, independent scientific modelling and the scientific monitoring programs which will be adopted within the Duntroon survey. • Sound impact information within the EP has been independently reviewed by JASCO Applied Sciences prior to submission to NOPSEMA and will again be reviewed prior to the next submission. <u>Cumulative Impacts</u>: The PGS Ceduna Survey in 2014-15 was located 235 km from the north-western corner of the Duntroon survey area. As such, given the distance between the two survey areas cumulative impacts within the marine environment from the activities is not expected. In addition, PGS is unaware of a GX Technology Corporation (ION Corporation) survey to be held in 2018. Whilst GX Technology held an accepted EP in 2015 this EP has since expired as indicated on the NOPSMEA website.  	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) PGS Letter (29/09/18) (remaining Items)	**(Above Question Continued)**	Past seismic surveys undertaken within EPP-41/42 was a 2D seismic survey by Santos in 2003. Survey activities in EPP-46 are significantly older (~1990s). As such repeated seismic sound exposure resulting from cumulative past impacts within these areas, given the time since surveying is not considered significant. It is possible that portions of the Duntroon MC2D may overlap portions of the Duntroon MC3D survey area in EPP-46 either in the 2019 season or 2020 season. As MC2D survey lines are a lower density grid (lines separated by 5 km), there are only limited areas, spaced over a wide grid which may be surveyed twice. Cumulative impacts in these limited areas is not considered to be significant given they are very localised and review of cumulative impacts is not considered to hold merit given this small overlap. It is to be noted that Evans et al (2017) identified that the timing of past geophysical surveys within the GAB had overlapped the spatial and temporal occurrence of juvenile southern bluefin tuna (SBT). The direct measurement of spatial overlap had inherent errors estimating the position of juvenile SBT at exact times. The authors concluded that "*while some parameters could be identified as influencing the behaviour of juvenile SBT, which ones, and the strength and direction of the relationships, varied temporally and across individuals. This made identifying clear relationships between behaviour and environmental parameters difficult, suggesting that the drivers for behaviour of juvenile SBT are complex, and potentially interdependent and covarying in nature*". Further, the authors did observe that during geophysical surveys, at a broadscale, tagged juvenile SBT individuals remained in the broader vicinity of the GAB during survey periods and for individuals where observations are available across multiple years, the individuals continued to return to the GAB over the austral summer period. Sound Modelling: Sound modelling has been revised for the 3260 in3 source array. This is the maximum sized source array which will be considered for the Duntroon survey. Lower source sizes may be utilised.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) PGS Letter (29/09/18) (remaining Items)	**(Above Question Continued)**	Independent Review of Acoustic Sound Impacts: PGS engaged JASCO Applied Sciences to independently review and verify the accuracy of the sound impact section within the Duntroon EP prior to previous submissions to NOPSEMA and will again engage JASCO prior to the next submission. In addition, as TWS would be aware, NOPSEMA have been delegated with assessing activities in Commonwealth waters in accordance with the EPBC Act 1999. As part of that process "*the facts and reasons for the impact and risk management choices must be made to allow independent judgement by NOPSEMA about whether it agrees that environmental impacts and risks will be reduce to ALARP and are of an acceptable level*" (Guidance on Environment Plan Content Requirements (N)4750-GN1344, Rev 3, April 2016) (Section 2.1.4 – ALARP & Acceptable Levels)). This assessment also provides independent review.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)
			2. PGS has revised the survey period to Mar 15 – May 31, 2019 (77 days). TWS SA notes that PGS does not agree to limit the survey period to avoid the SR Whale migration during the month of May. In rejecting the alternative of splitting the Duntroon Survey over multiple seasons, PGS claims that this would incur additional mobilisation costs (AUD $6M) and will not achieve the necessary objectives. PGS has not explained what those objectives are, not provided an assessment of whether splitting the survey would further mitigate the impact of the survey. It is noted that EPBC Policy Statement 2.1 advocates for seismic surveys to be conducted at different times of the year to avoid overlap with whales in biologically important areas (BIAs) and areas where whales may be foraging and explicit justification for why the proposed survey should take place during the proposed period needs to be provided.	The Duntroon survey timeframe has been altered from 15 March 2019- 30 May 2019 to 1 September to 30 November 2019 with the possibility of remobilisation for a second season between 1 September to 30 November 2020. This new timeframe avoids the period where the SR Whale is migrating to the calving BIA along the southern Australian coastline. It also avoids upwelling periods within the eastern GAB and impacts to foraging pygmy blue whales. By adopting this timeframe PGS conforms with the requirements of the EPBC Policy Statement 2.1 as seismic activity not being undertaken in BIA areas during biologically important times. As previously explained to TWS SA, the Duntroon survey does not spatially overlap the SR whale calving or calving buffer BIA which is present along the coastline of southern Australia. While the Duntroon survey temporally overlaps the period that SR whales are present within these BIAs, acoustic modelling predicts that received sound levels at the boundary of the SR whale calving BIA boundary is 125 dB re 1μPa (LF-weighted) from the closest point of the survey to this area. Please refer to Item 5 for the impact assessment of sound in the calving BIA. The survey objectives for the Duntroon survey are clearly identified in the Duntroon Environment Plan Section 2.2. These objectives have not varied in revisions to the Duntroon Environment Plan, of which you have been provided a copy.		

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(As per issue above)**	• Malme et al (1983;1984) documented reactions of migrating gray whales to seismic pulses. The study concluded that received levels exceeding 160 dB re 1µPa (SPL) were required to cause migrating gray whales to avoid airgun sounds, although statistically significant reactions that were less profound occurred at much lower received levels. Malme et al (1984) calculated 10, 50 and 90% probabilities of gray whale avoidance reactions in these conditions to 164, 170 and 184 dB re 1µPa respectively. • Dunlop et al (2017) as part of the BRAHSS Project, observed that humpback whales were more likely to avoid an operational air gun array within 3 km of the source at received noise levels over 140 dB re 1µPa2.s (SEL) meaning that both the proximity and the received level were important factors and the relationship between does (received level) and response is not a simple one. The 'control' in this study was the noise effects of the vessel without the array operating and behaviour assessment was determined in change in movement behaviour (i.e. a decrease of speed of movement and/or an increase in course deviation). When controlling for the received level, humpback groups had a greater response to a smaller source size (which was closer) than to the larger source illustrating that proximity to the source is also important. Dunlop et al (2017) noted that the derived values (exposure and distance) did not represent a response threshold, but responses were more likely to occur within those bounds than outside them. In addition, the response was highly variable in that some groups did not respond in within these values while others responded outside them. That is, not all movement responses translated into an avoidance response; therefore, a change in movement behaviour should not be assumed to be avoidance of the source. Dunlop et al (2017) noted that the study is only applicable to migrating whaled approaching a source vessel that is moving directly across their migratory path, although the whales do show significant behaviour typical of breeding grounds	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(As per issue above)**	Initially, the probability of inducing behavioural responses at 160 dB re 1 µPa (SPL) was derived from the HESS (1999) report which, in turn, was based on the responses of migrating mysticete whales to air gun sounds (Malme et al. 1983, Malme et al. 1984). The HESS team recognized that behavioural responses to sound may occur at lower levels, but significant disturbances were only likely to occur above 140 dB re 1 µPa (SPL). An extensive review of behavioural reactions to sound was undertaken by Southall et al. (2007, their Appendix B). Southall et al. (2007) found varying responses for most marine mammals between 140 and 180 dB re 1 µPa (SPL), consistent with the HESS (1999) report, but lack of convergence in the data prevented them from suggesting explicit step functions. Absence of controls, precise measurements, appropriate metrics, and context dependency of responses (including the activity state of the animal) all contribute to variability. For impulsive sounds, this threshold is 160 dB re 1µPa (SPL) for cetaceans (NFMS, 2013). Wood et al (2012) proposed a step function of the probability of response for impulsive sounds using a frequency weighted SPL metric. Based upon the Southall et al (2007), reflecting that most marine mammals exposed to impulse noise demonstrate reactions of varying magnitude in the 140-180 dB re 1µPa (SPL) exposure range, Wood et al (2012) applied a probabilistic metric at which 10%, 50% and 90% of individuals exposed were assumed to produce a behavioural reaction at exposures at exposures of 140, 160 and 180 dB re 1µPa (SPL) respectively. However, as noted by Southall et al (2007) certain marine mammal species in specific behavioural modes, appear to be significantly more sensitive to noise exposure. For instance, the migrating bowhead whale is much more likely than other mysticetes to respond clearly to seismic gun noise at much lower (~120-140 dB re 1µPa SPL) received sound levels (Richardson et al, 1999). As a protective approach for this behavioural state – 10%, 50% and 90% response probability for migrating mysticetes is estimated to occur at M-weighted exposure levels of 120, 140 and 160 dB re 1µPa (SPL). The migrating mysticete category has been applied in the analysis to SR whales, within the calving BIA and during migration.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(As per issue above)**	The Wood et al (2012) approach has been adopted also incorporating the frequency weighting from the NFMS (2018) (*refer Table below*). It is noted that adoption of this criterion is considered very conservative based upon studies which have reviewed behavioural impacts to low frequency cetaceans, with lower received levels identified in Table 1 associated with biologically insignificant behavioural responses as delineated by the ordinal ranking proposed by Southall et al (2007). *Refer to Item 5 for an assessment of behavioural impacts to SR whales.* Table 1: Behavioural exposure criteria for Calving and Migrating SR whales – probability of behavioural response to LF-weighted sound pressure level (SPL dB re 1µPa) (NFMS, 2018). Adapted from Wood et al (2012). Probability of response to frequency-weighted SPL (dB re 1µPa) 120 | 140 | 160 20% | 50% | 90%	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)
			As noted above, TWS SA is particularly concerned to ensure that the impact of the Duntroon Survey does not adversely affect the recovery of the SR Whale. In this regard, TWS SA note: b) The known risks of seismic activity leading to avoidance behaviour are moderate to catastrophic;	**Avoidance Behaviour Risk:** PGS requests the TWS to provide the data source for the claim that known risk of seismic activity leading to avoidance behaviour is 'catastrophic'. Based upon a similar comment in previous correspondence, PGS understands that this statement is possibly related to information within the Conservation Plan for the Southern Right Whale (Table 4 and Table 5) (SEWPC, 2012). Within these tables the consequence is assessed as moderate on a precautionary basis. PGS considers the claim of a 'catastrophic' consequence does not hold merit and the full context of the classification in the Conservation Plan has not been understood by TWS SA.		
			3. As noted above, TWS SA is particularly concerned to ensure that the impact of the Duntroon Survey does not adversely affect the recovery of the SR Whale. In this regard, TWS SA note: c) The foraging ecology of SR Whales is poorly understood and the migration pathways between coastal waters and offshore feeding grounds are not well defined;	**SR Whale Foraging Ecology:** SR whale foraging is poorly understood, and observations of foraging are rare; although feeding has been observed in the region of the sub-tropical convergence (41-44oS) in January and December (SEWPC, 2012). The current knowledge on the potential location of SR whale feeding grounds and movement to and from coastal aggregation areas is based on historical whaling data (Townsend 1935), discovery marks (Tormosov et al. 1998), photo-ID matches (Bannister et al. 1997) and satellite tracks of SR whales from New Zealand (NZ) (Childerhouse et al. 2010) and Tasmania to the South Pacific Ocean (SEWPC, 2012).		

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			3. As noted above, TWS SA is particularly concerned to ensure that the impact of the Duntroon Survey does not adversely affect the recovery of the SR Whale. In this regard, TWS SA note: d) Migratory paths of the SR Whale to calving areas in coastal waters of the GAB during April and May are likely to intersect the area affected by noise from the Duntroon Survey; and	**Migration:** Australian coastal migratory movements are reasonably well understood and coastal connecting habitat BIAs along the southern Australian coastlines have been established. As evidenced by photo-identification studies, seasonal movement west along these corridors has been observed (SEWPC, 2012). Less is known about the non-coastal movements, although SR whales are thought to be solitary during migration or accompanied by a dependent calf (SEWPC, 2012). A satellite tagging study conducted at Head of Bight in 2014 by Mackay et al., (2015) successfully obtained location data from three female SR whales accompanied by a calf. This data showed that two whales had a southern migration pathway directly south from Head of Bight and the other travelled west from Head of Bight parallel to the coast and into the Indian Ocean. Burnell (2001) hypothesised that SR whales show a general east to west movement along the southern Australian coastline within the breeding season, based on observations of SR whales arriving and leaving calving grounds and from photo-ID matches of individuals between southeast and southwest Australia. The movements of SR whales from Head of Bight obtained by satellite tagging suggest movement of females with calves does occur directly south from Head of Bight as well as to the west (Charlton, 2018). Tagging studies performed on SR whales from the Auckland Islands (NZ) showed movement to areas south of Australia between 38-48oS (Childerhouse, 2010). No defined migratory corridors have been identified.		

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	3. As noted above, TWS SA is particularly concerned to ensure that the impact of the Duntroon Survey does not adversely affect the recovery of the SR Whale. In this regard, TWS SA note: b) The Duntroon Survey area is adjacent to the BIA for the migratory SR Whales.	**Southern Right Whale Calving BIA**: The Duntroon survey area lies adjacent to a calving BIA for the SR whale. The known established breeding area within the GAB (SA) is located at the Head of Bight (HOB) (~ 380 km NNW of survey area). Within coastal calving grounds, SRW are primarily distributed within 1 km of shore in water depths less than 20 m (Charlton et al, 2015). The closest emerging calving area to the survey area is Encounter Bay (~ 300 km east of survey area). Several additional areas for SR whales are emerging which may be of importance, particularly to the south-eastern population, where small but growing numbers of non-calving whales regularly aggregate for short periods of time (SEWPC, 2012). This includes Sleaford Bay at the southern end of the Eyre Peninsula ~ 51 km NNE of the survey area. Emerging calving grounds are classified as having around three female and calf pairs per year (SEWPC, 2012). Whilst long term annual monitoring studies have been conducted in southwestern Australia (Bannister 2017) and at the major aggregation ground at Head of Bight, SA (Charlton 2017), little is understood about SRW in small and emerging calving grounds in SA including Sleaford Bay, Kangaroo Island and Encounter Bay (Charlton, 2018). *Refer to Item 5 for an assessment of impacts to coastal aggregation areas affected by sound from Duntroon survey activities.*	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	4. The PGS letter confirms that an aerial survey will be undertaken 3 days prior to commencement to establish the presence of whales to inform the start-up location of the survey and that aerial surveillance to support the surveillance vessel may also be 'considered' if whale numbers are higher than expected. In the EP the 'higher' whale numbers are defined by reference to '3 or more shut-down/power-downs per day to sperm or whale presence'. There is no explanation as to the basis upon which this criterion has been adopted, not does it appear to take account of the regularity of whale sightings over a number of days.	The survey period (September 1 to November 30) is outside the seasonal presence of pygmy blue whales in southern Australian waters however sperm whales may be present. On this basis, PGS will undertake an initial survey to confirm the presence of this species over the canyon systems to inform the start location of the survey. During the survey, PGS will adopt the requirements of the EPBC Policy Statement 2.1 (Part A: Standard Management Procedures) to prevent impacts to cetaceans. This includes pre-start-up visual observation from the survey vessel by trained and experienced Marine Fauna Observers (MFOs). As identified in Item 6, aerial surveillance is also planned if environmental monitoring during the survey period indicates the possibility of upwelling conditions. For TWS information only, the EPBC Policy Statement 2.1 (Section A.3.6) nominates that survey procedures need to be reviewed/modified if '*3 or more whale instigated power-downs or shut-downs have occurred during the preceding 24 hr*'. This has been used as guidance to determine if whale encounter is greater than expected.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) PGS Letter (29/09/18) (remaining Items)	5. The PGS letter states that there has been a thorough assessment of sound impacts of the Duntroon Survey to coastal aggregation sights of the SR Whale, but it is unclear what assessment has been undertaken of the noise impact on the migratory or foraging behaviour of the SR Whale. Further, the Revised EP relies upon a somewhat illusory spatial buffer zone that in turn depends upon the ability to physically observe the presence of SR Whales. The PGS letter states that the operational noise may cause SR Whales to deviate on their migratory pathway, but the statement that this is not 'considered significant' does not appear to be supported by any assessment. The assumption that the SR Whale (and other cetaceans) will leave or avoid the affected area during the Duntroon Survey and return unharmed once the survey is over, should be assessed by an independent expert, together with the proposed shut down and power down control measures. It also does not appear that PGS has undertaken a comprehensive assessment of the impact of the operational noise and seismic impulses from the Duntroon Survey on whale species. In particular: a) the difficulty of estimating the impact of low amplitude and frequency seismic impulses is noted, but the assertion that no significant impacts on SR Whale aggregation sights from air-gun impulses does not appear to be supported by assessment (Attachment 2 item 5 to the PGS letter); and **b)** PGS rely upon section 4.3 of the JASCO Applied Science modelling report to assess the cumulative impact of the Duntroon Survey on cetaceans, however the Report assesses the cumulative impact over a 24-hour period, not the entire proposed operating period for the survey.	<u>Impacts on the Migratory & Aggregation Behaviours of the SR Whale:</u> *This response must be read in conjunction with the information provided in Item 3.* The following points from that section are relevant to this assessment: • The SR whale does not generally forage in Australian waters. Foraging grounds are suggested to lie to the south of Australia at the sub-tropical convergence. Any foraging in Australian waters is opportunistic. • Duntroon survey activities conducted in the period September 1 to November 30 will not impact on SR whale migratory pathways into the GAB. • Sound impacts from Duntroon survey operations will vary as the vessel is in constant movement across the survey area. • Survey activities located at least 90 km from Kangaroo Island together with the shape of the sound footprint will not create a migratory barrier to whale movement. PGS has undertaken a comprehensive assessment of sound impacts to the SR Whale within the calving BIA and during open ocean migration utilising Acoustic Modelling and Animal Movement ('Animat') Modelling compiled by JASCO Applied Sciences (Wladichuk et al, 2018; Lucke et al, 2018) (*copies of reports are attached*). These studies provide predicted levels of sound exposure at sensitive coastal locations and estimates of the number of SR whales exposed to sound levels which could elicit behavioural disturbance or could be potentially injurious during a 24-hr period of the survey.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(Refer Previous issue)**	**Coastal Nearshore Areas**: Acoustic modelling predicts the following sound exposures within coastal (nearshore) areas adjacent to the Duntroon survey area (Wladichuk et al, 2018) (refer to Figure 1): • At the SR whale calving BIA boundary, the sound exposure is predicted to be 121.8 dB re 1µPa (SPL) (unweighed), 125 dB re 1µPa (SPL) (weighted) from the nearest survey line to the coast; • At Sleaford Bay (~51 km north), the nearest emerging aggregation area to the survey area, the sound exposure is predicted to be 110 dB re 1µPa (SPL). At Sleaford Bay, the nearest emerging aggregation area to the survey area, sound exposure to SR whales present in the area during the Duntroon survey period falls below sound levels which would have a behavioural response (10% response likelihood). In addition, the key coastal habitats where calving is seasonally present (i.e. Head of Bight ~ 380 km NNW and Encounter Bay ~ 300 km east) are not expected received sound levels enough to cause a behavioural response from Duntroon survey activities. This conforms with the objectives contained in the Conservation Plan for the SR whale to protect SR whale aggregations from behavioural impacts. Accordingly, impacts to SR whales in coastal aggregation areas is not assessed as significant as measured against criteria outlined in EPBC Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DOE, 2013) (*refer below*). At the calving BIA boundary, modelled sound exposures (121.8 dB re 1µPa SPL (unweighted)) is unlikely to have a behavioural response (10% response likelihood) to coastal migrating SR whales. It is noted that the coastal area affected by these sound levels (> 120 dB re 1µPa SPL (unweighted)) is estimated to be 25 km in length and exposed to westerly weather patterns (i.e. no protection to aggregating whales as compared with Sleaford Bay located further to the east (SEWPC, 2012)). Further, application of the animat modelling within the nearshore area estimates 5 SR whales from the entire Australian SR whale population (0.2% of the entire Australian SR whale population) and 1 SR whale from the eastern sub-population (0.4% of eastern SR whale population) may be affected by the sound level of 120 dB re 1µPa (SPL) (Lucke et al, 2018). That is, received sound levels at 120 dB re 1µPa (SPL) will likely have a 10% behavioural response likelihood to approximately 0.2% of the SR whale population.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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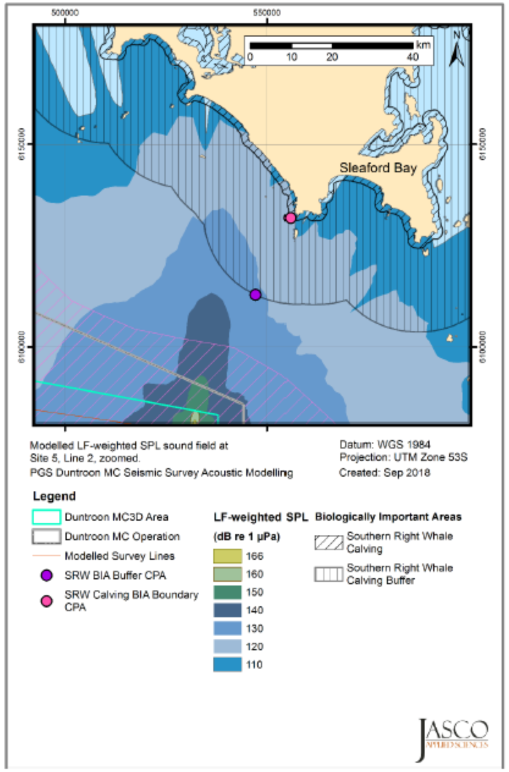
TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(Refer Previous issue)**	Figure 1: Sound level contour map focused on the coastal footprint showing maximum over depth LF-weighted SPL results for the 3260 in3 array towed at 7 m water depth at the closest point to the SRW BIAs. Receiver locations for sound levels at the boundaries are shown as circles (Lucke et al, 2018) 	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(Refer Previous issue)**	It is noted that McCauley et al (2000) observed avoidance reactions ('disturbance') in resting humpback pods with calves commencing at 140 dB re 1µPa (SPL). No whales are predicted to be exposed to received sounds ≥ 140 dB re 1µPa (SPL) (50% response likelihood) within the nearshore area. As identified in Item 3 (sound behaviour impacts) for low-frequency cetaceans (except bowhead whales not engaging in migration), behavioural disturbance onset was observed at received levels of 150 – 160 dB re 1µPa. These modelled sound exposures have been undertaken from the closest point of the EPP-41/42 MC3D survey to shore. Given the design of the Duntroon surveys across both continental shelf, slope and deep-water environments, sound within coastal corridors will not be continuous and will reduce as the survey moves further away from the coast. Accordingly, given this predicted behavioural impact to SR whales in coastal nearshore areas, the impact is not assessed as significant as measured against criteria outlined in EPBC Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DOE, 2013) (*refer below*). Offshore Areas: As per Item 3, while coastal migratory pathways are reasonably well defined for the SR whale (noting a seasonal movement west along this coastal corridor), offshore migratory routes to/from the Australian coastline are less defined with tagging studies identifying cow/calf pairs migrate directly south as well as to the west during oceanic migrations (Charlton, 2018). Behavioural studies into seismic sound impacts to migrating mysticetes have observed some deviation because of an operational array (Dunlop et al, 2017; McCauley et al, 2000; Richardson et al, 1999; Manley et al, 2007), however proximity to the operating source array, also appears to be a factor in the level of disruption to migration (Dunlop et al, 2017). SR whales undertaking oceanic migrations may be exposed to high levels of sound in close proximity to the operational array. Sound exposures will be controlled via implementation of controls detailed in the EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008).	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(Refer Previous issue)**	PGS has undertaken 'animat' modelling in 'offshore' areas to understand the number of SR whales potentially exposed to sound levels which could elicit behavioural reaction during oceanic migration. Application of 'animat' modelling estimates 5.4 SR whales within the entire Australian SR whale population (0.25% entire Australian SR whale population) or 1.12 SR whale within the eastern sub-population (0.44% eastern SR whale population) is likely to have a behavioural response (i.e. 10% response likelihood) when exposed to the sound level of 120 dB re 1μPa (SPL) (Lucke et al, 2018). For received sound levels of 140 dB re 1μPa (50% response likelihood), a sound level where behavioural disturbance in migrating Australian humpbacks have been measured, 1.15 SR whales within the entire Australian SR whale population (0.05% entire Australian SR whale population) or 0.24 SR whale within the eastern sub-population (0.09% eastern SR whale population) may be affected. Given these population level exposures, SR whales affected by sound levels leading to behavioural disturbance (i.e. migratory deviation) is not expected to be significant at a population level. **Assessment against National Environmental Significance Criteria:** Based upon the assessment of impacts above, behavioural impacts to SR whales in coastal aggregation and offshore areas is *not significant* as measured against criteria outlined in EPBC Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DOE, 2013) given the impacts is not expected to: • Lead to a long-term decrease in the size of the SR whale population; • Reduce the coastal area of occupancy of the species; • Fragment the population into two or more populations; • Adversely affect habitat critical to the survival of the species (i.e. BIAs); • Disrupt the breeding cycle of the population; • Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline; • Result in invasive species that are harmful to an endangered species becoming established in an endangered species habitat; • Introduce disease that may cause the species to decline; or • Interfere with the recovery of the species.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**(Refer Previous issue)**	PGS therefore assesses behavioural impacts to the SR whale as minor (*minor and temporary disruption to a small proportion of the population with no effects on critical habitats or activities*) in accordance with the PGS qualitative risk matrix. Cumulative Impacts over 24 Hours: PGS has adopted one of the most rigorously reviewed and developed recent guideline with respect to establishing injury impacts to marine mammals which includes dual metrics of weighted accumulated sound exposure levels (SEL) and peak sound levels for impulsive sounds (NMFS, 2018). The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, a period of time must be defined. For marine mammals, following the Southall et al. (2007) criteria, the period is 24-h or the duration of the activity, whichever is shorter. Exposures at the closest point of approach are the primary contributors to a receiver's accumulated level (Gedamke et al. 2011). Additionally, several important factors determine the likelihood and duration a receiver is expected to be very close to a sound source (i.e., overlap in space and time between the source and receiver). For example, accumulation time for mobile sources moving fast relative to the receiver is driven primarily by the source's characteristics (i.e., speed, duty cycle) (NMFS 2018). The period of accumulation of 24 h has been applied in this study for SEL, reflecting Southall et al. (2007).	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	**6.** The PGS letter also demonstrates the imprecision or uncertainty of the control or 'adaptive management' measures proposed by PGS to mitigate the impact of the Duntroon Survey on the migrating SR Whale and the foraging Blue Whale. The Revised EP indicates that there will be one 'scout' vessel responsible for identifying marine hazards and managing interaction with shipping and fishing activities and a supply vessel that will be used to transport supplies to the survey vessel. The PGS letter states that if foraging Blues Whales are detected within the BIA, the supply vessel and the scout vessel will undertake surveillance either side of the survey vessel to manage spatial separation (Attachment 2 item 3 of the PGS letter). It is however noted that the PGS letter states that the decision to use one or two vessels to monitor any pod of whales and maintain the buffer is said to depend on a number of factors, namely, the location of the sightings, the number of whales and the area of foraging relative to the path of the survey vessel. The additional vessel required for monitoring may take up to 7 days to mobilise (Attachment 1 item 3 of the PGS letter). Maintaining the spatial buffer with the mobilisation of two vessels appears to the primary control measure to mitigate the impact of the Duntroon Survey on the SR Whale and Blue Whales and accordingly, would require two vessels to be available at all times during the Survey.	These adaptive measures identified by TWS SA contained within the Duntroon survey EP and as provided to TWS SA, have now been removed. The following control supersedes previous advice: • PGS has modified the temporal window for the Duntroon survey to 1 September to 30 November 2019 (and possibly 2020) to limit overlap with upwelling periods and the potential for disturbance to foraging blue whales within the foraging BIA present in the survey area. PGS have put a control in place to monitor the environmental conditions in and around the Kangaroo Island upwelling throughout November to detect emerging conditions favourable to an upwelling event (Interpretation and verification to be undertaken by an independent third party). If measured conditions identify the presence in 'favourable conditions' for an upwelling recognising that zooplankton development lags phytoplankton (chlorophyll a) observations, PGS will deploy aerial surveillance to detect to possible presence of pygmy blue whales migrating into the survey area. If pygmy blue whales are detected migrating into the area via the aerial surveillance PGS will cease operations for the remainder of the survey period. If pygmy blue whales are not observed migrating into the survey area, aerial surveillance will continue until there is pygmy blue whale encounter (and the survey ceases) or November 30 is reached. • The survey will still retain a scout and support vessel to support the acquisition vessel and provide additional MFO support. All measures identified within the EPBC Policy Statement 2.1 (Part A) will be adopted within the survey noting that spatial overlap with biologically important areas at biologically important times has been observed and eliminated in the survey design.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)
			7. The Revised EP was submitted prior to the publication of the Western Eyre Peninsula Commonwealth Marine Reserve Management Plan under the South-west Marine Parks Network. As the Management Plan commences operation on 1 July 2018, TWS SA requests PGS to confirm that the Revised EP complies with all of the requirements of the Plan.	The revised Duntroon EP will comply with the Western Eyre Peninsula Commonwealth Marine Reserve Management Plan under the South-west Marine Parks Network Management Plan as published on July 1st, 2018.		

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	8. TWS SA requests that all data from the aerial surveillance undertaken prior to commencement of the Duntroon Survey be provided to TWS SA within 24 hours, in addition to recorded sightings of whales during the Survey.	This timeframe is not practical for information to be collated and supplied to third-parties so there is no misinterpretation of results. PGS agrees to provide aerial surveillance data, and MFO reports on all marine fauna sightings obtained during the survey to TWS at the end of the Duntroon Survey acquisition. In addition, PGS will make a summary of whale sightings available to TWS SA weekly during the survey period.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)
			9. In 2015, the Italian Ministry of Environment (MATTM) included, as a mandatory requirement for the issue of a permit for oil and gas exploration, 60-day monitoring periods before and after the activity to gather information on marine mammal presence, density and distribution. Further, the MATTM require the submission of a Monitoring and Mitigation Plan that includes: a bibliographic review of available information for the operation area to evaluate data on local marine mammals; acoustic modelling to calculate exclusion zones; the before and after phase survey details; and mitigation protocol details3. The collection and publication of this before and after data, in addition to data collected during seismic operations, may be used to inform mitigation measures and provide guidance for future seismic surveys. These regulations inform what may be considered best practice regarding the content of a monitoring plan.	As discussed in previous PGS correspondence, the presence of cetaceans within the Duntroon survey area is seasonal. While the Italian Ministry of Environment (MATTM) guidelines may be considered as best practice for Italian waters, the collection of cetacean species sighting data 60 days prior to the survey (July-August), will differ dramatically with the 60-day period after the survey (December -January). An assessment of the pre and post operational monitoring associated with the Duntroon survey could not be compared with any available seasonal baseline data and it is unclear that any valuable effects data could be drawn from the temporal assessment of species, seasonally present in the area, before and after the survey. PGS considered that this suggestion does not hold merit.		

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TWS	eNGO	TWS Letter (20/04/18) PGS Letter Response (29/07/18) (excluding Items 3 & 5) TWS Letter (04/09/18) PGS Letter (29/09/18) (remaining Items)	10. It is unclear what measurable environmental outcomes have been adopted by PGS in relation to minimising the impact of the survey on cetaceans. The PGS letter confirms that PGS will monitor the location and behaviours of cetaceans in relation to the survey vessel during the Duntroon Survey to assist with operational decision-making. TWS SA also notes that PGS discount the ‘benefit (merit) in monitoring cetaceans prior to or in subsequent years as their behaviours rely on upwelling conditions’ (Attachment 1 item 7). Yet at the same time, PGS rely on the lower likelihood of an upwelling during April/May to support the conclusion of a lower potential for Blue Whale foraging.	PGS considers, based upon the revised Duntroon survey timeframe, that the measurable outcomes of the survey are quite clear with respect to cetaceans. These outcomes reflect the requirements of conservation management plans for threatened species present in the survey area and relevant regulatory requirements: • No interference with pygmy blue whale foraging behaviours in the blue whale foraging BIA (including no displacement from the foraging area); • No behavioural disturbance to SR whale activity within the coastal aggregation or calving areas in South Australian waters. • No injury to whales. All control measures within the Duntroon survey EP are designed around achieving these outcomes.		
			11. TWS SA considers that all monitoring data relating to the presence of cetaceans before, during and after the Duntroon Survey is important to evaluate the impact of seismic activity on the environmental sensitivities of the GAB and requests that this data be recorded and made available to interested stakeholders. In particular, detail in relation to the verification of the effectiveness of the mitigation and low power/shut down procedures that occur during the operation of the seismic activity should be included.	This has been discussed in Item 8 and Item 9. PGS agrees to provide aerial surveillance data, and MFO report on all Marine Fauna sightings at the end of the Duntroon Survey acquisition activity for the season. Information included in this report includes sighting data, location of whales and action taken. As committed to stakeholders on Kangaroo Island, this will include a member of the Kangaroo Island community that has been trained in MFO requirements as a measure of transparency.	Merit assessment and feedback has been provided in Record 42RA and Record 42RB	Record 42R (TWS Letter – 20/04/18) Record 42RA (PGS Letter – 29/7/18) Record 42RB (TWS – 04/09/18) Record 42RC (PGS Correspondence – 25/09/18)

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TWS	eNGO	PGS Email (23/07/18) PGS Follow-up Email (26/7/18) TWS Response (27/07/18) PGS Response email (27/07/18) PGS Response (30/07/18)	12. PGS acquired bio-acoustic data during the Ceduna Multi-Client 3D marine seismic survey and agreed with the CSIRO on a proposal to analyse the data to investigate the changes in environmental conditions and marine organisms during seismic operations. The costs to PGS of the project was estimated at approximately $56 000. TWS SA considers that the evaluation of this data and publication of the scientific conclusions, together with evaluation of further data acquired during the Duntroon Survey, is important to understand both the immediate and long-term impacts of seismic surveys in the GAB, including that currently proposed by PGS.	PGS understands there may be some confusion associated with the Ceduna multi-client 3D data which was collected in conjunction with CSIRO. During the PGS Ceduna survey, a collaboration between PGS and CSIRO collected bioacoustics data during seismic operations. CSIRO has the data associated with this survey, PGS provided the operational platform to acquire the data. The proposed CSIRO desktop study is largely to determine 'what can be seen' from the data collected and will be a proof of concept to assess if Simrad echo sounders installed on seismic vessels can be used to monitor pelagic habitats during seismic surveys. The project will also make recommendations on how existing/new instrumentation could be used to optimise opportunistic environmental monitoring during surveys. Note the data was previously collected under the IMOS project purely as goodwill for scientific purposes by PGS. It has only recently been recognised that there may be this additional value in the data, hence the potential desktop study by CSIRO. It is not certain that useful outcomes will be obtained from this study. CSIRO are in control of this activity.		
			13. TWS SA also notes that Appendix E to the Revised EP is a Scientific Monitoring Plan that appears to relate to an oil spill. It is unclear whether this has been included in the Revised EP in error.	The scientific monitoring plan has always been included in the Duntroon survey EP. Vessel collisions and subsequent oil spill impacts (as provided in the EP impacts and risk assessment) require assessment if a significant spill occurs.		
			23/07/18: PGS Email requesting a meeting with TWS during late July/early August and finalising response to concerns raised on April 20th, 2018. **30/07/18:** Information provided to update TWS on survey activities and provide feedback on the TWS Letter (above entry for 29/07/18) **31/07/18:** Meeting held in Adelaide	NA	NA	Record 42S
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 42T

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TWS	eNGO	TWS Response Letter (19/10/18) PGS Response Letter (2/11/18)	**19/10/18: Response to information sent on 29/09/18** **Background** The Wilderness Society of South Australia (***TWS SA***) responded on 4 September 2018 to the letter from PGS Australia Pty Ltd (**PGS**) of 29 July 2018 relating to the updated Duntroon Survey. As noted in the TWS SA letter of 4 September 2018, further consideration of the issues and any meaningful discussion between TWS SA and PGS would depend upon the revised sound modelling for the updated Duntroon Survey and the revised Environment Plan to be submitted by PGS to NOPSEMA in relation to the updated Duntroon Survey (***Updated EP***).	PGS has provided revised sound and animat modelling and provided impact assessment details for the items identified by TWS as a concern. PGS acknowledges your letter of the 19th October associated with the Duntroon MC3D and MC2D surveys in the eastern Great Australian Bight (GAB). It is disappointing that TWS states that they have not had reasonable opportunity to provide feedback given that TWS has had the necessary information required for evaluation for more than a month, and because PGS has made itself available to TWS throughout the process.	Merit assessment and feedback has been provided in Record 42W	Record 42 U Record 42V
			Consultation in relation to the Updated EP TWS SA previously expressed its concern that there was no collaborative engagement prior to PGS submitting the Revised EP on 20 October 2017 and the further information to NOPSEMA on 9 March 2018 in relation to the former Duntroon Survey. As a result, PGS did not adequately address many of the issues and concerns raised by TWS SA, nor demonstrate how the merits of these issues regarding the adverse environmental impacts of the Survey had been assessed. TWS SA notes that the new timeframes for the survey activities raise unique and specific environmental issues that TWS SA has not yet had an opportunity to consider and discuss with PGS. Accordingly, TWS SA has not been able to provide input into the measures by PGS to mitigate the impacts of the survey. TWS SA appreciates that the EP for the Updated Duntroon Survey will to some extent replicate the information in the EP for the former Duntroon Survey. However, as the timing of the survey has been deferred from autumn to spring, the control measures to monitor and mitigate the environmental risks have changed. TWS SA requires a reasonable opportunity to consider other changes in the Updated EP and provide further feedback	While TWS has expressed concern regarding 'no collaborative engagement' prior to the Environment Plan submission, PGS would like to advise that it has adopted a consultation strategy which meets the requirements of the Offshore Petroleum and Greenhouse Gas Storage Environment Regulations 2009 and has provided you with guideline references describing those requirements. Further, PGS has previously provided TWS with the full EP for the activity which exceeds those requirements.		Record 42W
			Acoustic Sound Impacts TWS SA will provide further feedback and identify any issues and concerns that it has in relation to the environmental impacts and risks of the updated Duntroon Survey once it has reasonable opportunity to consider the detail in the Jasco Applied Sciences acoustic modelling and animal movement reports dated 19 September 2018 (***Jasco Reports***). It is noted these reports are highly technical and based upon a range of other studies and technical reports. TWS SA had not yet had an opportunity to fully consider the assumptions and data upon which the Jasco Reports are based. Accordingly, TWS SA is not able to satisfy itself whether there is a sound basis for the assessment by PGS of the impacts upon marine species in the GAB and the adequacy of the mitigation measures proposed.	PGS understands the technical nature of the reports which have been provided to TWS.		Record 42W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
TWS	eNGO	TWS Response Letter (19/10/18) PGS Response Letter (2/11/18)	As a preliminary comment, TWS SA notes that the Jasco Reports confirm that there is no consensus in the scientific community as to the appropriate metric or sound levels useful for assessing behavioural reactions of marine mammals to sound exposure. Despite the references in the Jasco Reports to conservative assumptions, it is not clear how the precautionary principle has been applied by PGS in so far as it concludes that the behavioural impacts on the Southern Right (***SR***) whales in coastal aggregation and offshore areas is '*not significant'*. In particular, how has the principle been applied in respect of the migration of SR whales and calves away from coastal areas at the end of the calving season, taking them close to the survey operational area, when there is a 'complete lack of information' on the migratory corridors. The effectiveness of the measures outlined in the PGS letter to mitigate the environmental risks of the updated Duntroon Survey will be considered by TWS SA in the context of the Jasco Reports and the environmental impact assessment in the Updated EP as soon as all of the information is available. TWS SA also notes that PGS did not refer the Jasco Reports and the impact assessment for independent peer review. This is contrary to best practice and places an unreasonable burden on stakeholders to obtain independent scientific advice to assess the impacts of the survey.	With regard to the issue of behavioural reaction sound thresholds for marine mammals, while there is not a consensus in the scientific community at this time, PGS has undertaken a thorough review of the available scientific literature and adopted conservative criteria for assessment purposes. Moreover, review of the available scientific data and collaboration with independent Australian experts on the behavioural characteristics (e.g. migration speed, diving depths) and presence of southern right whales in the GAB has informed the JASCO Reports and in turn, the Duntroon EP. In the information provided on the 25th September 2018, addressing the specific issues and concerns raised by TWS from their letter dated 4th September 2018, PGS believes that the issue surrounding the 'significance' of impacts to the southern right whale both in coastal areas and during oceanic migration has been addressed. The references provided in that correspondence should suitably inform TWS of the key Commonwealth Government documents upon which environmental impact assessment and significance to matters of national environmental significance is based. The impact assessment details provided to you in correspondence dated 25th September 2018 and included within the Duntroon EP have been independently peer-reviewed by JASCO Applied Sciences.	Merit assessment and feedback has been provided in Record 42W	Record 42W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
TWS	eNGO	TWS Response Letter (19/10/18) PGS Response Letter (2/11/18)	**Assessment of the behavioural responses of marine mammals** The PGS letter refers to numerous studies relevant to the SR whale, whilst noting there are limited *behavioural effect* studies. The Jasco Reports also note that 'it remains unclear if there are migratory corridors' for the SR whales migrating south after the calving season. It is difficult to reconcile these statements in the Jasco reports with the assertion at paragraph 3 of the PGS letter that 'coastal migratory movements are reasonably well understood'. It is conceded in the letter that SR whales undertaking oceanic migration may be exposed to high levels of sound which could elicit behavioural response and deviation. This behavioural disturbance of the migrating SR whales is assessed by PGS as 'not expected to be significant'. It is unclear what data has been relied upon for the purpose of the 'animal modelling' in regard to the numbers of SR whales likely to be present in the migratory paths at the time of the survey. It would also be necessary for assessment of the cumulative impacts of the survey and previous surveys to be undertaken to assess whether the disturbance of the migratory pathways may interfere with the recovery of the SR whale population. The complexity in determining the cumulative impact of seismic surveys in the GAB in recent years has been noted: *With an increase in areas surveyed, greater complexity in surveys conducted (with the transition from 2D to 3D), and an increase in air gun array size, it could be assumed that the amount of noise being generated has increased. However, direct calculations of the estimated spatial noise output from each survey are difficult to determine given the directivity patterns of air gun arrays, the complexity of modelling air gun propagation in a real environment and the problem of dealing with cumulative sound loadings through time for the moving sound source.*	There appears to be confusion by TWS around the available scientific literature associated with migration of the southern right whale. The southern right whale has been observed to have quite distinct movement within coastal corridors during their presence in coastal regions during May to November. While these movement are well understood, the migration of the whales to/from the Australian coastline from the Southern Ocean is less understood with only a few studies available to inform migration. To assist TWS in understanding this distinction, please refer to the references provided in correspondence dated 25th September 2018 or to the National Conservation Values Atlas administered by the Department of Energy and Environment. Relevant data on which the behavioural characteristics for 'animal modelling' have been based are contained in Appendix C of the Duntroon Marine Seismic Survey – Animal Movement Modelling for assessing marine fauna exposures for a 3260 in3 array (Lucke et al, 2018) provided to TWS. PGS also notes that in assessing impacts to the southern right whale, both cumulative and instantaneous impacts have been assessed using internationally accepted 'metrics'. PGS notes that there is complexity with assessing cumulative sound impacts from any sound source in the environment (including continuous and more frequent shipping sound). Cumulative sound impacts from the Duntroon survey have been based upon the internationally-accepted methodology contained within the JASCO Duntroon Acoustic modelling report supplied to you on 25th September 2018. PGS has adopted the minimum sound source in the Duntroon survey required to meet survey objectives (i.e. subsurface geological mapping) of 3260 in3 which is a smaller source size than previous surveys in the region which used a source size of 4130 in3. PGS has and will continue to undertake sound source verification studies to confirm sound emitted to the environment from its sound source to confirm it is representative of the sound source modelled.	Merit assessment and feedback has been provided in Record 42W	Record 42W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
TWS	eNGO	TWS Response Letter (19/10/18) PGS Response Letter (2/11/18)		TWS states that it is necessary for the assessment of cumulative impacts of the survey and previous surveys to assess whether the disturbance of migratory pathways may interfere with the recovery of the SR whale population. PGS notes that sound from the Duntroon survey, as per the information provided to TWS on 25th September 2018, does not significantly encroach into coastal migratory pathways due to the distance of the activity from the coastline. Moreover, the estimated number of animals exposed to sound that may cause behavioural reactions is very small and temporary. In addition, the Conservation Management Plan for southern right whales (CoA, 2012) identifies that not all whales migrate to the coast each year. Previous surveys undertaken in the GAB (latest in 2014) have been undertaken further west and in deep water. As per the acoustic modelling (Wladichuk et al, 2018) provided to TWS for the Duntroon survey, there is little encroachment of sound from deeper water onto the continental shelf where the recognised 'coastal' migratory pathways are reasonably well understood. On this basis, the potential for cumulative impacts within the coastal migration areas from multiple surveys would be small.	Merit assessment and feedback has been provided in Record 42W	Record 42W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
TWS	eNGO	TWS Response Letter (19/10/18) PGS Response Letter (2/11/18)	**Further consultation** TWS SA does seek a further opportunity to participate in consultation with PGS in respect of matters relevant to the potential impact of the proposed updated Duntroon Survey on its activities, functions and interests. However, TWS SA is not in a position to discuss with PGS the mitigation and control measures proposed by PGS, pending further consideration of the Jasco Reports and review of the Updated Duntroon Survey EP. In regard to consultation during the survey activity, TWS SA is not satisfied with the proposed provision of aerial surveillance data at the end of the survey period. It is also unclear why PGS would not be able to notify stakeholders, including TWS SA of whale sightings on an almost contemporaneous basis during the survey and further confirm the mitigation measures adopted by PGS in response. Further consultation with PGS, both in relation to the Updated Duntroon Survey EP and during the survey will assist TWS SA to assess whether and to what extent the updated Duntroon Survey may adversely impact upon its activities and functions concerning the protection of the environmental sensitivities of the GAB. In the meantime, TWS SA will take the opportunity to further review the Jasco Reports and the detailed responses in the PGS letter	For information and as a recipient of the Duntroon EP, TWS would be aware of a number of control and verification measures which have been adopted for the Duntroon survey. Due to TWS's interests previously expressed, PGS would like to identify that it has adopted the following controls: • The spatial separation between Duntroon survey activities and the male and female sea lion foraging BIA has been increased to 10 km to add a greater level of conservativeness to the received sound level in this BIA. Given the hard boundary of this BIA, the survey vessel will be provided with these coordinates to maintain this spatial separation during the survey; • A shutdown zone of 500 m for pinnipeds in water depths < 200 m to protect the Australian Sea Lion; and • Placement of a sound logger at the boundary of the southern right whale calving BIA to verify acoustic modelling with respect to sound propagation. With regard to provision of aerial surveillance and MFO data, PGS reiterates advice provided in PGS correspondence dated 29/09/18 – The timeframe stated (24hrs) is not practical for information to be collates and supplied to third parties so there is no misrepresentation of results. PGS has stated that it will make a summary of whale sightings available to TWS SA weekly during the survey period.	Merit assessment and feedback has been provided in Record 42W	Record 42W

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Natural Resources Kangaroo Island	Ecotourism	PGS Letter (15/11/16) Delivery Receipt (15/11/16) (Record 43A) PGS/KINR Meeting (30/11/16)	**30/11/16:** PGS Meeting Held. Meeting Minutes identify that KI Natural Resource Management's concerns with any seismic activity taking place in the proposed Duntroon area in May due to the likely presence of the Southern Right Whale (Record 43B). These concerns will be noted in the Environment Plan, and we will provide feedback on how this has been considered within our EP prior to submission to NOPSEMA	KINR Concerns noted within the EP. An assessment of the impacts to Southern Right Whales has been assessed within the Duntroon EP to understand possible impacts of undertaken seismic in the May period. To protect migrating baleen whales such as the southern right whale, the EPBC Policy Statement 2.1 requirements will be implemented. This protects against PTS/TTS in the species. On a behavioural basis, migrating baleen whales might avoid the operational array by 15 km (shelf) and 40km (deep-water). The possible deviation around the survey vessel may plausibly add a few tens of kilometres to this migration. Such a marginal increase is not expected to significantly affect the metabolic demands of individuals who have migrated from Southern Ocean feeding grounds (~1000-3500 km). In coastal areas, predicted sound from modelling performed identified residual sound levels at the coast should be within the range of ambient sound levels and no behavioural disturbances to calving or coastal migrations are expected. On this basis the residual impact to the southern right whale is not considered to be significant.	Refer Record 43C	Record 43 Record 43A Record 43B Record 43C
		PGS Email (04/01/17)	**04/01/17:** Email providing section within EP on Southern Right Whale	No response provided to date	NA	Record 43D
		PGS Email (28/04/17) KI Natural Resources Response (02/05/17)	**28/04/17**: PGS provided advice that the Duntroon survey would not proceed this season and will resubmit the EP to cover the period January 1 to May 31 next season. PGS will provide further updates. **02/05/17:** KI Natural Resources appreciates the update.	Not Applicable	NA	Record 43DA
		PGS Email and Letter (18/09/17) Email receipt (19/09/17)	**18/09/17:** Email and letter providing an update to the Duntroon Survey. No response received.	No response provided to date	NA	Record 43E
		PGS Update Letter (21/1/18) KINR Response email (23/01/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **23/01/18:** Many thanks, we will raise the matter with the NRM Board, noting also, form a DEWNR agency point of view	No additional issues or concerns raised to date.	NA	Record 43F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Natural Resources Kangaroo Island	Ecotourism	PGS Email (15/10/18) NRKI Email Response (16/10/18)	**15/10/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Provided assessment and controls adopted for the Duntroon survey for the Southern Right Whale. **16/10/18:** [redacted] acknowledgement of receipt.	No issues identified to date	NA	Record 43G
[CONTACT]	Lobster and Deep-Sea Crab Fishermen	PGS Letter (23/11/16) Read Receipt (24/11/16) (Record 44A) PGS Resend (28/12/16) Response (30/12/16)	**30/12/16:** Feedback that the industry has been hit hard due to the creation of state parks resulting in the loss of productive fishing grounds. [CONTACT] does rely upon crab fishing as part of his business and has reservations regarding seismic – not only for crab but for lobster too. Concern is for the sustainability of the lobster and crab fishery.	**30/12/16:** PGS will send [CONTACT] the PGS assessment of the recent FRDC Report into Lobsters for his information. PGS would appreciate spatial information for where deep-sea crab fishing occurs to understand any sustainability impacts and will request information. PGS notes that available literature identify that adult crabs exposed to SELs of up to 187 dB re 1μPa^2.s from an acoustic array located 2 m from the test species showed no acute or chronic mortality and stress indicators (e.g., proteins, enzymes, cell type count) showed no significant difference (Christian et al. 2003; 2004). However, in separate studies (Payne et al. 2004, 2007) there was some measurement of sub-lethal impacts. Behavioural impacts (i.e. test species leaving area) identified that test species did not immediately leave area exposed. Effects on the fishery are not expected to be significant based upon these results and the limited area affected by survey activities. Preliminary findings did identify possible effects to fertilised eggs at close range to an acoustic source, however sample size was limited and conditions in the study (proximity) are not replicated in the Duntroon survey.	PGS provided lobster assessment to Andrew which was provided to SARLAC and requested fishing details (Record 44D)	Record 44 Record 44A Record 44B Record 44C Record 44D
		PGS Email (28/04/17)	**28/04/17:** PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates. Also requested spatial data to identify any overlaps in fishing.	No response claims or objections raised.	NA	Record 44E
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 44F
		PGS Letter Update (18/07/18)	**18/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 44G
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 44H

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Aboriginal Lands Trust	Interests in coastal waters and adjacent land.	PGS Letter (23/11/16) ALT Email (28/11/16) (Record 45B) ALT Email (30/11/16) (Record 45C)	**28/11/16:** ALT to contact PGS on 29/11/16 to discuss survey. **30/11/16:** ALT thanks PGS for the provision of information regarding the seismic survey and hopes PGS can present program to the board in early 2017.	No issues or claims raised	NA	Record 45 Record 45B
		ALT Email (03/03/17)	03/03/17: Confirmation of Adelaide Meeting Date.	NA	NA	Record 45BAA
		PGS/ATL Meeting (09/03/17)	09/03/17: PGS/ALT meeting. Meeting was to inform ALT on marine seismic primarily due to ALC members having limited exposure to marine seismic exploration. The visit was primarily related to the provision of information. PGS provided a presentation outlining the survey area along with an overview of seismic operations including videos of the source array firing, and animations of seismic vessel operations. There was limited time available, so business cards were left with each person present for further information requests. There was time for a few questions, and the relevant ones with respect to the EP were centered on risks to marine life. A brief overview of standard mitigation measures for marine mammals was provided, noting that while operations were not risk free, Australian regulations imposed some of the toughest standards on interactions with seismic and marine mammals, and that PGS adhered to these standards, with independent MFOs on board at all times during operations.	Not Applicable	Not Applicable	Record 45BA
		PGS Email (28/04/17) ALT response (28/04/17)	28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates. 28/04/17: ALT response – out of office.	No claims or objections raised.	NA	Record 45 C
		PGS Email (18/10/17) ALT Response (19/10/17)	18/10/17: PGS email to provide an update to the Duntroon survey activity. 19/10/11: Advice that the information would be passed onto the Chief Executive and Board for their information.	No claims or objections raised.	NA	Record 45 D Record 45E
		PGS Update Letter (21/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 45F
		PGS Update Letter (16/07/18)	**16/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 45G

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Aboriginal Lands Trust	Interests in coastal waters and adjacent land.	PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 45H
		ALT Phone-call (19/10/18)	**19/10/18:** I received a call from [CONTACT] representing the Aboriginal Lands Trust, they have an upcoming board meeting in 3rd week of December and would like up to provide any additional update to the Duntroon Activities by 1st week of December. We discussed that since the formal update in July there had been no major changes, but further sound modelling and animal movement modelling had been completed which we were happy to provide. [CONTACT] said he would respond to my email and request the above-mentioned modelling and any further updated to be communicated by X date for the December board meeting	No issues or concerns raised	NA	Record 45I
SA State Minister – Resources and Energy	SA interest in resource development	PGS Letter (23/11/16) Minister Letter (20/12/16) (Record 46A)	**20/12/16:** Minister expressed support for the project and keen to see that PGS take into account any local concerns particularly around the fishing industry and Kangaroo Island community interests.	PGS has engaged with the fishing community and Kangaroo Island community and is addressing their concerns (refer to separate entries).	NA	Record 46 Record 46A
Geoscience Australia	Possible coincident surveys	PGS Letter (23/11/16) Minister Response (28/11/16) (Record 47A)	**28/11/16**: Email acknowledgement and item will be brought to the attention of the Minister.	No claims or issues raised.	NA	Record 47
KI Futures Authority [CONTACT]	Body to deliver economic, environmental and social sustainability to Kangaroo Island	PGS Letter (23/11/16) PGS Email (30/11/16) (Record 48A)	**30/11/16**: KI Futures Authority has been disbanded.	No issues or claims raised.	NA	Record 48 Record 48A
KI Commissioner [CONTACT]	KI Commissioner	PGS Letter (23/11/16) PGS/KIF Telephone Conversation (25/11/16) (Record 49) PGS Email (28/11/16) PGS Email (02/12/16) (Record 49A)	**28/11/16:** Meeting between KI Commissioner and PGS set for 30th November (12:30pm). Meeting Minutes: During our meeting referred to below, [CONTACT] outlined her role as KI Commissioner. [CONTACT] was supportive of the project provided we consulted appropriately in KI, noting the community concerns around the clean and green image of Kangaroo Island, and conservation values. [CONTACT] offered to post project Q and A on her site should we wish to. **02/12/16:** PGS to post answers to common questions on KI Commissioner site.	No issues or claims raised to date	NA	Record 49 Record 49A Record 49AA

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KI Commissioner [CONTACT]	KI Commissioner	PGS Email (31/01/17)	**31/01/17:** PGS provided update of survey plans and provided information relating to Questions and Answers on seismic surveys for KI Commissioner review and feedback.	No feedback to date	NA	Record 49B
		PGS Email (28/02/17) PGS Email (28/04/17)	28/02/17: PGS advice that EP was submitted. 28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No response claims or objections raised.	NA	Record 49C
		PGS Email (08/09/17) KI Commissioner Email/Letter (11/10/17) PGS Email Response (11/01/17)	**08/09/17:** Duntroon survey information update provided to KI Commissioner **11/10/17:** Response from KI Commissioner included the following: • My interests will be primarily related to ensuring adequate engagement with the Kangaroo Island community and the Kangaroo Island Council throughout the process. As you would be aware, there are many businesses that rely on Kangaroo Island's pristine marine environment for their operations and trust that they will have the opportunity to provide feedback to PGS on the potential impacts that offshore exploration may have on their businesses. I would like to seek your formal reassurance that the Kangaroo Island Community and Council will be engaged throughout the process where appropriate and will have access to relevant information on the proposal. • To assist with this process, I will be providing links to information and resources on offshore exploration provided by NOPSEMA, the Department of State Development and the South Australian Government. I will also provide a link to the Lightning 3D MSS Environment Plan. If my Office can provide any assistance or advice in relation to community / stakeholder engagement, we would be happy to assist. • As indicated recently via email the KI Community Expo is being held in Kingscote on 27 November and I really appreciate your interest in being involved in this. It will be a great opportunity to promote what is occurring with the project and enable community interaction	PGS continues to consult with the KI Council and other members of the KI community and relevant Government and commonwealth authorities. This reassurance will be provided to the KI Commissioner. PGS does not object to the links to information and resources on offshore exploration or other material on website. Unfortunately, PGS will not be able to attend the KI Community Expo.	PGS Response: PGS has and continues to engage with the KI Council and the KI Community where appropriate, along with the relevant SA Government and Commonwealth authorities. This includes the provision of relevant information on the proposal. The engagement process will also be reviewed by NOPSEMA. Regarding the KI Community Expo, we do very much appreciate the invitation, but unfortunately that timing doesn't work well for PGS and we will not be able to attend. However, we do of course remain open to any queries and always happy to go to KI to meet stakeholders further as appropriate if requested	Record 49D
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 49E
		PGS Update Letter (18/07/18)	**18/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 49F
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 49G

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Exceptional Kangaroo Island [CONTACT]	KI Tourism Operator	PGS Letter (23/11/16)	No feedback provided.	No claims or objections raised.	NA	Record 50
Kangaroo Island Fishing Adventures [CONTACT]	KI Tourism Operator	PGS Letter (25/11/16)	No feedback provided.	No claims or objections raised.	NA	Record 51
Kangaroo Island Marine Adventures [CONTACT] Neighbour)	KI Tourism Operator	PGS Letter (25/11/16)	No feedback provided.	No claims or objections raised.	NA	Record 52
Central Zone Abalone Fishery [CONTACT]	SA Fishery Industry Body	PGS Letter (07/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 53
Central Zone Abalone Fishery [CONTACT]	SA Fishery Industry Body	PGS Email (28/04/17)	28/04/17: PGS provides advice that Duntroon survey will not proceed this year but will resubmit EP for the period Jan1-May 31, 2018, PGS will provide further updates.	No claims or objections raised.	NA	Record 53AA
Central Zone Abalone Fishery [CONTACT]	SA Fishery Industry Body	PGS Email and Letter (08/09/17) Delivery Receipt (08/09/17) Email Receipt Advice (18/09/17)	18/09/17: Letter provided to the Central Zone Abalone Fishery on update to the Duntroon survey *No feedback to date*	No claims or objections raised.	NA	Record 53A
		PGS Update Letter (18/1/18) PGS Resend (24/01/17)	**18/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 53B
		PGS Update Letter (16/07/18)	**16/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 53C
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 53D
Abalone Industry Association of SA [CONTACT]	SA Fishery Industry Body	PGS Letter (07/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 54
		PGS Email and Letter (08/09/17)	08/09/17: PGS Information on the Duntroon Survey	No claims or objections raised.	NA	Record 54A
		PGS Update Letter (19/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 54B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Abalone Industry Association of SA [CONTACT]	SA Fishery Industry Body	PGS Update Letter (16/07/18) AIASA Response Letter (31/07/18) PGS Email (10/10/18)	**16/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **31/07/18 Response:** AIASA position in regards to seismic testing in South Australian waters (in line with WFSA's): • AIASA is not anti-development, however sees no upside to seismic activity in South Australian waters, only risk to our industry. • We strongly oppose any seismic activity undertaken close to the coast and outer reef systems and during the sensitive abalone spawning months. • No such consideration of support will be forthcoming for any seismic activity unless; ○ An income protection / indemnity policy being taken out for our industry by the Operators (should this work negatively impact our Industry) AIASA are responsible industry leaders who actively work alongside government to ensure local abalone stocks are environmentally sustainable and financially viable. We acknowledge development yet must ensure our industry will not be negatively affected. We kindly request being included and informed on any future developments regarding this application.	PGS understands from the latest Western Zone Blacklip and Greenlip Abalone Fisheries (2016) Report (Stobart et al, 2017), the closest abalone fishing areas (Spatial Assessment Units (SAU)) are the Neptune Islands, located approximately 49 km east; Cape Carnot, located 51 km north; Four Hummocks Island located 36 km northeast; and Greenly Island located approximately 30 km north. All are measured from the nearest OA boundary. Given the distance of the Duntroon OA from the coast and these coastal features, and more specifically the survey area minimum water depths (100 m) and location of the survey lines within this polygon, PGS believes that the survey and seismic activity is not located close to the coastal and outer reef systems where abalone is being harvested. However, PGS understand that AIASA is concerned that survey activities may affect abalone stock and spawning given the survey does coincide in timeframe with the spawning period for the greenlip abalone (late spring to early summer) and blacklip abalone (spring [October to December] and autumn [February to April]) (Stobart et al, 2012; PIRSA, 2012). PGS also understands AIASA's concern associated with impacts to larvae particularly with recently issued papers on zoo-plankton impacts from seismic operations by McCauley et al (2017). While this study has some significant issues with the survey design, PGS has assessed possible impacts using this study's results and impacts to plankton (including larvae) would be limited to a radius of 8.05 km around the operational array on the continental shelf. Given the distance of the survey activities from the identified abalone harvesting areas, and the relatively localised dispersion of abalone larvae during spawning, survey activities are not predicted to have a significant impact on spawning success and recruitment.	Information provided in Record 54F	Record 54C Record 54D Record 54E Record 54F
		PGS Email (18/10/18)	**18/10/18:** PGS follow-up to determine if there are any issues associated with correspondence sent.	No response provided to date	NA	
Recreational Charter Boat Fishery	SA Recreational Charter Industry Body	PGS Letter (07/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 55
		PGS Email and Letter (08/09/17) Read Receipt (09/09/17)	08/09/17: Updated information on the PGS Duntroon survey provided to fishery. No response to date.	No claims or objections raised.	NA	Record 55A
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 55B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Recreational Charter Boat Fishery	SA Recreational Charter Industry Body	PGS Update Letter (19/07/18)	**19/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 55C
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 55D
Calypso Star Charter	Charter boat operators around Neptune Island.	Calypso Star Charter Email (08/12/16)	**08/12/16**: In response to a recent email received from the SA Charter Boat Owners Assn, Calypso Star Charters don't fish much these days but instead concentrate on Shark Cage Diving at the nearby Neptune Islands. Unlikely it's related but in 2015 when some testing was going on (further WSW) we had a visit by a pod of Orcas that scared the sharks away for several weeks. We don't usually see Orcas on inside the Shelf- food for thought and will see what happens next year. In 2015 several guys off the survey boats jumped on for a Shark Cage Dive (day trip) when they changed crews (month on month off it think they did). Request the right direction of getting in contact with the operators of the survey boats so a brochure can be forwarded onto their crews who hopefully might be able to arrive a day early or leave a day late after change over. A benefit to the local economy (brochure attached).	Email distributed to vessel manager on proposed season 1 vessel.	Email forwarded on to PGS Vessel Manager	Record 56
RECFish SA	Peak Recreational Fishing Body in SA	PGS Letter (12/12/16)	No feedback provided.	No claims or objections raised.	NA	Record 57
		PGS Email and Letter (08/09/17) Delivery Receipt (08/09/17)	08/09/17: PGS Information update on Duntroon survey. No feedback provided to date.	No claims or objections raised to date.	NA	Record 57A
		PGS Update Letter (19/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 57B
		PGS Update Letter (19/07/18)	**19/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **23/07/18:** RecFish SA response – new contact as [redacted] no longer works for the organisation. Email has been forwarded to [redacted]	No additional feedback provided	NA	Record 57C Record 57D
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 57E
Aboriginal Affairs and Reconciliation Department	Aboriginal Affairs in SA	PGS Letter (13/12/16) Read Receipt (13/12/15) (Record 58A)	No feedback provided to date.	No claims or objections raised to date.	NA	Record 58 Record 58A

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Aboriginal Affairs and Reconciliation Department	Aboriginal Affairs in SA	PGS Email and Letter (08/09/17)	08/09/17: PGS letter providing update to Duntroon survey.	No claims or objections raised to date.	NA	Record 58B
		PGS Update Letter (21/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 58C
		PGS Update Letter (16/07/18)	**16/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback provided to date	NA	Record 58D
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 58E
[CONTACT]	SA Lobster Fisherman	Telephone Call (15/12/16)	**15/12/16:** [CONTACT] advised that he catches lobster well away from the work area and won't be impacted by the survey. Suggested that any lobster fishermen that do work the area operate out of Port Lincoln.	PGS appreciates this information and has been incorporated into EP.	Feedback provided by phone	Record 59
Small Pelagic Fishery Industry Association (SPFIA)	Industry Body for Small Pelagic Fishery	Email and Letter (08/09/17) SPFIA Email Response (11/09/17) PGS Email Response (14/09/17) PGS/SPFIA Telecon (19/09/17)	**08/09/17:** PGS Email and letter advising SPFIA of the Duntroon activity. **11/09/17:** SPFIA responded in the following way: I work for three industry associations; small pelagic fishing industry association (SPFIA), southern shark industry alliance (SSIA) and the south east trawl fishing industry association (SETFIA). There is effectively no fishing in the SPFIA presently and the trawl fishery is further east so the gillnet shark fishery (represented by SSIA) is the only active fishery that has overlap in that area. Every two years SETFIA runs a survey (like the GAB trawl survey) but thankfully this is not in the area you propose. I would be very interested in whether you have obtained any information on gillnet (technically called the GHaT fishery) fishing in that area. We would be interested in seasonality, catch and volume. I note that the GHaT fishery mostly operates in <200m. Have you obtained any fisheries data to check overlap? If you could contract SSIA to do this. SSIA is not-for-profit so the cost would not be expensive. We have completed similar work for Roc Oil, Cooper, Santos, Hibiscus etc... **19/09/17:** PGS/SPFIA discussion to confirm that there would be nobody working in the SPF during the Duntroon survey period. SPFIA indicated only one person was working in the fishery in southern NSW not SA.	PGS appreciates information and this has been used in the EP to assess risks of interaction	NA	Record 60
		PGS Update Letter (19/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 60A

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Small Pelagic Fishery Industry Association (SPFIA)	Industry Body for Small Pelagic Fishery	PGS Update Letter (19/07/18)	**19/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 60B
		PGS Reminder Email (3/10/18) SPFIA (5/10/18)	**3/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds. **5/1018:** The SPF fishery does technically extend that far but there are no vessels working in the area so again there is no need to continue communications for that fishery	No further consultation required.	NA	Record 60C Record 60D
Southern Shark Industry Alliance (SSIA)	Quota Holders for Shark Fisheries	Email and Letter (08/09/17) SSIA Email Response (11/09/17) PGS Email Response (14/09/17)	**08/09/17:** PGS Email and letter advising SSIA of the Duntroon activity**.** **11/09/17:** SPFIA responded in the following way: I work for three industry associations; small pelagic fishing industry association (SPFIA), southern shark industry alliance (SSIA) and the south east trawl fishing industry association (SETFIA). There is effectively no fishing in the SPFIA presently and the trawl fishery is further east so the gillnet shark fishery (represented by SSIA) is the only active fishery that has overlap in that area. Every two years SETFIA runs a survey (like the GAB trawl survey) but thankfully this is not in the area you propose. I would be very interested in whether you have obtained any information on gillnet (technically called the GHaT fishery) fishing in that area. We would be interested in seasonality, catch and volume. I note that the GHaT fishery mostly operates in <200m. Have you obtained any fisheries data to check overlap? If you could contract SSIA to do this. SSIA is not-for-profit so the cost would not be expensive. We have completed similar work for Roc Oil, Cooper, Santos, Hibiscus etc... No further feedback has been provided.	PGS has used information to inform EP. PGS in response to the SSIA request provided all available information within EP on the GHaT fishery. Information includes catch, location and volume. No seasonality information available.	EP Information provided as per Record.	Record 61
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 61A
		PGS Telephone Conversation (04/03/18)	**04/03/18:** Conversation between [CONTACT] and [CONTACT] to confirm the type of equipment used in the GHaT fishery in SA. S[CONTACT] confirm that hook fishery and no gillnet fishery would be the methodology adopted in SA waters due to closures.	Information revised in EP	NA	NA

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Southern Shark Industry Alliance (SSIA)	Quota Holders for Shark Fisheries	PGS Update Letter (23/07/18) SSIA Email Response (24/07/18) PGS Response Letter (04/09/18)	**23/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **24/07/18:** SSIA made an anecdotal comment that we thought that there would not be many Cth GHaT gillnetters fishing in that area. We urge you to obtain data from AFMA but understand the issues associated with the 5-boat rule. The aim of the following is to address some of your questions: ***Some*** of the Cth GHaT hook (not gillnet) vessels fishing the area are: - ACE OF HEARTS: [CONTACT], [PHONE], [EMAIL] - IMPULSE: [CONTACT], [PHONE], [EMAIL] - PASADENA STAR: [CONTACT], [PHONE], [EMAIL] I stress that this is ***NOT*** a comprehensive list, just some hook vessels. You should ask these vessels for referrals to other potentially impacted vessels. The best solution to minimising your impacts would be to: 1. Ask fishers when (season) they would prefer the survey 2. Ask them if there is a particular area that they would like excised from the polygon 3. Compensate fishers for lost income if they are unable to fish in other areas 4. Provide preferably 6 months, and at worst 3 months-notice, that some GHaT fishing grounds will not be accessible. One month is insufficient. 5. Inform vessels as soon as the survey has finished. Not within 10 days. I would like to see your data on Cth GHaT sub-fisheries if possible just to understand the extent of the impact. I may or may not need to get involved. The ABARES data is too course but again I note the 5-boat rule.	PGS agrees that the only methodology which can supply actual catch and effort data is via individual fishermen as the 'confidential' nature of fishing in the survey area will not provide quantifiable data as identified by SSIA. PGS has contacted all fishermen (refer Stakeholders 77, 78, 79 records) to identify if they fish within that area. Waiting their response. PGS cannot provide 3-6 months' notice of survey activities within the Duntroon survey area with timing clarity. Notification of two months prior to survey commencement allows PGS to accurately confirm movement and timing of vessels. Data for the fishing year 2016/17 for the GH&T fisheries has been provided to SSIA.	This information has been provided to SSIA in Record 61D.	Record 61B Record 61C Record 61D
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 61E
		SSIA Email (4/10/18) PGS Response (5/10/18) SSIA Request (5/10/18)	**4/10/18:** SSIA Request to confirm if the Duntroon Survey falls in the SE Trawl fishery. **5/10/18:** The Gillnet Hook and Trap fishery (Cth) does operate there. I am also engaged by the industry association representing that fishery (SSIA). Can you tell me the amount of effort (shots and/or tonnes) that occur annually in your proposed polygon for that fishery. I apologise if we have had this conversation but I am overwhelmed by oil/gas work.	5/10/18: PGS confirmed the survey is not within the fishery. 5/10/18: PGS confirmed that PGS had already discussed the presence of the GH&T fishery within the Duntroon survey area and you have helped us enormously by providing three contacts, which we have contacted, to discuss whether they fish in the area. As previously advised the area is considered 'confidential' and we have discussed that data which might be available from AFMA will not provide the level of detail we seek on catch/effort. We attach that email for your records.	NA	Record 61F

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
SA Environment Protection Authority (EPA)	Environment Protection Agency for SA Coastal Waters	PGS Email and Letter (26/09/17) EPA Delivery Advice (email) (26/09/17)	**26/09/17**: PGS Email and letter advising SAEPA of the Duntroon activity**.** *No response provided to date.*	No claims or objections raised to date.	NA	Record 62
		PGS Update Letter (23/1/18) EPA Response Email (23/01/18)	**23/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **23/01/18:** EPA will get back to you with any questions	No additional questions raised or issues/concerns.	NA	Record 62A
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 62B
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 62C
Director of National Parks (DNP)	Management Authority for the Western Eyre Commonwealth Marine Reserve	PGS Email & Letter (09/06/2017) Resent (12/06/17) PGS Telephone Conversation and follow-up email (11/7/17) DNP Response Email (28/08/17)	**09/06/17**: PGS Email and letter advising SAEPA of the Duntroon activity**.** 28/08/17: DMP response included the following: 1. Apologies for the delay in our response and thank you for engaging with the Director of National Parks on the proposed Duntroon Surveys (MSS). Consulting the DNP is an important step to ensure that Australian marine parks are appropriately considered in the preparation of environment plans. 2. We note that the operational area overlaps the multiple use and special purpose zones (IUCN VI) of the Western Eyre Commonwealth Marine Reserve (CMR) which forms part of the South-west CMR Network. Transitional management arrangements currently apply for this marine park. These arrangements allow a range of activities, including mining operations (which includes seismic surveys), to continue until a management plan comes into effect. The Director of National Parks has issued general approvals to implement these transitional management arrangements for all new areas added to the Commonwealth marine reserve estate (general approval for the Western Eyre CMR). This approval does not replace the need for titleholders to have an accepted Environment Plan under the OPGGS Act for all petroleum activities.	PGS has assessed the requirements of the DMP as per the following: 1. No assessment required 2. PGS has utilised information within the EP recognising general approval requirements. 3. PGS has assessed potential impacts of the activity in Section 6 of the EP against the conservation values of the marine park. On this basis PGS considers the impacts and risks to be ALARP and acceptable. 4. PGS has utilised latest research findings within the GAB including the program sunder the GAB research Project (Section 3) to understand the ecosystem and enable assessment on ecosystem and broader benthic biodiversity to be assessed (Section 6.2). 5. PGS recognises the transitional arrangements will end on the finalisation of the Management Plan with may occur in the first half of 2018. This has been flagged in the EP for reassessment via a Management of Change should this occur. 6. Notification will be provided to DNP on EP acceptance, 5 days prior to equipment deployment and at the completion of seismic acquisition (EP Table 9-3)	PGS thanked the DNP for this feedback	Record 63

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Director of National Parks (DNP)	Management Authority for the Western Eyre Commonwealth Marine Reserve	PGS Email & Letter (09/06/2017) Resent (12/06/17) DNP Response Email (28/08/17)	3. These reserves are managed primarily for ecologically sustainable use of natural ecosystems while protecting and preserving biological diversity and natural values of the reserve in the long term. We recommend that in the preparation of the Environment Plan, PGS consider the potential impacts of the planned activity on the conservation values of the marine parks, and risk to those values, and explain how PGS plans to reduce impacts to as low as reasonably practicable. This may include explanation of controls that will be used to mitigate impacts. Specific marine park values that should be considered include seasonal calving for southern right whales, foraging area for Australian sea lions, white shark and several species of seabird. More information on the key conservation values and key ecological features for the South-west network can be found on our website. 4. We also recommend that PGS give consideration to the latest research findings from within the GAB, including any projects completed under the Great Australian Bight Research Program. Noting the potential implications of seismic activities on ocean ecosystem structure and health, consideration should also be given to the impacts of seismic testing on the productivity of the ecosystem and broader benthic biodiversity. 5. On 21 July 2017 the Director of National Parks released for public comment, five draft management plans for 44 Australian Marine Parks that are managed by Parks Australia. You can review the draft management plans and provide feedback through the marine parks website at www.parksaustralia.gov.au/marine. Comments close on 20 September 2017. Proposed arrangements within the draft plans outline that the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) will remain the sole assessor for offshore petroleum and greenhouse gas activities in Commonwealth waters and additional assessment by the Director of National Parks will not be required in Special Purpose and Multiple Use zones. Additional approval from the Director of National Parks will be required for pipelines in Habitat Protection, Recreational Use and National Park zones. **6.** We look forward to notification regarding the final approval of this environment plan and notification of any planned operations that may impact on reserve values. Any ongoing correspondence can be directed to the Marine Protected Areas Branch at marinereserves@environment.gov.au.	Refer above	PGS thanked the DNP for this feedback	Record 63

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Director of National Parks (DNP)	Management Authority for the Western Eyre Commonwealth Marine Reserve	PGS/DMP Telephone Discussion (5/10/17)	**5/10/17:** Discussion with DNP [redacted] to understand the arrangements for scientific monitoring should a spill occur within the Western Eyre CMR. DMP requested that PGS send through relevant information on scientific monitoring for information.	No response provided to date	PGS sent scientific monitoring information contained in the EP to DMP for information.	Record 63A
		PGS Update Letter (21/1/18) DNP Response (22/01/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31. **22/1/18:** Thank you for updating the Director of National Parks (DNP) on the delay to the Duntroon survey. We also acknowledge the notification milestones for the DNP outlined in your letter	No issues or concerns raised.	NA	Record 63B
		PGS Update Letter (20/07/18)	**20/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 63C

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Director of National Parks (DNP)	Management Authority for the Western Eyre Commonwealth Marine Reserve	PGS Reminder Email (1/10/18) DNP Feedback Email (11/10/18)	**1/10/18 (PGS):** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds. **11/10/18 (DNP):** Thank you for providing the Director of National Parks (DNP) with an update on the summary of proposed actions for Duntroon MultiClient two-dimensional (MC2D) and MultiClient three-dimensional (MC3D) Marine Seismic Surveys (MSS) ('Duntroon Survey') Environment Plan in the eastern Great Australian Bight (GAB). As noted in your letter of 20 July 2018, the proposed activity is located in the Multiple Use Zone and Special Purpose Zone of the Western Eyre Marine Park, which forms part of the South-west Network of Marine Parks. We also note that your activity is located approximately: • 50 kilometres from Western Kangaroo Island Marine Park, • 142 kilometres from the Great Australian Bight Marine Park, and • 150 kilometres from the Southern Kangaroo Island Marine Park. The *South-west Marine Parks Network Management Plan 2018* came into effect on 1 July 2018. The management plan allows for mining authorisation to be given through a class approval for the Multiple Use Zone, Special Purpose Zone and Special Purpose Zone (Trawl) of the Western Eyre Marine Park. The class approval requires an accepted Environment Plan (EP) under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*. You need to be aware of your obligations under the class approval (including conditions). Please note, NOPSEMA remains the sole assessor of environmental management arrangements for activities authorised by the class approval. To assist in the preparation of an EP for petroleum activities in an Australian marine park, NOPSEMA has worked closely with Parks Australia to develop and publish a guidance note that outlines what titleholders need to consider and evaluate. In preparing the EP, you should consider all activities associated with the operation of the seismic program. To take into account Australian marine parks, titleholders are expected to consider the impacts and risks of activities in the context of the management plan objectives and values. This includes the representativeness of the relevant values and the activity footprint on the representative area of the Australian marine park.	The Duntroon EP has considered all marine park management prescriptions, conservation values and class approval documents when collating regulatory requirements. Duntroon survey impacts and risks have been assessed to a level which is acceptable and ALARP in accordance with species Conservation Management Plans and KEF ecosystem functioning. PGS has consulted the NOPSEMA Guidance Note GN1785 – Petroleum activities and Australian marine national parks (July 2018) in compiling this EP.	NA	Record 63D Record 63E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person

Director of National Parks (DNP)	Management Authority for the Western Eyre Commonwealth Marine Reserve	PGS Reminder Email (1/10/18)
		DNP Feedback Email (11/10/18)
			Values are broadly defined into four categories: natural, cultural, heritage and socio-economic. Specific natural values for the Western Eyre Marine Park include (but are not limited to):
			• Biologically important areas such as
			  ○ a calving buffer area for the threatened southern right whale,
			  ○ foraging habitat for the migratory pygmy blue whale,
			  ○ foraging habitat for the threatened Australian sea lion, threatened white shark and sperm whale, and
			  ○ breeding and foraging habitat for seabirds.
			• Examples of ecosystems representative of the Spencer Gulf Shelf, GAB Shelf Transition and the Southern Province.
			• Five key ecological features: the ancient coastline between 90 m and 120 m depth (valued for relatively high productivity, aggregations of marine life and high levels of biodiversity and endemism); Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwelling (valued for high productivity, aggregations of marine life and unique seafloor features with ecological properties of regional significance); mesoscale eddies (valued for high productivity and aggregations of marine life); benthic invertebrate communities of the eastern GAB (valued as a species group or community that is nationally and regionally important to biodiversity); and small pelagic fish of the South-west Marine Region (valued as a species group that has a regionally important ecological role).
			As mentioned above, there are known biologically important areas in the region and the EP should consider options to avoid and/or mitigate all known or potential impacts.
			Further information on the values for the Western Kangaroo Island, Great Australian Bight and Southern Kangaroo Island marine parks are located in the management plan.
			In the context of the management plan objectives and values, you should ensure that the EP:
			- identifies and manages the impacts and risks on marine park values to an acceptable level and has considered all options to avoid them or reduce them to as low as reasonably practicable.
			- clearly demonstrates that the activity will not be inconsistent with the management plan.
			Consideration should be given to the latest research findings relevant to the GAB, including any projects completed under the Great Australian Bight Research Program. Noting the potential implications of seismic activities on ocean ecosystem structure and health, consideration should also be given to the impacts of seismic testing on the productivity of the ecosystem and broader benthic biodiversity.
				As per above.	NA	Record 63D
						Record 63E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Director of National Parks (DNP)	Management Authority for the Western Eyre Commonwealth Marine Reserve	PGS Reminder Email (1/10/18) DNP Feedback Email (11/10/18)	<u>Emergency responses:</u> The DNP should be made aware of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. Notification should be provided to the 24-hour Marine Compliance Duty Officer on [PHONE]. The notification should include: - titleholder details - time and location of the incident (including name of marine park likely to be affected) - proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.); and - contact details for the response coordinator. <u>Notification milestones:</u> Thank you for providing the opportunity to comment on the suitability of the "planning notification" timeframe and the standard notification milestones for the second season activities. We consider the timeframes suitable. The DNP also requests notification to [EMAIL] if <u>the EP is approved by NOPSEMA.</u> Please don't hesitate to contact <u>[EMAIL]</u> if you have any further questions.	Information has been added to emergency response arrangements within Section 7.7.2.3 of the Duntroon EP. Notification milestones are already contained in Table 9-3 of the Duntroon EP.	NA	Record 63D Record 63E
Geo-venture Solutions (Asia Pacific)	Stakeholder with active EP with acquisition overlapping areas with PGS	PGS Email and Letter (18/10/17)	**18/10/17:** PGS email requesting feedback on survey activities proposed by the company in and around the Duntroon survey area. *No feedback to date.*	Not Applicable	NA	Record 64
Department of Energy and Environment (DoEE)	Commonwealth Environmental Regulator	PGS Email (20/07/17) DoEE Response (21/08/17)	**20/07/17:** Query to DoEE to understand the definition of the calving buffer zone. DoEE response: For southern right whale breeding areas, a buffer of 12 nautical miles has been applied. The intention of the buffer was to be consistent with the management approach used for the *Former Great Australian Bight Marine Park – Marine Mammal Protection zone*. This zone extends from 3 nautical miles to approximately 12 nautical miles offshore and was primarily intended to provide for undisturbed calving for the southern right whale and protection of Australian Sea-lion colonies (GAB Marine Park Management Plan 2005-2012). The use of buffers is also discussed in the *Report of the Australian Southern Right Whale Workshop 2009 … 'The setting of soft boundaries and buffer zones on maps is critical as users tend to interpret hard boundaries (e.g. lines on maps) as meaning anything outside the line is OK*'. The full report is found here: http://www.marinemammals.gov.au/__data/assets/pdf_file/0005/1103/AMMC---Southern-right-whaleworkshop-report-March-2009.pdf	Information included in the collation of the Duntroon EP	NA	Record 65

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Cetacean Ecology Behaviours and Evolution Lab (CEBEL) (Flinders University)	Scientific Organisation with interests in the GAB	PGS Email and Letter (18/10/17)	**18/10/17:** Email requesting feedback on proposed survey activities.	Not Applicable	NA	Record 66
		PGS Update Letter (21/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No claims or objections raised.	NA	Record 66A
		PGS Letter Update (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 66B
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 66C
Great Australian Bight Right Whale Study	Scientific Organisation with interests in the GAB	PGS Email and Letter (18/10/17)	**18/10/17:** Email requesting feedback on proposed survey activities.	Not Applicable	NA	Record 67

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Great Australian Bight Right Whale Study	Scientific Organisation with interests in the GAB	GABWS Response (27/10/17) PGS Email Response (03/11/17)	**27/10/17:** Thanks for your email and opportunity to comment on the Duntroon MSS. I am travelling overseas for a conference at the moment. I will have a detailed look over the consultation letter in within the week and get back to you with any additional comments. On first glance, the obvious key considerations for that area are blue whales and commercial fisheries. I am sure that you are keeping busy with fisheries stakeholder feedback and trust that you have consulted with [CONTACT] and the Blue Whale Group. Southern right whales are likely to be migrating to the coast in the region of the survey in May. To mitigate potential noise impacts to pregnant southern right whales and their young calves, it would be recommended for the survey to be finished by the start of May. Given the sound transmission of seismic airguns, if the survey was to continue through May, there is a high chance of interaction with migrating southern right whales.	PGS has had a number of competing environmental and social sensitivities with respect to the preferred timeframe and sequencing of the Duntroon MC2D and MC3D surveys. Since the PGS correspondence provided to you on 18th October, PGS has narrowed the timeframe for the Duntroon survey scope to between March 1 and May 31, 2018 to limit the overlap in times with a higher probability of upwelling within the Kangaroo Island Pool and its associated environmental sensitivities. As you would be aware, the Duntroon survey spatially overlaps a biologically important area for the blue whale (foraging). PGS has recognised the survey timeframe overlaps the period where southern right whales are migrating to the southern Australian coastline to calve. An assessment to the southern right whale based upon survey activities occurring in the March to May timeframe is provided in Section 6.2.3.8 of the attached EP. PGS commissioned JASCO Applied Sciences to undertake acoustic modelling for the Duntroon survey across representative topographies to provide sound footprints allowing us to assess impacts to different environmental sensitivities in different locations from the survey area. As part of that modelling we have conservatively modelled from a point which is close to shore. We have identified, based upon this modelling the following and possible impacts to the southern right whale: Injury Thresholds: o For low frequency cetaceans (i.e. southern right whale), sound exposures which could lead to PTS might be experienced within a maximum horizontal distance from the a fully operational array of 0.74 km. This is a 24-hr cumulative metric (SEL_{24hr}) based on the assumption that an animal is constantly exposed to these noise levels at a fixed position relative to the vessel and represents an unlikely worst-case scenario. More realistically, cetaceans would not stay in the same location or same range for 24 hrs. o Another complementary sound metric on a per-pulse basis (not cumulative) is also used to assess for PTS (based on PK pressure). This radius is limited to a horizontal distance of 30 m from the operating array. • *The Duntroon survey in implementing a 500 m shutdown zone, a 2 km low-power zone (for migratory whales) and 3 km low-power zone (if foraging whales are identified in the BIA) around the operational array protects LF cetaceans against PTS/TTS injury and implements EPBC Policy Guidelines 2.1 requirements.*	Information provided in Assessment of merit contained on email response	Record 67A Record 67B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Great Australian Bight Right Whale Study	Scientific Organisation with interests in the GAB	GABWS Response (27/10/17) PGS Email Response (03/11/17))	**27/10/17:** Thanks for your email and opportunity to comment on the Duntroon MSS. I am travelling overseas for a conference at the moment. I will have a detailed look over the consultation letter in within the week and get back to you with any additional comments. On first glance, the obvious key considerations for that area are blue whales and commercial fisheries. I am sure that you are keeping busy with fisheries stakeholder feedback and trust that you have consulted with [CONTACT] and the Blue Whale Group. Southern right whales are likely to be migrating to the coast in the region of the survey in May. To mitigate potential noise impacts to pregnant southern right whales and their young calves, it would be recommended for the survey to be finished by the start of May. Given the sound transmission of seismic airguns, if the survey was to continue through May, there is a high chance of interaction with migrating southern right whales.	Behavioural thresholds: PGS has adopted the National Marine and Fisheries Service (NMFS) (part of NOAA) sound level criterion for behavioural disturbance from impulsive sounds (160 dB re 1µPa SPL). Modelling predicts that cetaceans may exhibit avoidance behaviours at distances up to 9.2 km (max) from the operational array. This may cause migrating southern right whales to marginally deviate on their migratory pathway, but this is not considered significant. The Duntroon survey is 50 km from shore and does not block or create barriers to migration. · Shoreline sound levels (calving and coastal migrations): Given the minimum distance of the survey from the SA coastline (51 km), sound levels within the southern right whale buffer BIA are approximately 120- 130 dB re 1µPa SPL, below the threshold for behavioural change. On this basis calving and coastal migration is not expected to be impacted. · Shoreline Masking: o Southern right whale 'calls' are an up-sweep at 50-200 Hz for long-distance contact and to bring groups together (Clark, 1983; cited in Richardson et al. 1995). A down call, at a frequency of 100-200 Hz, may be used to maintain acoustic but not physical contact. Source levels for the whale have been estimated between 172-187 dB re 1µPa @ 1m (measurement not defined) (Richardson et al. 1995). Other sounds include mixtures of amplitude and frequency modulation all with the major energy at 50 – 1000 Hz (Clark, 1982, 1983; cited in Richardson et al. 1995). Webster and Dawson (2011) in field studies to understand the vocal repertoire of southern right whales in New Zealand waters established that the majority of calls from the species were up-calls with an average peak frequency of 127 Hz (SD +34.71, range: 61-208 Hz) with an average peak frequency of all calls of 156 Hz (SD+ 168.04, Range: 37 – 1599 Hz). The average call duration was 0.74s (SD = 0.32, range: 0.18-2.15s).	Information provided in Assessment of merit contained on email response	Record 67A Record 67B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Great Australian Bight Right Whale Study	Scientific Organisation with interests in the GAB	GABWS Response (27/10/17) PGS Email Response (03/11/17)	**27/10/17:** Thanks for your email and opportunity to comment on the Duntroon MSS. I am travelling overseas for a conference at the moment. I will have a detailed look over the consultation letter in within the week and get back to you with any additional comments. On first glance, the obvious key considerations for that area are blue whales and commercial fisheries. I am sure that you are keeping busy with fisheries stakeholder feedback and trust that you have consulted with [CONTACT] and the Blue Whale Group. Southern right whales are likely to be migrating to the coast in the region of the survey in May. To mitigate potential noise impacts to pregnant southern right whales and their young calves, it would be recommended for the survey to be finished by the start of May. Given the sound transmission of seismic airguns, if the survey was to continue through May, there is a high chance of interaction with migrating southern right whales.	• Acoustic modelling from the closest modelling site to the coast predicts sound levels in coastal areas to be ~ 120 – 130 dB re 1µPa (SPL). Measured ambient sound levels at the Head of the Bight in 50 m over approximately a six-month period had a median of 98 dB re 1µPa (broadband SPL, 3 to 3180 Hz) (McCauley et al, 2013). The impulses propagating across the continental shelf from the survey are expected to only contain low frequency components. If the geo-acoustics close to the coast are similar to those in Bass Strait as reported in Duncan and Garilov (2012) and Erbe et al. (2015), then potentially the pulses will contain no frequencies higher than approximately 40 Hz, which is below the typical frequency band of southern right whales. It is difficult to estimate impacts due to seismic impulses of low amplitude and frequencies below the typical vocalisation range of the whale. No significant impacts are expected from airgun impulses at emerging southern right whale aggregation sites at adjacent coastal areas. On the basis of this assessment, PGS predicts little to no impacts to individual southern right whales which aggregate in South Australian waters.	Information provided in Assessment of merit contained on email response	Record 67A Record 67B
		PGS Update Letter (21/1/18)	**21/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or concerns raised to date	NA	Record 67C
		PGS Letter Update (25/09/18)	**25/09/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Letter also provided an impact assessment to the SRW (coastal aggregations, oceanic migration) through acoustic modelling and animat modelling.	No issues or concerns raised to date	NA	Record 67D
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 67E
SA Oyster Growers Association	Oyster Growers peak industry body (adjacent coastline)	PGS Email and Letter (19/09/17) SAOGA Email Delivery (19/09/17)	**19/09/17:** PGS Email and letter advising SAOGA of the Duntroon activity. No response to date	NA	NA	Record 68

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
SA Oyster Growers Association	Oyster Growers peak industry body (adjacent coastline)	SAOGA Email and Letter Response (30/11/17) PGS Response (03/11/17)	**03/11/17:** Letter from OGASA with the following issues: I am writing on behalf of the South Australian Oyster Growers Association (SAOGA) to advise of our concern with the proposed timing of the seismic surveys. From a purely oyster industry perspective, the impact that these activities will have, is a huge unknown. No specific research has been undertaken to determine the impact on oysters, however for seismic surveys to occur in the most productive area of the GAB at the most productive time of the year (i.e. through upwelling season) is imposing an unacceptable risk. This is the time of the year when the major food source for our industry is created by the upwellings. This risk is easily avoidable by moving the timing of the seismic surveys. The precautionary and preferred approach would be to operate entirely after the upwelling season. After consultation with other aquaculture and fishing industries whose livelihoods are based on stock assessments, and therefore quotas, during the period suggested the timeline proposed is considered completely unacceptable. Industries such as Australian Southern Blue Fin Tuna have been able to reference research undertaken (Japan & CSIRO) that extensively supports their concerns. SAOGA requests all surveys to start at the earliest mid-April 2018, which is believed to be more in-line with NOPSEMA's principles of ALARP. SAOGA strongly suggests PGS moves all seismic activity to commence after mid-April in 2018 and any future seasons.	PGS seeks to reassure SAOGA that consultation is being undertaken with the Australian Southern Bluefin Tuna Industry Association (ASTBIA), the Great Australian Bight Industry Association (GABIA) and other relevant fishing industry associations on the proposed seismic survey activities. Each of those industry bodies have particular concerns which PGS is addressing. PGS has also requested the referenced research (CSIRO and Japan) from ASBTIA to inform PGS's assessment of impacts to southern bluefin tuna as it appears to conflict with other international guidelines which have been issued for sound impacts on fish species1. On this basis, PGS acknowledges the two issues raised by the SAOGA which relate to oysters within your correspondence: 1. Impacts of seismic activity to oysters is unknown; and 2. Survey activities occurring in the most productive area of the GAB at the most productive time of the year is imposing an unacceptable risk. <u>Seismic Impacts to Oysters:</u> PGS agrees that scientific studies into the impacts of seismic on oysters are limited with most available studies examine the impacts of explosives as a sound source on oysters. PGS understands that oyster farming on the Eyre Peninsula is undertaken in protected areas at Coffin Bay, Port Lincoln, Streaky Bay and Ceduna. The closest of these areas is Coffin Bay located approximately 75 km north-east of the nearest survey boundary. PGS has engaged JASCO Applied Sciences to undertake acoustic modelling for the Duntroon survey. Modelling predicts maximum residual sound levels from the survey activities along the southern Eyre Peninsula coastline (~ 51 km to the north of the survey area) at 120-130 dB re 1 µPa (rms). As a comparison, based upon work undertaken by BP2 in the Great Australian Bight to understand underwater sound characteristics of the area, sound loggers deployed near the Head of Bight in a water depth of 50 m had ambient sound levels which varied from 73.5 to 131.9 dB re 1µPa (rms). Given oyster cultivation is undertaken in protected waters on the Eyre Peninsula and at greater distances than 51 km from the survey area, any residual sound levels from survey activities, if present, are expected to fall within ambient sound levels.	Information contained in assessment of merits provided to stakeholder	Record 68A

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
SA Oyster Growers Association	Oyster Growers peak industry body (adjacent coastline)	SAOGA Email and Letter Response (30/11/17) PGS Response (03/11/17)		Duntroon survey activities impacts in upwelling productivity: PGS recognises that the primary marine sensitivities within the region during the January to April period lie *on the continental shelf* or *at the shelf break* and are largely associated upwelling events where productivity is high. CSIRO have advised that upwellings are reliant on both deep-sea currents flowing onto the shelf and upwelling favourable south-easterly winds with most upwellings occurring seasonally between mid-December and mid-March. Accordingly, PGS has taken a precautionary approach and revised the Duntroon survey timeframe to between March 1 and May 31, 2018 to avoid possible overlaps in upwelling events. Additionally, to prevent spatial overlap and possible impact to the Kangaroo Island Pool upwelling during the March period, PGS will commence MC3D survey activities in the deeper off-shelf areas of the EPP-41/42 MC3D survey polygon **OR** MC2D survey activities, a low-density survey to the west of the Kangaroo Island Pool in EPP-46. In adopting these controls, no significant impacts to upwelling activity and associated productivity are expected. PGS considers that the survey timeframe - March 1 to May 31 – is the minimum required to complete the Duntroon survey scope. The survey cannot be shifted into the June/July timeframe due to unsuitable survey weather conditions and vessel safety considerations. With the controls adopted (as outlined above), PGS considers that impacts to upwelling productivity are low and the controls adopted are as low as reasonably practicable (ALARP).	Information contained in assessment of merits provided to stakeholder	Record 68A
			SAOGA would also like to be kept updated on the progress of all surveys.	PGS will keep OGASA updated on activities. PGS understands that your request to be kept updated on the progress of all surveys includes the following notifications: • At least one month prior to survey commencement; • Pending commencement of the survey five days prior to streamer deployment; • At survey commencement; and • At the completion of the survey. PGS notes that the PGS website will be updated during the survey with a 48 hrs lookahead.		
		PGS Update Letter (11/1/18)	**11/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues of claims raised on this communication.	NA	Record 68B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
SA Oyster Growers Association	Oyster Growers peak industry body (adjacent coastline)	PGS Update Letter (19/07/18)	**19/07/18:** Letter to advice of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. **23/07/18:** SAOGA thanked PGS for the update.	No issues or concerned raised.	NA	Record 68C Record 68D
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 68E
Eyre Peninsula Local Government Authority (EPLGA)	Regional Authority – Eyre Peninsula	PGS Letter (08/09/17) EPLGA/RDAWEP Letter (12/09/17)	**08/09/17:** PGS Information for the Duntroon Survey. **12/09/17:** EPLGA and RDAWEP provided the following response to the Duntroon Survey information update: Thank you for forwarding detailed and extensive information on the proposed Duntroon Multiclient three-dimensional and two-dimensional Marine Seismic Surveys within the Commonwealth waters of South Australia, and specifically in the Great Australian Bight The Eyre Peninsula Local Government Association [EPLGA] and Regional Development Australia Whyalla and Eyre Peninsula Inc. [RDAWEP] work in collaboration in achieving positive economic outcomes for the Eyre Peninsula in addition to ensuring all measures are undertaken to protect the diverse industries of the region The EPLGA and RDAWEP supports the proposal by PGS Pty Ltd to conduct the seismic surveys under the conditions as stated in your correspondence, to obtain qualified data for the relevant stakeholders, whilst ensuring minimum impact on environmental sensitivities. We look forward to receiving regular updates as the survey advances, including notification: • on the acceptance of the Duntroon Survey Environment Plan; • of the pending commencement of the survey 5-10 days prior to initiation of activity; • Of the completion of the survey around 10 days after vessel demobilisation from the area.	PGS acknowledges the requests made within the letter and will advise the EPLGA and RDAWEP at the notification triggers identified (contained in EP Table 9-3)		Record 69
		PGS Update Letter (20/1/18)	**20/1/18:** Letter to advise of altered arrangements for the Duntroon survey. Survey to be undertaken in 2019 with earliest commencement date of 15 March and only deep-water acquisition (1500m+) and 30 km from the shelf-break between March 15-31.	No issues or claims raised to date.	NA	Record 69B
		PGS Update Letter (17/07/18)	**17/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 69C
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 69D
		OGASA Email (2/10/18)	**2/10/18:** OGASA required a resend of the details associated with the survey.	No feedback provided to date	NA	Record 69E

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
Flinders Ports	Notification Point for Oil Spills in SA waters	PGS Email (13/06/17) Flinders Ports Email (14/06/17)	**13/06/17:** PGS contact with Flinders Ports to find the appropriate contact with DPTI to discuss oil spill arrangements. Feedback identified that [redacted] – DPTI Emergency Management Team Leader was the contact.	PGS utilised this information to contact DPTI (relevant section).	NA	Record 70
Game Fishing Club of South Australia	Regional Game Fishing Club holding Competitions in Port Lincoln	PGS Letter (08/11/18) PGS Email (13/02/18) PGS Telephone Call & Email (2/3/18)	**08/01/18:** PGS email providing information on the Duntroon survey and requesting feedback on the Blue water classic tournament (game Fishing) which is run in April from Port Lincoln. **2/3/18:** GFASA advise that their competitors do not proceed any further south than the Neptune Islands. The 2019 competition maybe held in either March or April depending upon other events in the area.	No issues or concerns raised.	NA	Record 71 Record 71A
		PGS Update Letter (18/07/18)	**18/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed.	No feedback to date	NA	Record 71B
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 71C
[CONTACT]	Giant Crab Fisherman	PGS Letter (1/2/18) [CONTACT] (Phone Call and Confirmation Email)	**1/2/18:** Telephone Contact between [CONTACT] and [CONTACT] on potential fishing conflict in Duntroon OA in April. Issues resolved through management of resources (pre-fishing). Email Confirmation: Thanks for your time today. Based on our discussions, I understand that you generally operate [REDACTED DUE TO COMMERCIALLY SENSITIVE INFORMATION] In terms of operations you would typically set a few independent pots. As discussed, it would seem that with good planning, we could avoid operational overlaps. In this regard, we will contact you a month ahead of operations to ensure that there is an opportunity to work in the area ahead of our operations commencing should you be active around that area at the time. We will also be able to provide you a daily updated forward plan and a near real time web based seismic vessel positioning should this be of use.	Arrangement is consistent with the consultation strategy approach. Will be adopted	Email Response	Record 72 Record 72A
		PGS Letter (18/07/18)	**18/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested information on fishing activity in the survey area.	No Response to Date		Record 72AA Record 72B

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
The Greens	Political Party	Greens Email (24/10/17) PGS Response (26/10/17) PGS Response (03/11/17)	**Greens:** Email form [CONTACT] requesting a copy of the EP submitted to NOPSEMA on 24/10/17	26/10/17: PGS is happy to provide a copy of the EP. Should be available in the next week. Names need to be removed for privacy reasons. 03/11/17: Dropbox link provided containing the EP.	NA	Record 73
[CONTACT]	Crab Fisherman	PGS Letter (11/01/18)	Information provided to fisherman on Duntroon Survey.	No Response to Date	NA	Record 74 Record 74 (Confirmation)
		PGS Letter (18/07/18)	**18/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested information on fishing activity in the survey area.	No Response to Date	NA	Record 72AA Record 74B
[CONTACT]	Crab Fisherman	PGS Letter (11/01/18)	Information provided to fisherman on Duntroon Survey.	No Response to Date	NA	Record 75
		PGS Letter (18/07/18)	**18/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested information on fishing activity in the survey area.	No Response to Date	NA	Record 72AA Record 75B
[CONTACT]	Crab Fisherman	PGS Letter (11/01/18)	Information provided to fisherman on Duntroon Survey.	No Response to Date	NA	Record 76
		PGS Letter (18/07/18)	**18/07/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested information on fishing activity in the survey area.	No Response to Date	NA	Record 72AA Record 76B
[CONTACT]	Shark Hook Fisherman	PGS Letter and email (03/09/18)	**03/09/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested information on fishing activity in the survey area.	No feedback to date	NA	Record 77
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 77A
[CONTACT]	Shark Hook Fisherman	PGS Letter and email (03/09/18)	**03/09/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested information on fishing activity in the survey area	No feedback to date	NA	Record 78
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 78A

Stakeholder	Relevance to Activity (& 'interests')	Information Provided (Date, Method)	Summary of Response	Assessment of Merits of Adverse Claim/Objection	Operator's response to each objection/claim	Record No: Full Text of Communications with Relevant Person
[CONTACT]	Shark Hook Fisherman	PGS Letter and email (03/09/18)	**03/09/18:** Letter to advise of the altered timeframe of the Duntroon Surveys. Survey to be undertaken in the period September 1 to November 30, 2019 with the possibility of a second season if surveys are not completed. Requested information on fishing activity in the survey area	No feedback to date	NA	Record 79
		PGS Reminder Email (1/10/18)	**1/10/18:** Email providing prompt for feedback and provision of timeframes for notifications for the 2020 season if it proceeds.	No feedback provided.	NA	Record 79A

Appendix J: Oil Spill Trajectory Modelling

MEMORANDUM

TO:	Leonie Chapman	**DATE:**	6/12/2013
FROM:	Nathan Benfer/Laura Allum	**REFERENCE:**	Q0122
RE:	Oil Spill Modelling for Bight Petroleum Seismic Survey, SA		

1 INTRODUCTION

Bight Petroleum is planning to embark on an exploration seismic survey program within the proposed survey area located south of Eyre Peninsula in Lease Blocks EPP 41 and 42.

The release site selected for this study is situated in the northwest section of the survey area (i.e. closest point to the mainland and islands), approximately 75 km south of Eyre Peninsula and 105 km west of Kangaroo Island, in the Great Australian Bight (Figure 1). The depth of water at the release site is approximately 135 m.

The proposed period of operations is schedule for January to June 2013.

Prior to the commencement of the seismic survey program, Bight Petroleum commissioned Asia-Pacific Applied Science Associates (APASA) to conduct a stochastic hydrocarbon spill modelling study to assess the likely probability of exposure to the sea-surface and contact to the shorelines from a hypothetical, yet plausible scenario. The details of the scenario are provided in Table 1.

Sensitive areas surrounding the survey area are shown in Figure 2.

Exposure to surrounding waters and contact with shorelines was calculated using the advanced trajectory and fates model, OILMAP. The OILMAP physical fates model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbon over time, based on the prevailing metocean conditions during the January to June and the physical and chemical properties of the marine gas oil (MGO) used in the modelling.

A stochastic modelling approach, involving repeated simulations of the same spill scenario (i.e. 200 for the scenario) under different, randomly sampled, conditions during the January to June period was used. This type of modelling can objectively define the probability of contact to surrounding waters from hydrocarbons, at thicknesses exceeding a minimum threshold.

Please note that the OILIMAP system, the methods and analysis presented herein use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, Asia-Pacific ASA warrants that this work meets and exceeds the ASTM Standard F2067-07 "*Standard Practice for Development and Use of Oil Spill Models*".

Note that the modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that Bight Petroleum propose to have in place during the seismic survey. The modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas.

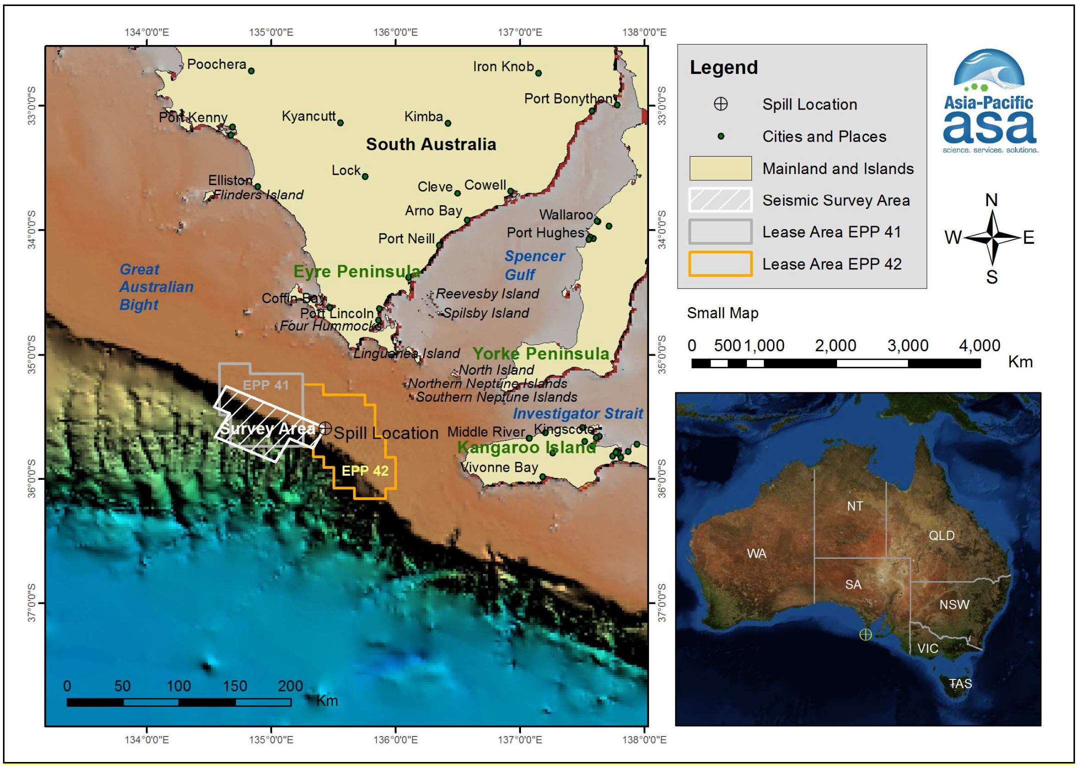


Figure 1: Location of the survey area, lease areas EPP 41 and EPP 42, and the release site used for the seismic survey modelling study.

Table 1: Summary of model settings used for spill modelling.

Scenario description	Loss of fuel tank
Release type	Sea-surface
Release rate	50 m^3/hour
Release duration	6 hours
Total release volume	300 m^3
Oil type	Marine gas oil
Period analysed	January to June
Release location	35°35.71' S, 135°26.05' E
Minimum oil thickness each spill is tracked to on the sea-surface (or zones of sea-surface exposure)	- 0.5 g/m^2 (~ 0.5 µm) (very low exposure) - 10 g/m^2 (~ 10 µm) (moderate exposure)

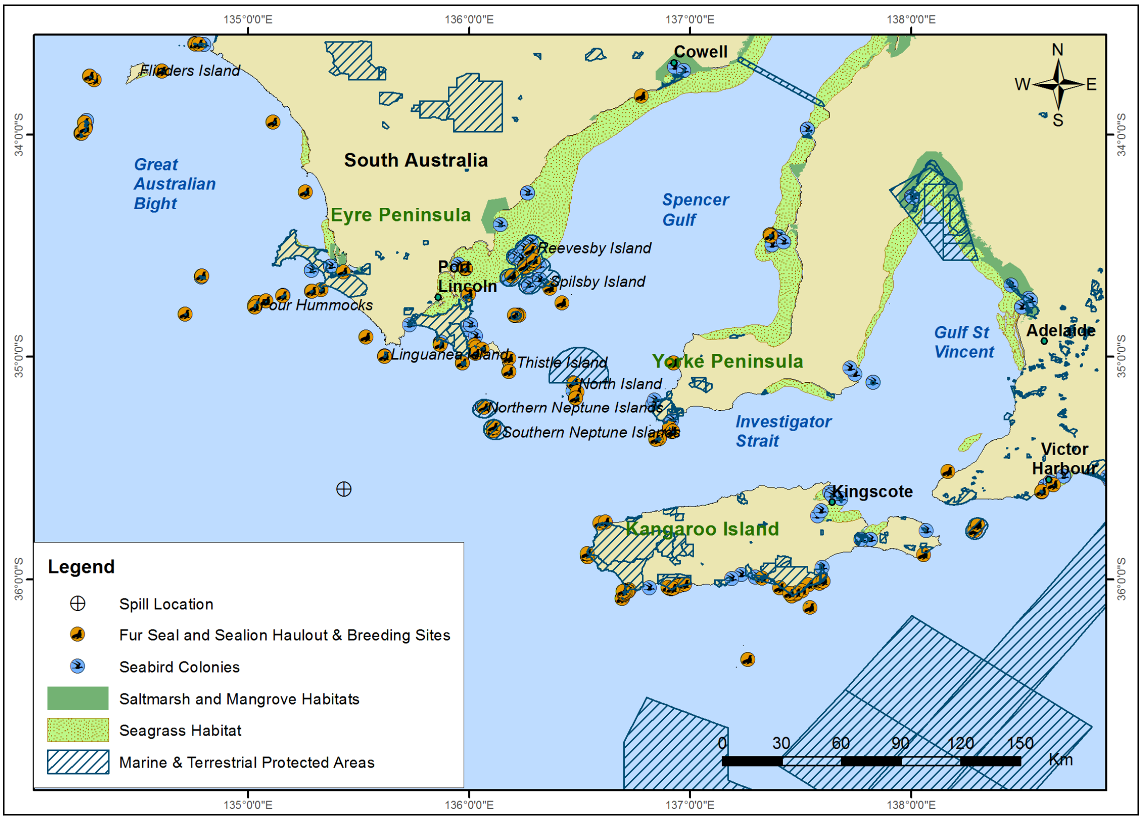


Figure 2: Location of the biological resources surrounding the release site used in the seismic survey modeling study.

1.1 HYDROCARBON PROPERTIES

For the purpose of this study, the oil type used as input into the oil spill model was a marine gas oil (MGO), chosen from the OILMAP database.

MGO has an initial density of 842 kg/m^3 (API 36.5), a dynamic viscosity of 7 cP and a flash point of 73ºC. Diesel is classified as a Group 3 (AMSA, 2012).

Figure 3 illustrates a sample weathering and fates graphs for a 300 m^3 surface release of MGO over 6 hours, under 3 static winds of different magnitudes (5, 10 and 15 knots). As the graph demonstrates, MGO has a strong tendency to physically entrain into the upper water column in the presence of moderate winds (i.e. >12 knots) or waves. When these energies abate, it is expected that entrained MGO resurface, potentially away from the release site.

Within 5 days of simulation, approximately 50 to 60% of the total volume spilled was lost to the atmosphere, under any of the three static wind conditions assessed.

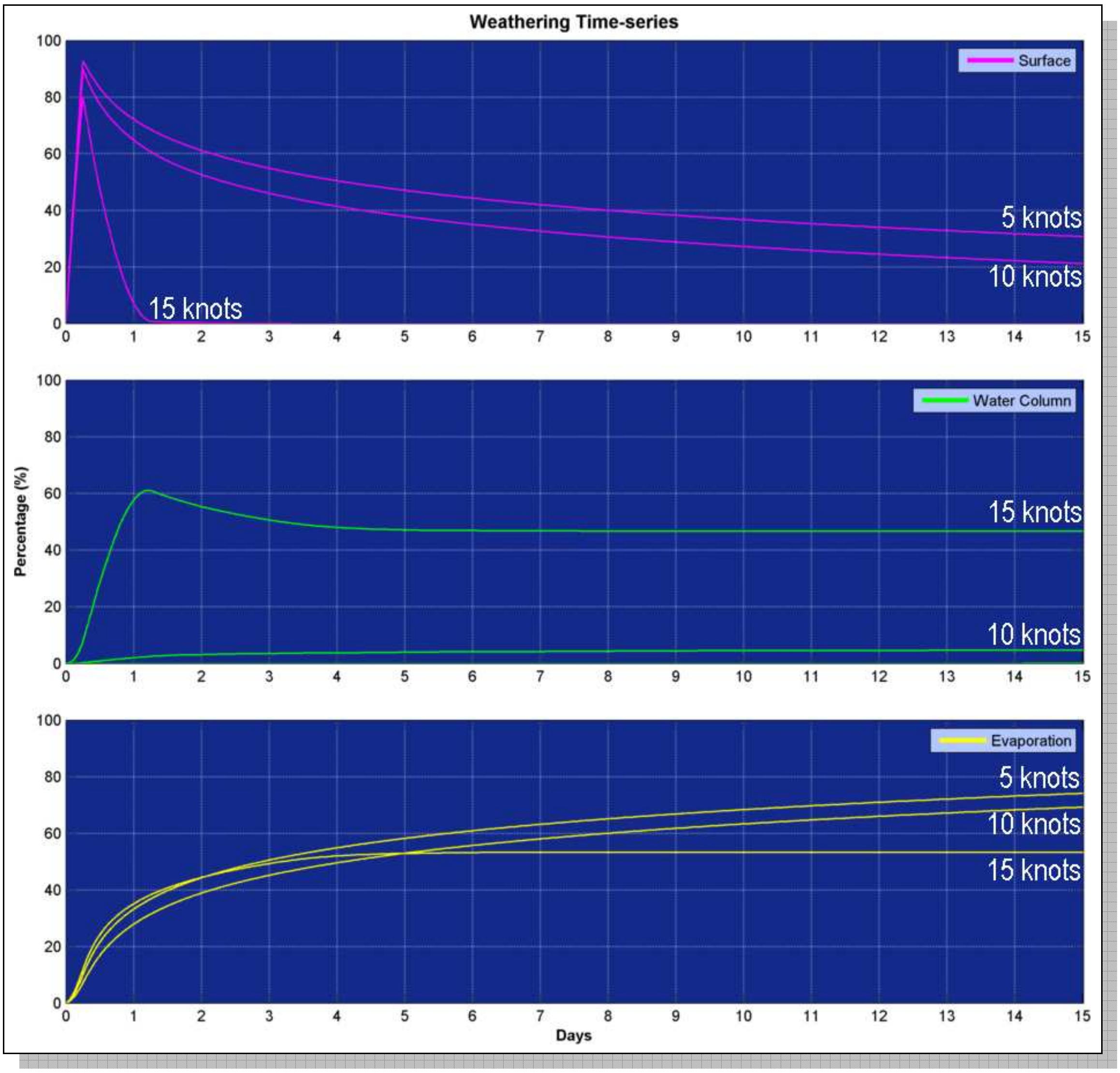


Figure 3: Predicted weathering and fates graphs, as percentage for a selected single spill trajectory under 3 constant wind conditions. Results are based on a 300 m^3 surface release of MGO over 6 hours.

1.2 SEA-SURFACE AND SHORELINE THRESHOLDS

The OILMAP model is able to track hydrocarbons to levels that are lower than biologically significant or visible to the naked eye. Therefore, reporting thresholds have been specified (based on scientific literature) to control the recording of "contact/exposure" to locations when at meaningful levels only.

Based on literature reviews of oil effects on aquatic birds and marine mammals by Engelhardt (1983), Clark (1984), Geraci and St. Aubin (1988), and Jenssen (1994), the threshold thickness of oil that could be harmful to some intersecting wildlife individual is 10 g/m^2 (~10 µm). Hence, 10 g/m^2 has been selected to define the moderate exposure zone. Below 0.5 g/m^2, surface hydrocarbons are unlikely to be visible, even from an aircraft, unless fitted with specialist remote sensing equipment (AMSA, 2012). Figure 4 is a photograph illustrating the difference in appearance of spilled oil in the marine environment. Table 2 provides a summary of the threshold concentrations applied during the modelling study for reporting potential sea-surface and shoreline exposure.

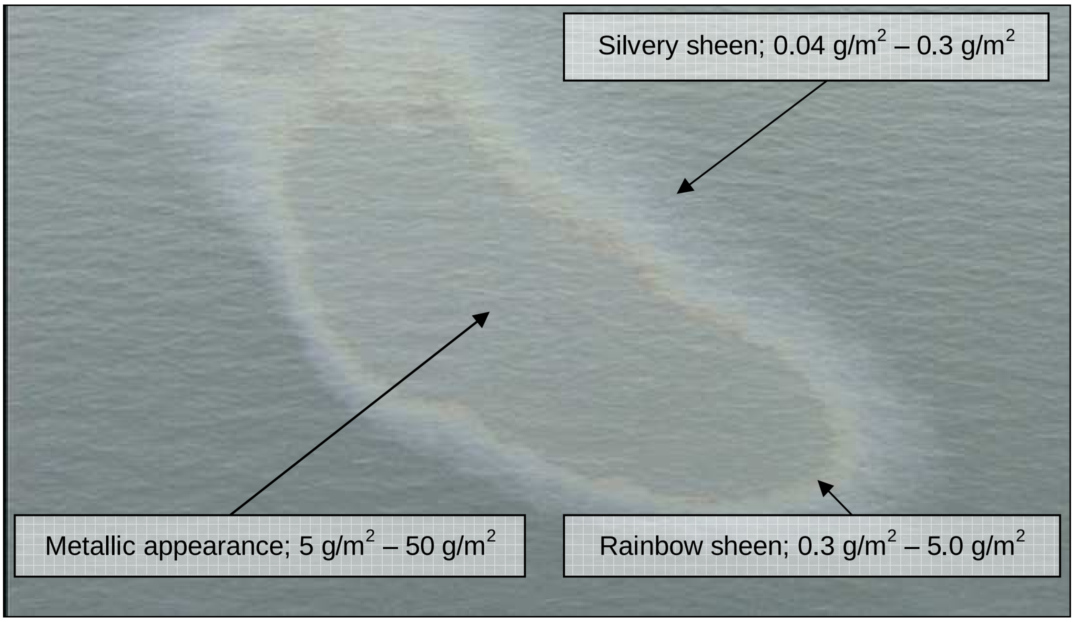


Figure 4: A photograph showing the difference between metallic appearance in the centre and the silvery and rainbow sheen oil around the edges. The thickness of the metallic is between 5 g/m^2 – 50 g/m^2; rainbow sheen is between 0.3 g/m^2 – 5.0 g/m^2; and silvery sheen is between 0.04 g/m^2 – 0.3 g/m^2. (source: Bonn Agreement Aerial Surveillance Handbook, 2004 – Part 3, Annex A).

Table 2: Sea-surface and shoreline threshold values applied as part of the modelling study.

Threshold value (µm or g/m^2)	Potential level of exposure
0.5	Very low exposure
1	Low exposure
10	Moderate exposure
25	High exposure

2 RESULTS

The OILMAP's stochastic module was used to simulate 200 hypothetical trajectories from a 300 m^3 surface release of diesel from the selected release site.

When interpreting the stochastic results, it should be noted that the estimators (probability and load) are calculated independently for each surface location in the model domain. Hence, the plots do not show the extent of effect that would be expected from any single release. Rather, the contours show likelihood of contact, given the predicted weathering rates, wind and current patterns for randomly selected time-periods. For example, areas enclosed by a 0-5% probability contour were exposed (above the chosen thickness threshold of 0.5 and 10 g/m^2) by at least 1 and up to 5% of the total number of simulated spills undertaken.

Locations with higher probability ratings were exposed during a greater number of spill simulations, indicating that the combination of the prevailing wind and current conditions are more likely to result in contact to these locations. The areas outside of the 0-100% contour indicate that contact will be unlikely under the range of prevailing conditions for this region and the respective season. It is important to note that the probabilities are derived from the samples of data used in the modelling. Therefore, a zero value does not necessarily indicate absolutely "no likelihood" of an outcome, but a generally low probability.

Upon completion, the stochastic results for the scenario were reviewed and the spill trajectory with the highest amount of oil reaching shore was identified (see Section 2.1.12.1.1) and displayed as surface oil thicknesses based on the Bonn Agreement thresholds. All stochastic results are provided in Section 2.1.2.

Note the results herein provide the reader with a better understanding of the likely simulated trajectories and weathering, not actual occurrences.

2.1.1 Single Worst Case Trajectory

The "worst case" spill trajectory resulting in the greatest probability of shoreline contact (i.e. the worst case single run) for the 0.5 µm threshold, was identified to occur at 3:00 am, 7th June 2010.

Figure 5 shows screenshots of the surface oil thickness at 10 and 19 hours and at 2, 4, and 5 days after the initial release (3:00 am, 7th June 2010) for the worst case spill trajectory. Following the initial release, the spill trajectory was predicted to travel southeast from the spill site and dropping below 0.05 mm in thickness (50 µm) within 12 hours. The surface plume was driven subsurface by strong winds within 20 hours and didn't appear on the sea surface again until 2 days and 15 hours after the initial spill. Shoreline contact was made within 4 days and 1 hour to the Southern Neptune Islands, followed by contact to the Northern Neptune Islands, 20 hours later. Within

5 days and 11 hours after the initial release, no further diesel remained on the water surface at thicknesses above 0.5 µm.

Figure 6 and Figure 7 illustrates the fates and weathering graph for the identified worst case single spill trajectory. The figures illustrate the high evaporative potential of diesel, especially within the first day after the spill (up to 35%). The graphs also reveal the decline of oil on the water surface, corresponding to the increase of diesel in the water column and the evaporative loss. After 5 days (approximately 140 hours), over 50% of diesel (~160 m^3) was lost to evaporative processes and 90 m^3 (30%) remained within the water column, while there was still 10% on the sea surface, but at levels below the 0.5 µm threshold. A maximum of approximately 20 m^3 of diesel (~8%) stranded on shore during the 10 day tracking period.

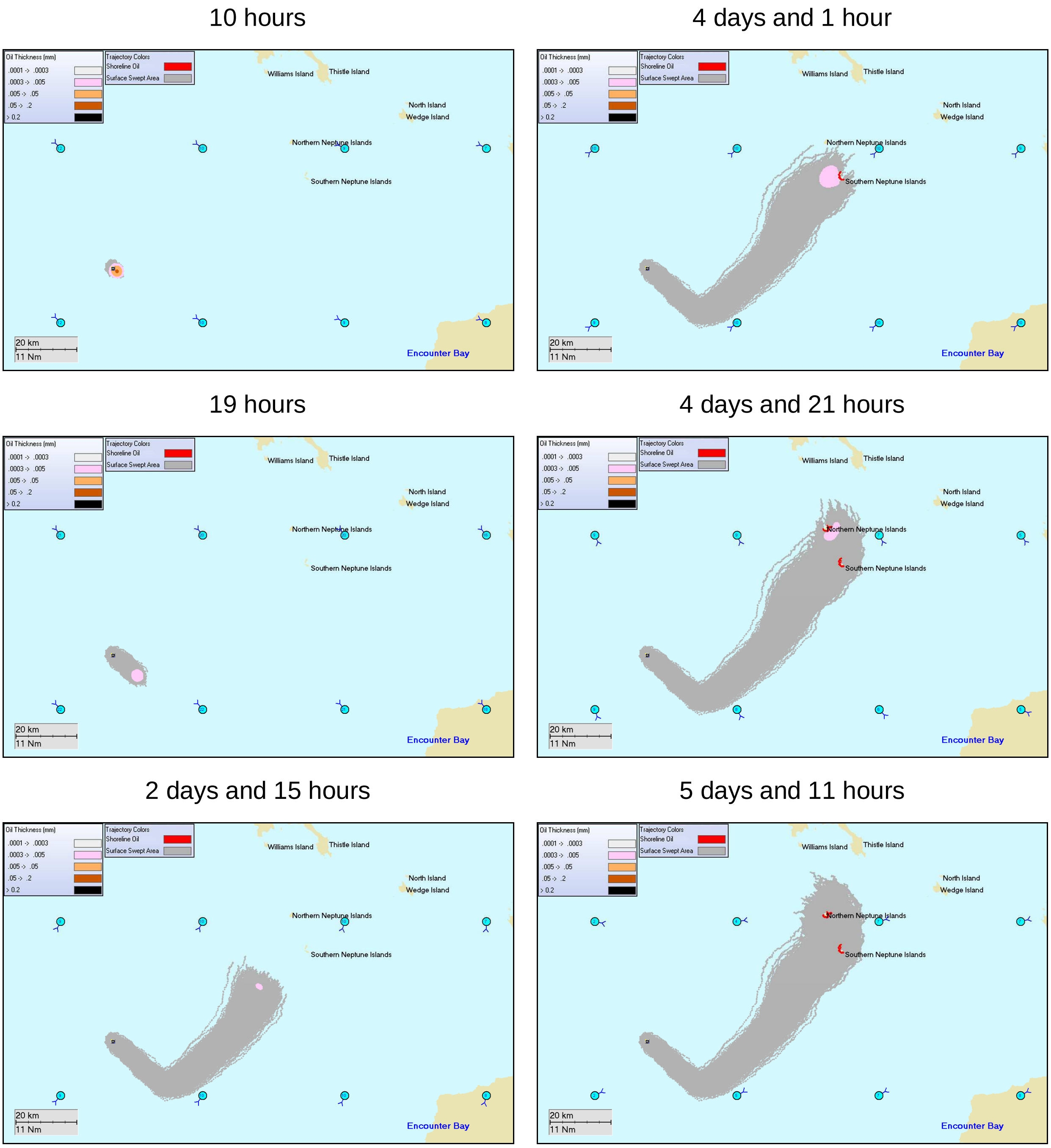


Figure 5: Predicted oil thickness on the sea surface at 10 and 19 hours and at 2, 4, and 5 days after the initial release (3:00 am, 7th June 2010) for the worst case spill trajectory identified from the diesel scenario. Results are based on a 300 m³ release of diesel over 6 hours, following a vessel spill incident during January to June wind and current conditions.

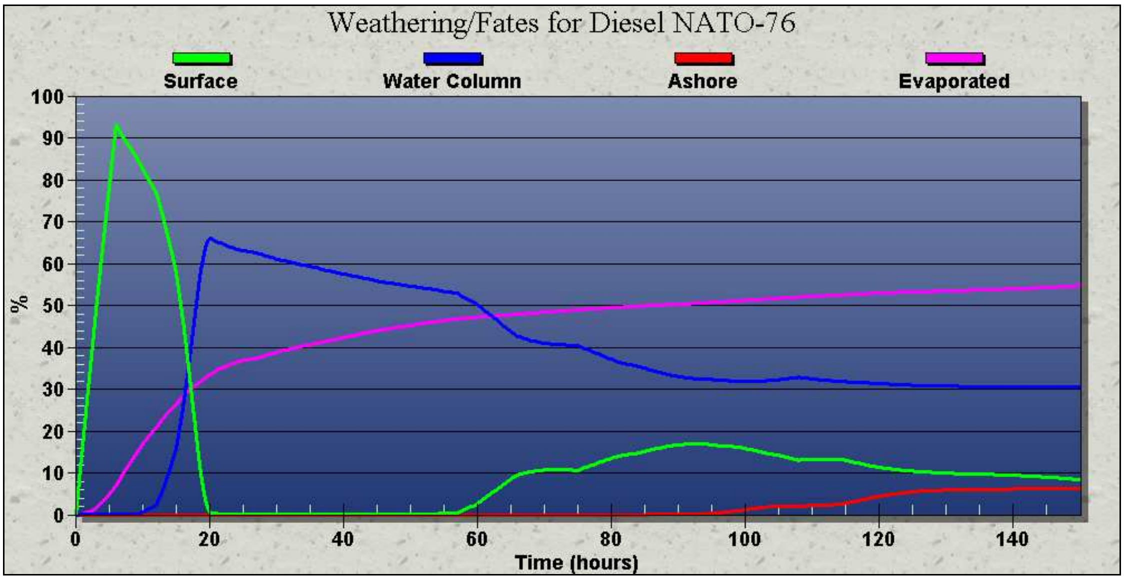


Figure 6: Predicted weathering and fates graph, as a function of percentage, for the worst case spill trajectory identified from the 200 simulations for the 0.5 µm threshold. Results are based on a 300 m^3 release of diesel over 6 hours, following a vessel spill incident. The output is calculated for each grid cell and provides a summary from 200 spill trajectories modelled, during January to June wind and current conditions.

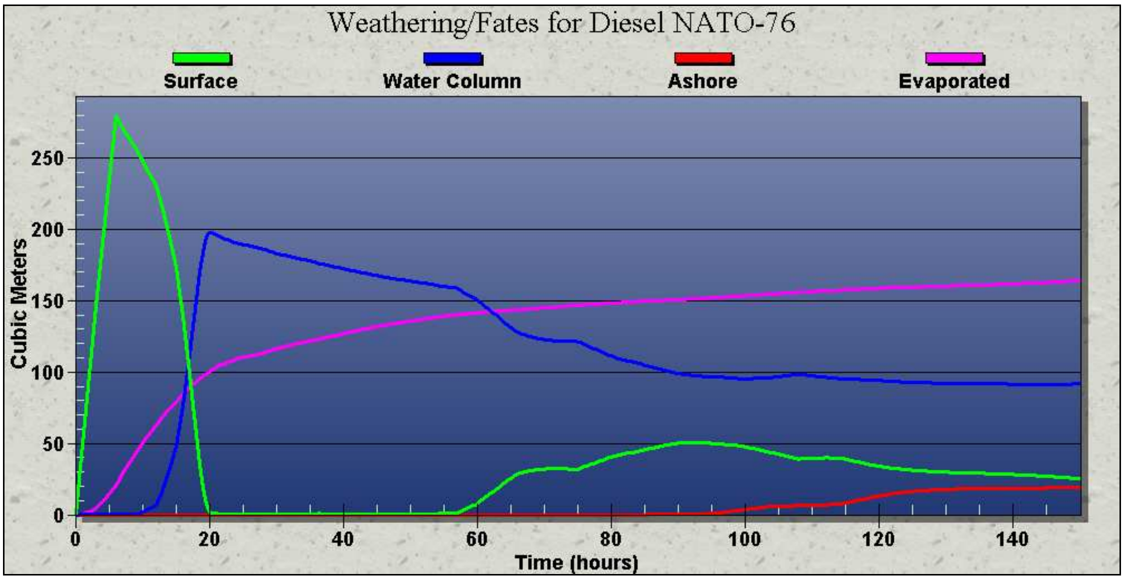


Figure 7: Predicted weathering and fates graph, as a function of volume, for the worst case spill trajectory identified from the 200 simulations for the 0.5 µm threshold. Results are based on a 300 m^3 release of diesel over 6 hours, following a vessel spill incident. The output is calculated for each grid cell and provides a summary from 200 spill trajectories modelled, during January to June wind and current conditions.

2.1.2 Stochastic Trajectory Analysis

Figure 8 shows the probability of sea-surface exposure for January to June conditions, reported for the minimum threshold thickness of 0.5 g/m^2 (very low exposure) and 10 g/m^2 (moderate exposure). The predicted minimum time before sea-surface exposure for both thresholds is presented in Figure 9.

Stochastic modelling for the very low exposure threshold (i.e. 0.5 g/m^2) showed the majority of exposure (i.e. 80%) remained in the vicinity of the selected release site, within a 25 km radius (Figure 8). Less than 5% of trajectories contacted surface waters up to 140 km northwest and south from the spill site. Additionally, a small number of trajectories (i.e. <5%) extended northeast towards the islands located at the mouth of Spencer Gulf and Investigator Strait. Shoreline contact was made for 18 out of 200 simulations (9% of trajectories, see Table 3) at the Northern and Southern Neptune Islands and at the southeast tip of Eyre Peninsula (Lincoln National Park) at the visible oil threshold. However, shoreline contact was not made at levels sufficient to cause environmental harm, as the conservative environmental threshold of 1 um did not make shoreline contact. Visible hydrocarbons were predicted to not persist beyond 7 days.

Stochastic modelling for the moderate exposure threshold (10 g/m^2) revealed a significantly smaller zone of sea surface exposure with the majority of exposure (i.e. 80%) remaining within a 10 km radius. Less than 5% of trajectories extended a maximum distance of 31 km northwest.

Table 3 provides a summary of the predicted shoreline statistics for any coastline and Table 4 provides a summary of the predicted shoreline contact to various mainland and island coastlines, for the 0.5 µm and 1 µm threshold. The minimum time to shoreline contact was 1.3 days and the maximum volume of oil predicted to contact the shore was ~19 m^3. Shoreline contact was only predicted for the 0.5 µm threshold.

Table 3: Summary of predicted shoreline statistics for any coastline. Results were calculated for a 300 m^3 release of diesel over 6 hours following a spill incident. The statistics were calculated from 200 spill trajectories modelled, during January to June wind and current conditions.

Shoreline statistics	***0.5 µm threshold***	***1 µm threshold***
Probability of contact to any shoreline (%)	9	0
Minimum time to shore (days)	1.3	0
Maximum volume of oil ashore (m^3)	18.94	0
Average volume of oil ashore (m^3)	3.63	0

Table 4: Summary of predicted shoreline contact to various mainland and island coastlines. Results were calculated from a 300 m^3 release of diesel over 6 hours, following a vessel spill incident. The statistics were calculated from 200 spill trajectories modelled.

	Minimum time (days) [hours] before shoreline contact above 0.5 µm (light oiling)	*Probability (%) of shoreline contact above 0.5 µm (light oiling)*	*Probability (%) of shoreline contact above 1 µm (moderate oiling)*
Eyre Peninsula – Lincoln National Park	3.6 [85]	1	0
Northern Neptune Islands Conservation Park	1.5 [37]	1	0
Southern Neptune Islands Conservation Park	1.4 [33]	1	0
William Island	0	0	0
Thistle Island	0	0	0
Wedge Island	0	0	0
Yorke Peninsula	0	0	0
Kangaroo Island	0	0	0
Rowley Shoals	0	0	0

Under the January to June conditions, predicted zones of heavy exposure from spilled hydrocarbons could potentially extent to a maximum of 18 km southeast of the release site (refer to Table 5 and Figure 10).

Table 5: Summary table of the potential zones of exposure from surface diesel, resulting from a 300 m^3 release of diesel over 6 hours following a spill incident. The output is calculated for each grid cell and provides a summary from 200 spill trajectories modelled, during January to June wind and current conditions.

Distance & direction of each zone	***Very low exposure***	***Low exposure***	***Moderate exposure***	***High exposure***
Max. distance from spill site (km)	140	126	31	18
Direction	WNW	WNW	NW	SSE

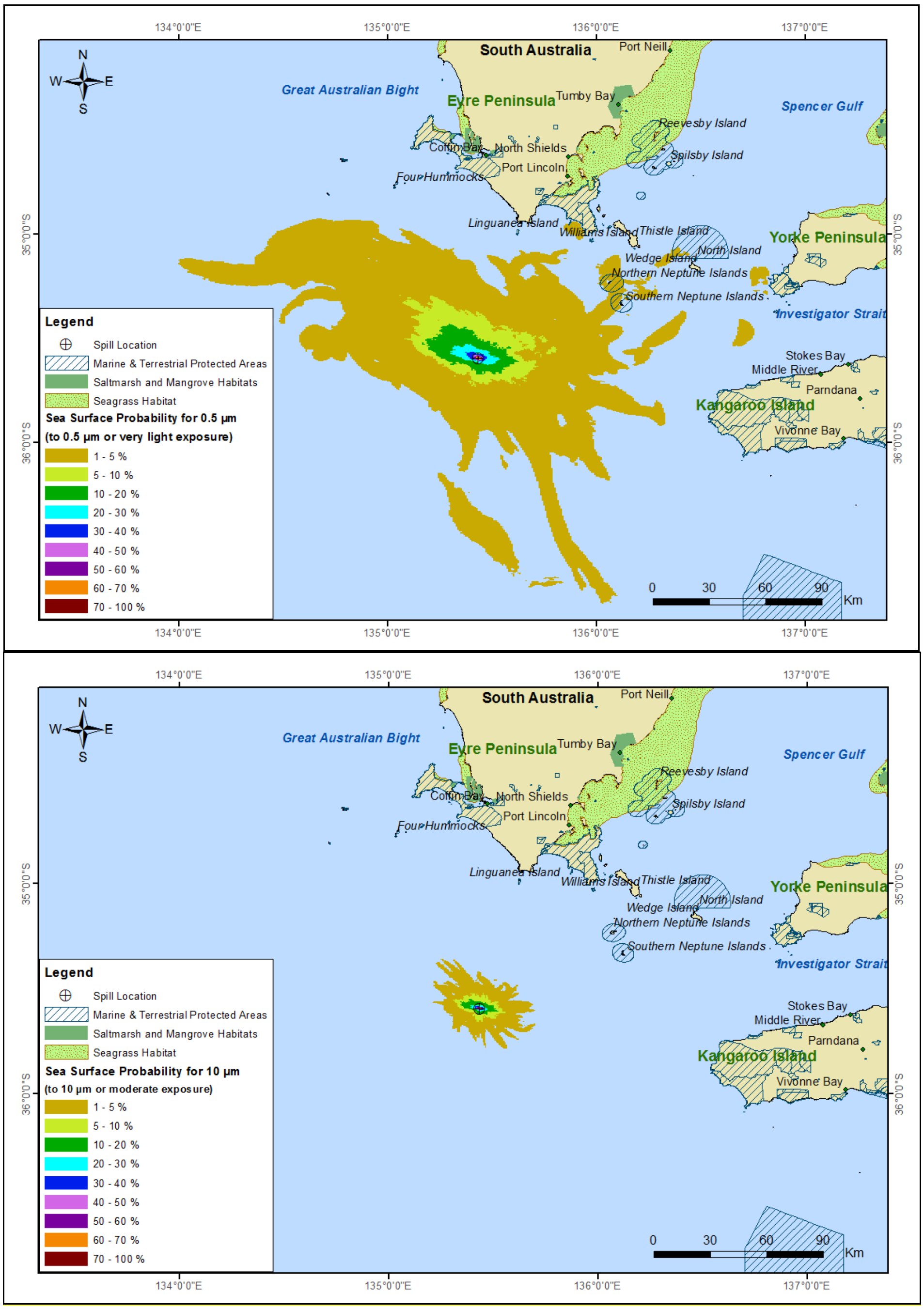


*Figure 8: Map showing the **probability of sea surface exposure** (reported to **0.5 g/m²** (top) and **10 g/m²** (bottom)), in the event of a 300 m³ release of diesel over 6 hours, following a vessel spill incident. The output is calculated for each grid cell and provides a summary from 200 spill trajectories modelled, during **January to June** wind and current conditions.*

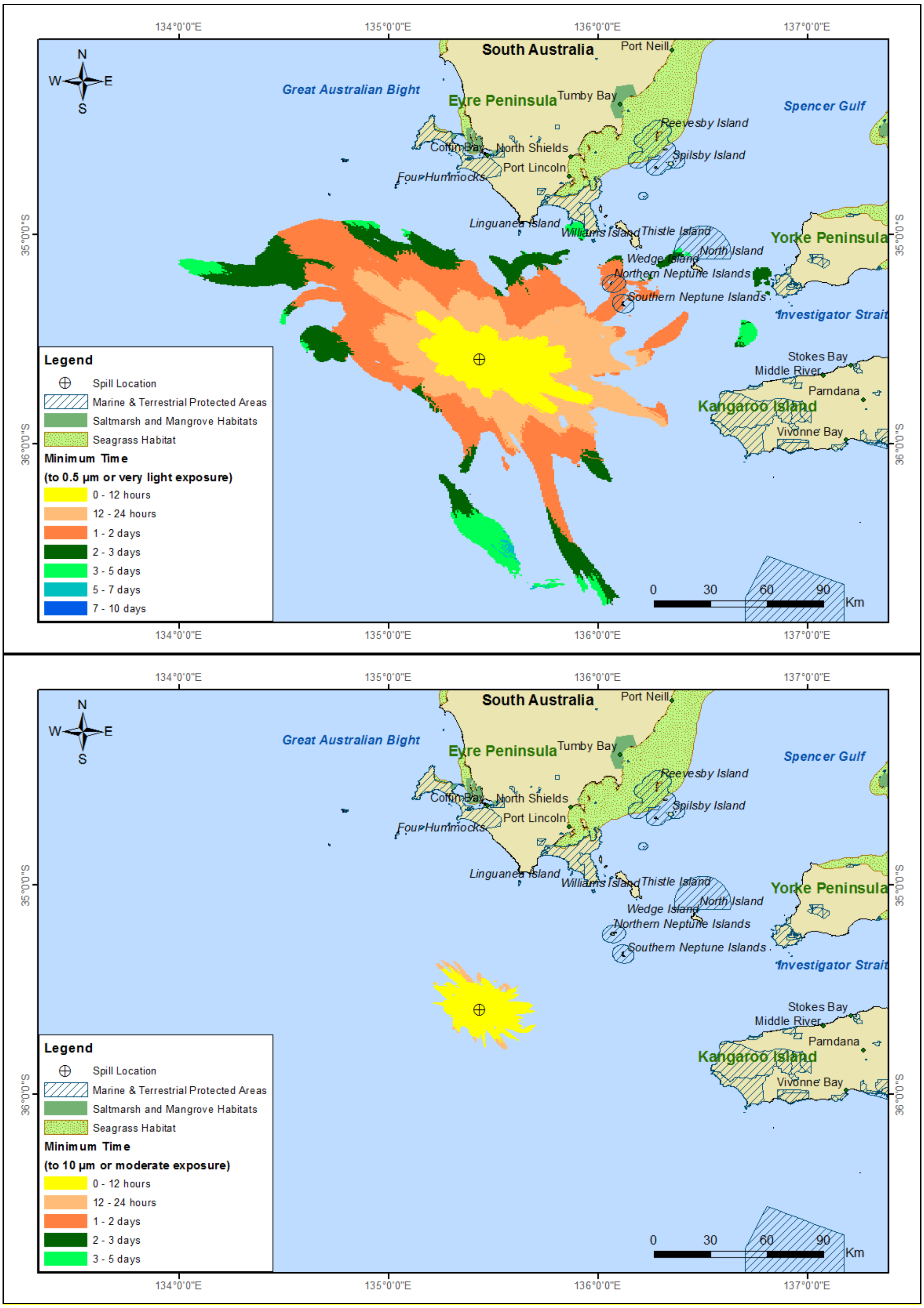


*Figure 9: Map showing the **minimum time to sea surface exposure** (reported to **0.5 g/m^2** (top) and **10 g/m^2** (bottom)), in the event of a 300 m^3 release of diesel over 6 hours, following a vessel spill incident. The output is calculated for each grid cell and provides a summary from 200 spill trajectories modelled, during **January to June** wind and current conditions.*

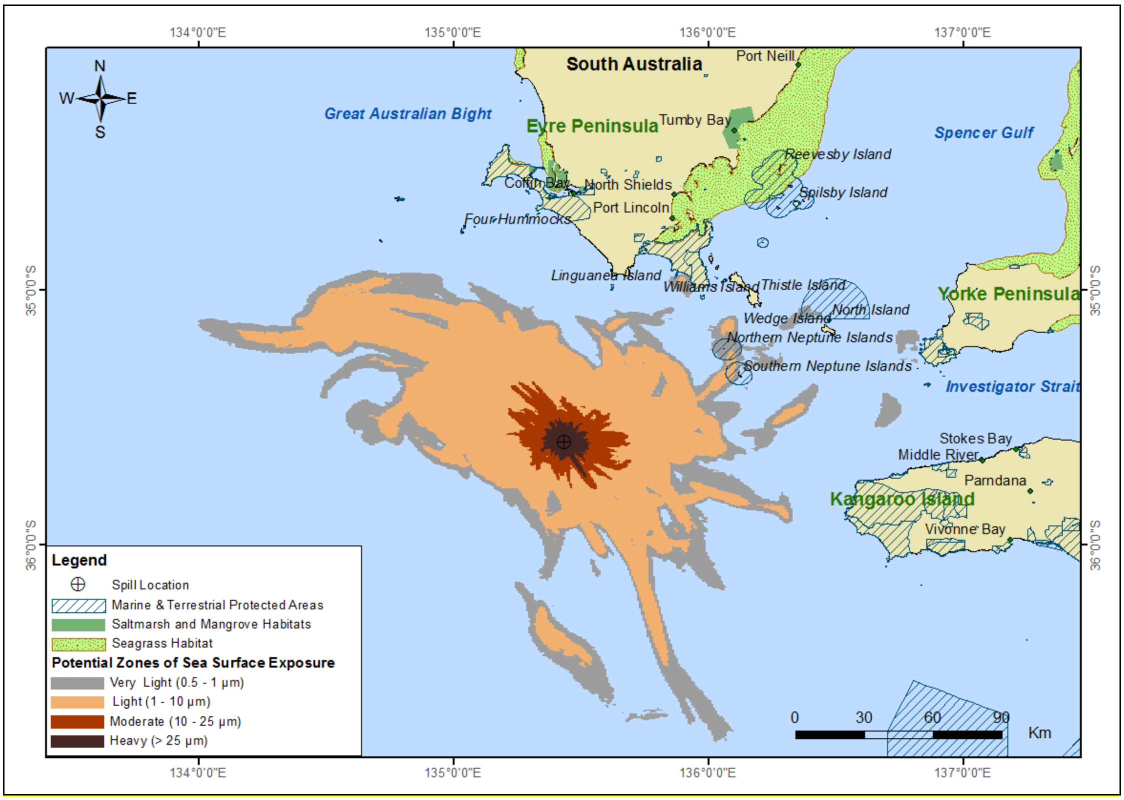


*Figure 10: Map showing the **potential zones** and **level of sea-surface exposure** in the event of a 300 m^3 release of diesel over 6 hours, following a vessel spill incident. The output is calculated for each grid cell and provides a summary from 200 spill trajectories modelled, during **January to June** wind and current conditions.*

3 REFERENCES

Australian Maritime Safety Authority (AMSA), 2012. Interim Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities, 1-63.

Bonn Agreement, 2004. Part 3: Guidelines for oil pollution detection, investigation and post flight analysis/evaluation for volume estimation – Annex A: The Bonn Agreement oil appearance code in Bonn Agreement Aerial Surveillance Handbook. 96p.

Clark, R.B., 1984. Impact of Oil Pollution on Seabirds. Environmental Pollution 33, 1–22.

Engelhardt, F.R., 1983. Petroleum Effects on Marine Mammals. Aquatic Toxicology 4,199–217.

Geraci, J.R. and St. Aubin, D.J., 1988. Synthesis of Effects of Oil on Marine Mammals. Report to U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study, MMS 88 0049, Battelle Memorial Institute, Ventura, CA, 292 p.

Jenssen, B.M., 1994. Review article: Effects of Oil Pollution, Chemically Treated Oil, and Cleaning on the Thermal Balance of Birds. *Environmental Pollution* 86, 207–215.

Appendix K: Plankton Comparison

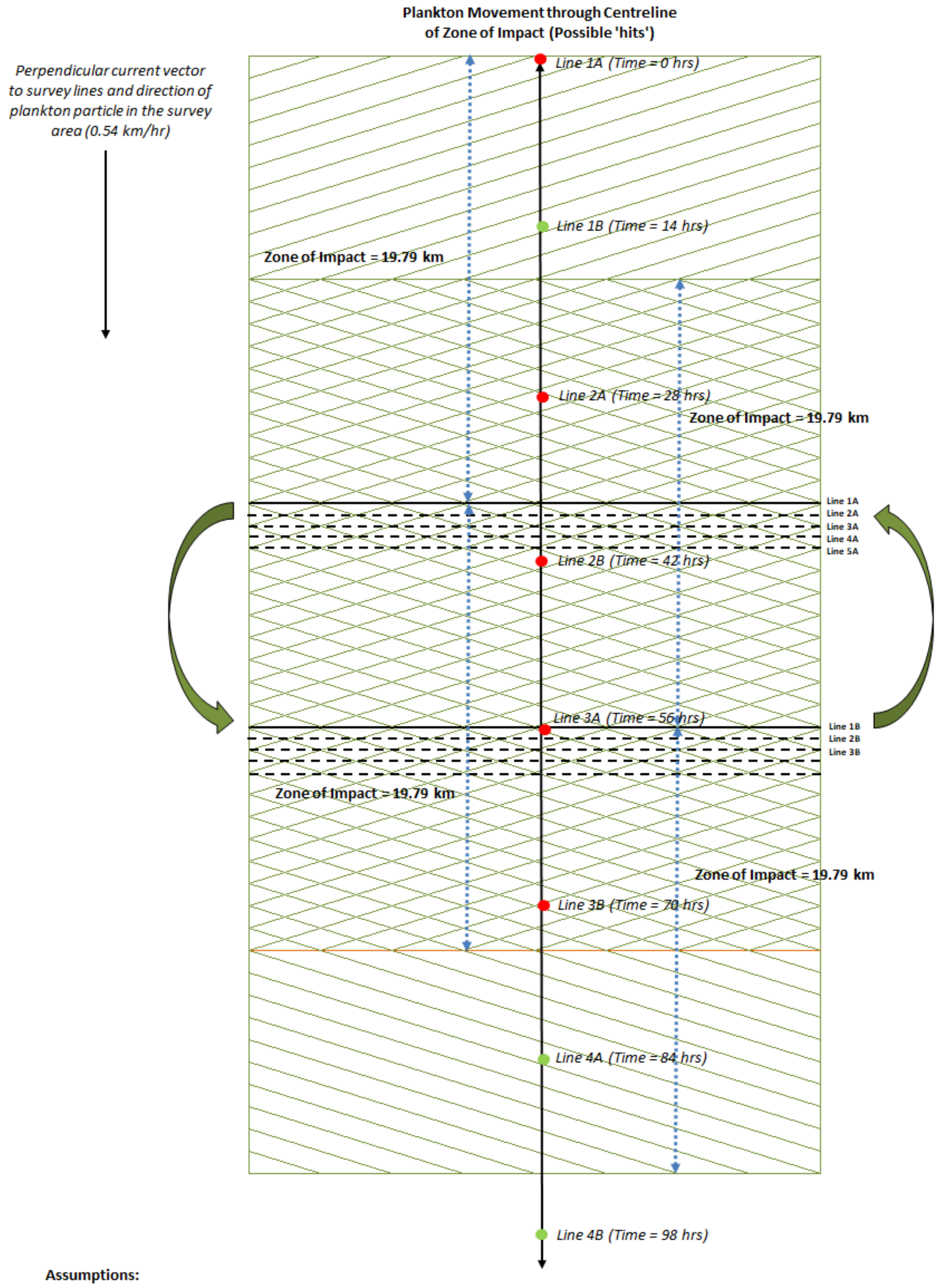
Appendix K: Plankton Impact Calculation

This appendix provides a comparison of a plankton particle movement through the survey racetrack identifying potential ‘exposure hits’ from acoustic sound. The comparison considers environmental parameters present during the NWS simulation by Richardson et al (2017) and equivalent parameters in the Duntroon survey area. These include:

- Current speed and direction;
- Survey line orientation to current;
- Survey line layout and spacing;
- Most conservative horizontal distance from operating array that zooplankton could be impacted from McCauley et al (2017).

A comparison of these ‘exposure hits’ allows for comparison between surveys of the relative biomass reduction within the survey area on a conservative basis.

Duntroon Racetrack - Plankton Particle Movement through sound affected area



Assumptions:

(1) Sequential MC3D seismic lines are 10 km apart. Adjacent MC3D seismic lines are 500m apart.

(2) From Duntroon survey area current analysis (page 2), average current is 0.41 knots (0.76 km/hr) prevailing at 45° to the seismic lines direction . Average current vector component perpendicular to the survey lines across survey 'plankton impact' zone is 0.54 km/hr

(3) MC3D survey line length is 80 km which takes 12 hours to complete with an additional 2 hours for line turns (14 hours per line).

(4) Time for a plankton particle to move across the racetrack impact zone (50 km @ 0.54 km/hr) is 93 hrs

(5) Length of Zone of Impact to Plankton is 19.79 km horizontal distance from operating array

Legend:

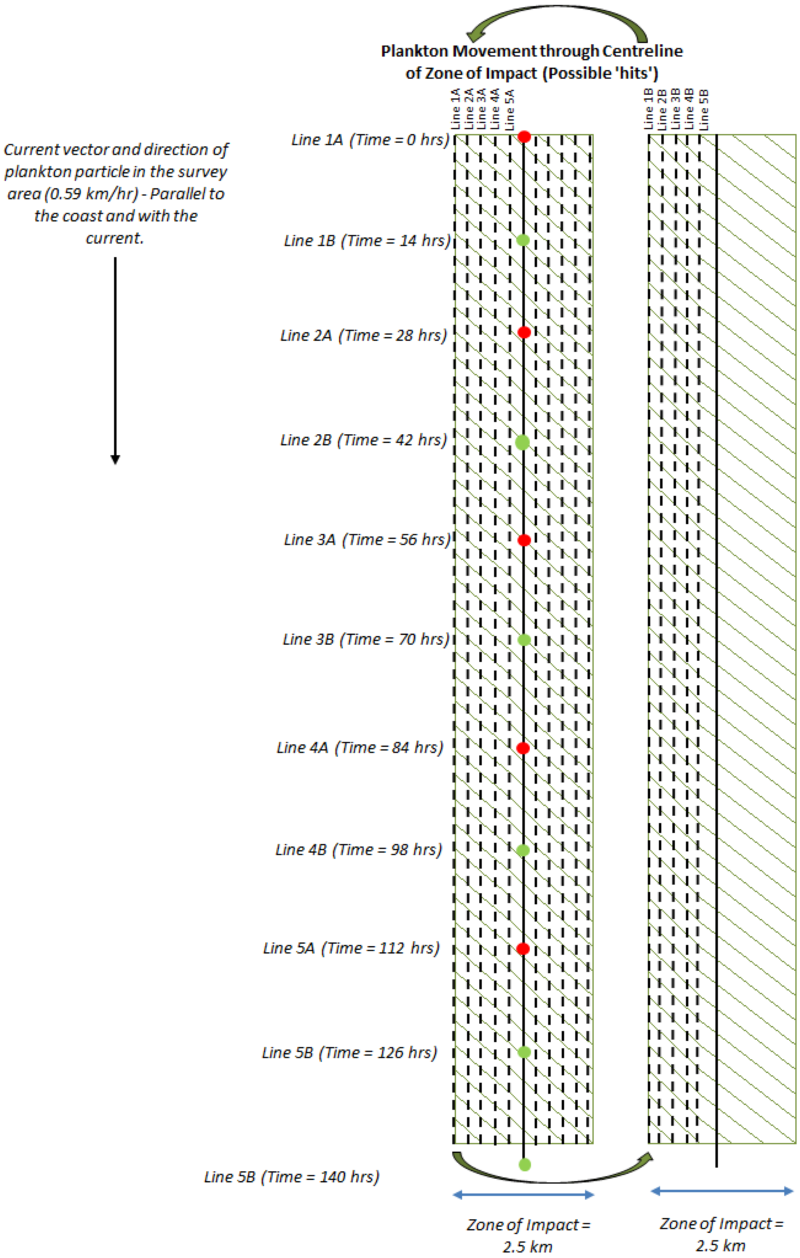
Zone Impacted by 'A' Survey Lines

Zone Impacted by 'B' Survey Lines

Plankton particle not impacted from seismic line

Plankton particle impacted from seismic line

NWS Racetrack - Plankton Particle Movement through sound affected area



Assumptions:

(1) Sequential MC3D seismic lines are 7 km apart. Adjacent MC3D seismic lines are 500m apart.
(2) From NWS survey area current analysis (page 4), average current is 0.31 knots (0.59 km/hr) parallel the seismic lines direction .
(3) MC3D survey line length is 80 km which takes 12 hours to complete with an additional 2 hours for line turns (14 hours per line).
(4) Time for a plankton particle to move across the racetrack impact zone (80 km @ 0.59 km/hr) is 136 hrs
(5) Length of Zone of Impact to Plankton is 2.5 km horizontal distance from operating array

Legend:

Zone Impacted by Survey Lines

Plankton particle not impacted from seismic line

Plankton particle impacted from seismic line

Current Analysis
Duntroon Australia

Department : GIS
Client : Multi Client
Author / Date : Faizah Azmi / 2018 07 26

Current Analysis

Outline

- Introduction

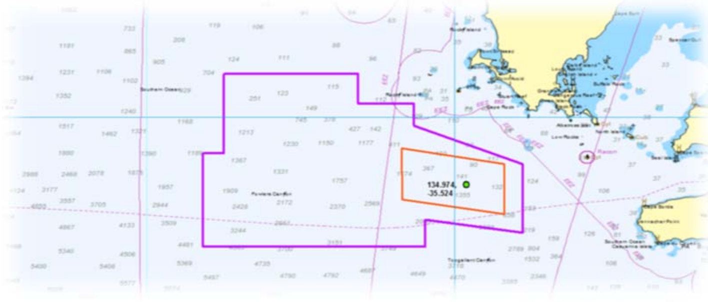
- Currents Analysis
  - Point Currents
    - PC

  - Regional Currents

Introduction

- This report summarizes currents analysis for Duntroon, Australia.

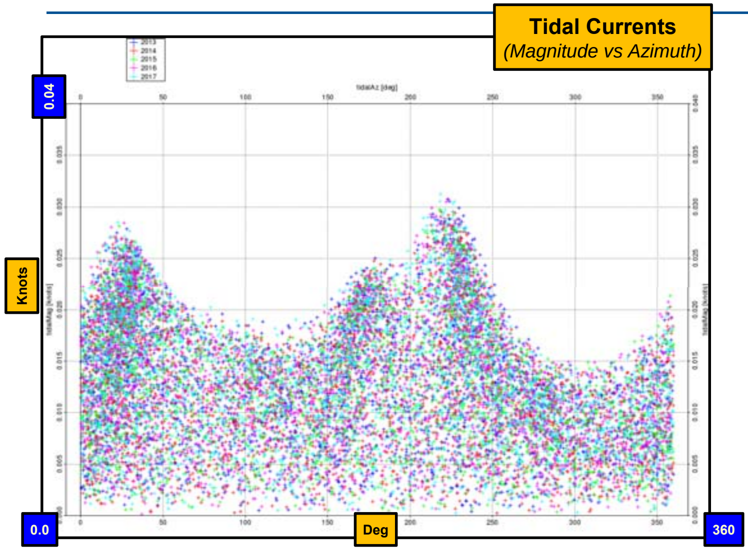
- There is one locations around the survey area that has been used in the point currents analysis
    - PC
        - Latitude : -35.524
        - Longitude : 134.974

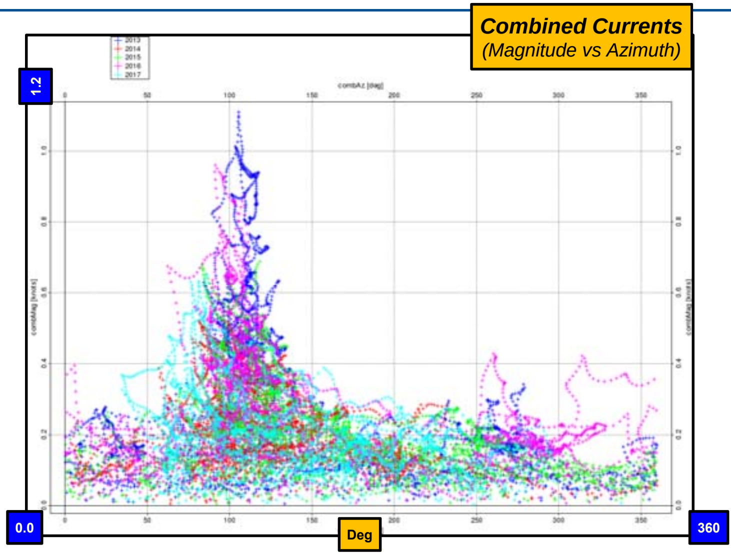


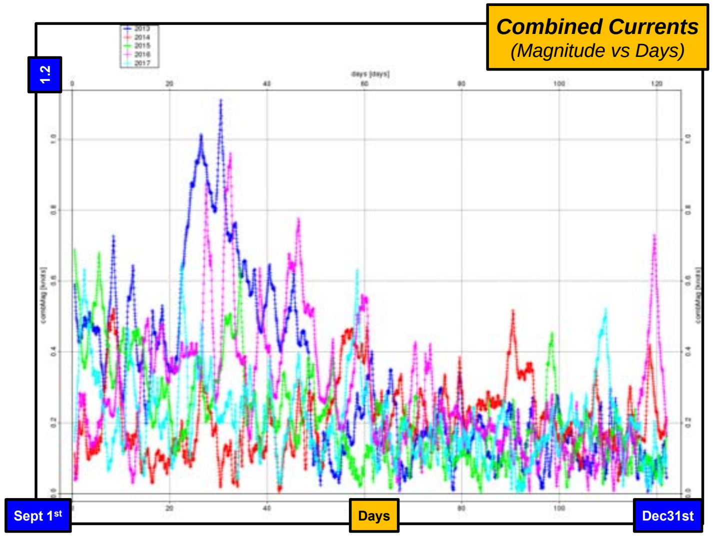
– Currents from 2013 – 2017 were used in the analysis.

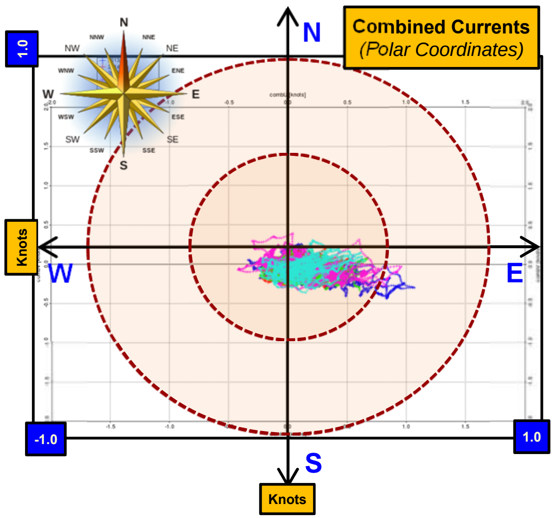
Point Currents

PC (Duntroon)



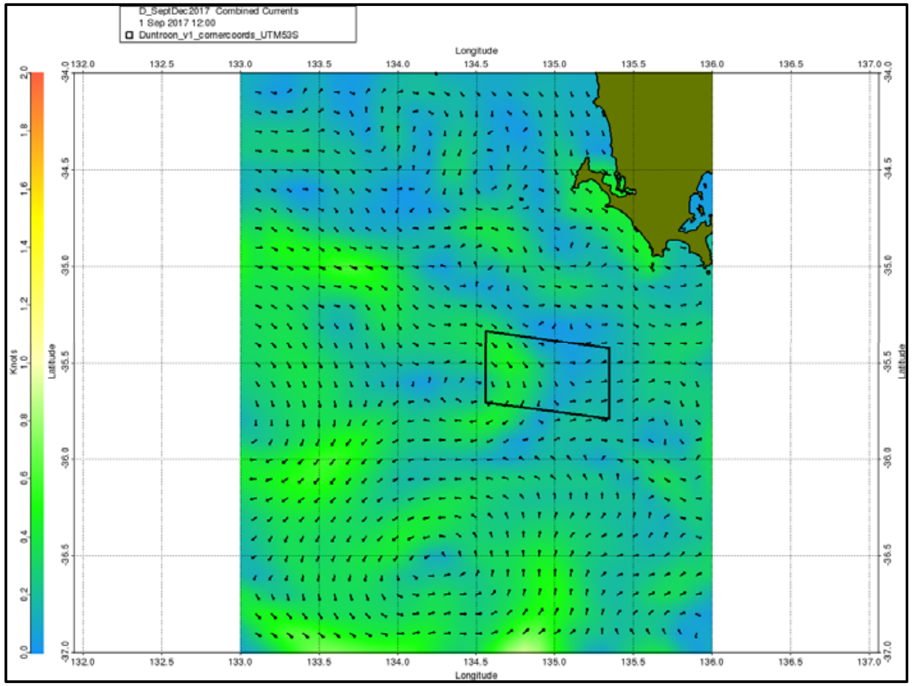


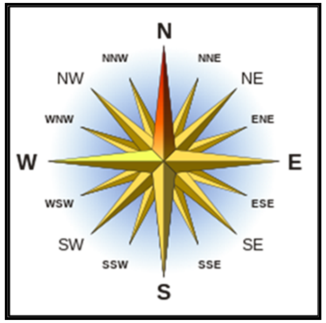




- This slide shows historical current at ***PC*** reference point from ***Sept 1st – Dec 31st.***
- Maximum tidal currents' strength is less than ***~0.035 Knots*** with the dominant azimuth of ***~25^{0}*** and ***~225^{0}***
- Maximum combined currents' (tidal + circulation) strength is up to ***~1.1 Knots***.
- Dominant azimuth for the currents is the ***South East*** direction.

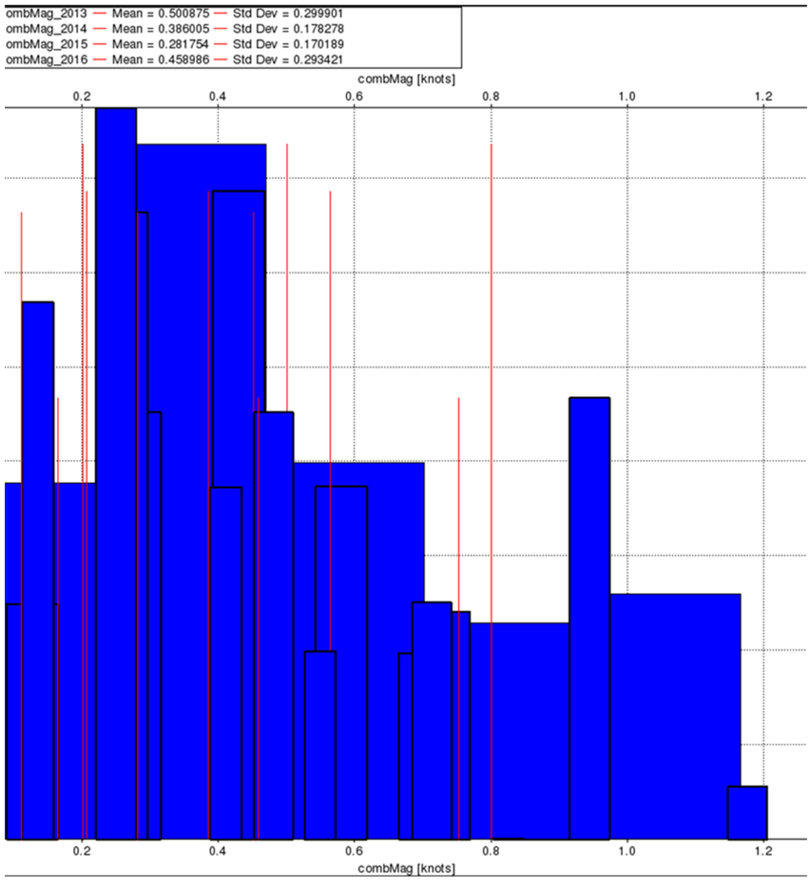
Regional Currents (Duntroon)





- This slide shows regional currents around Offshore Duntroon for Sept 1st - Dec 31st, 2017.
- The current strength around the survey area is up to ***~1.1 Knots***.

Regional Currents (Duntroon) – Average Currents



- Average current speed is 0.41 knots (0.75 km/hr) @ 45° to the MC3D survey area.
- Current vector component moving perpendicular to the survey orientation is 0.54 km/hr

Current Analysis
North West Shelf Australia

Department : GIS
Client : Multi Client
Author / Date : Karen Lum / 2017 08 3

Current Analysis

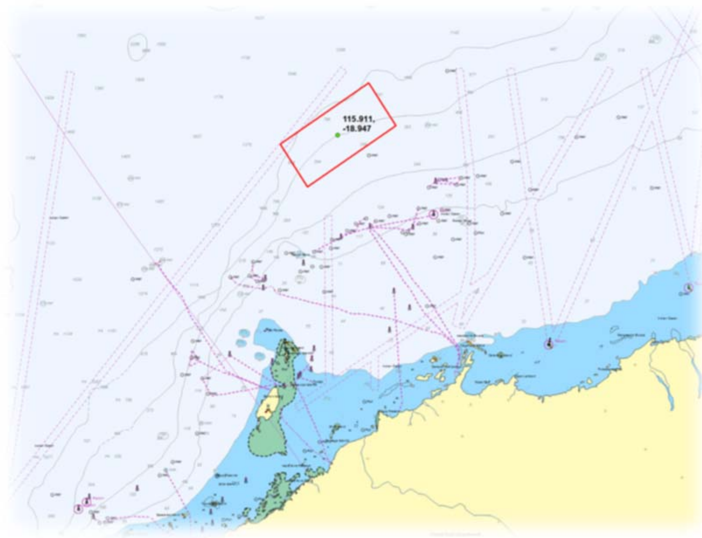
Outline

- Introduction
- Currents Analysis
  - Point Currents
    - PC
  - Regional Currents

Introduction

- This report summarizes currents analysis for North West Shelf, Australia.

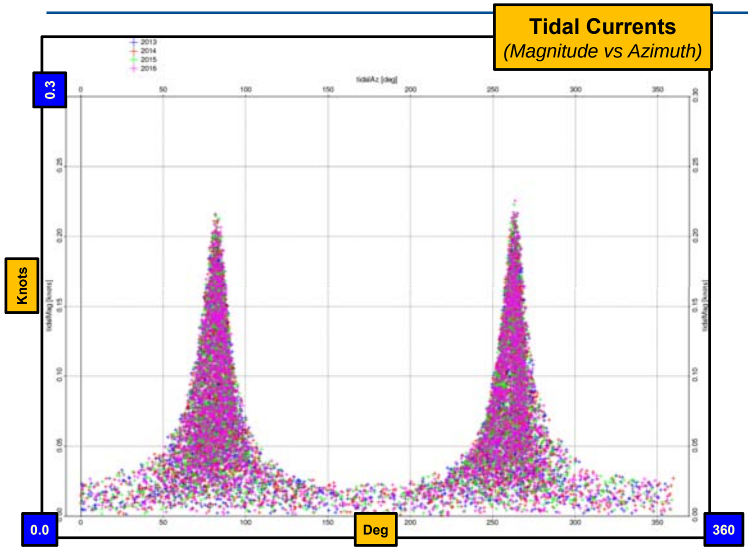
- There is one locations around the survey area that has been used in the point currents analysis
    - PC
        - Latitude : -18.947
        - Longitude : 115.911

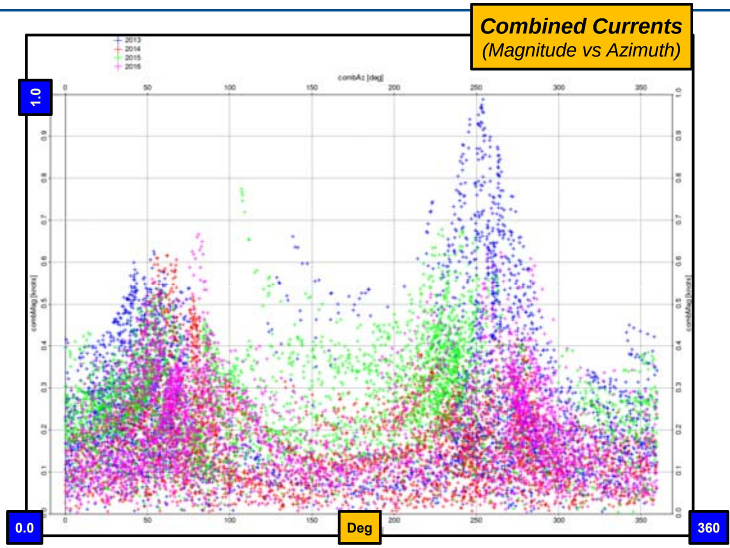


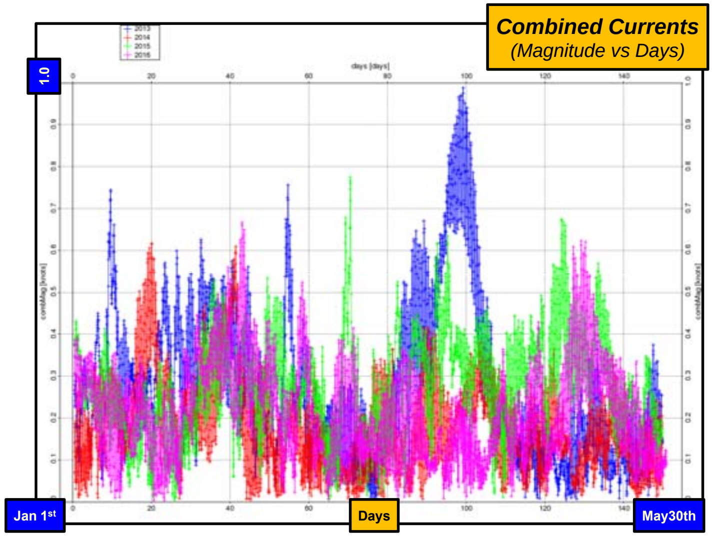
- Currents from 2014 – 2017 were used in the analysis.

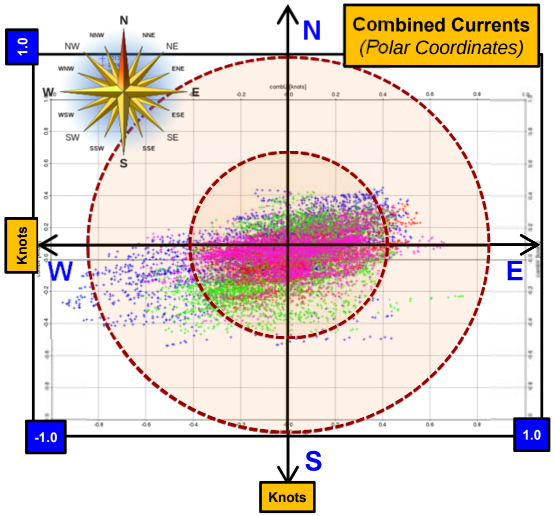
Point Currents

PC (North West Shelf)



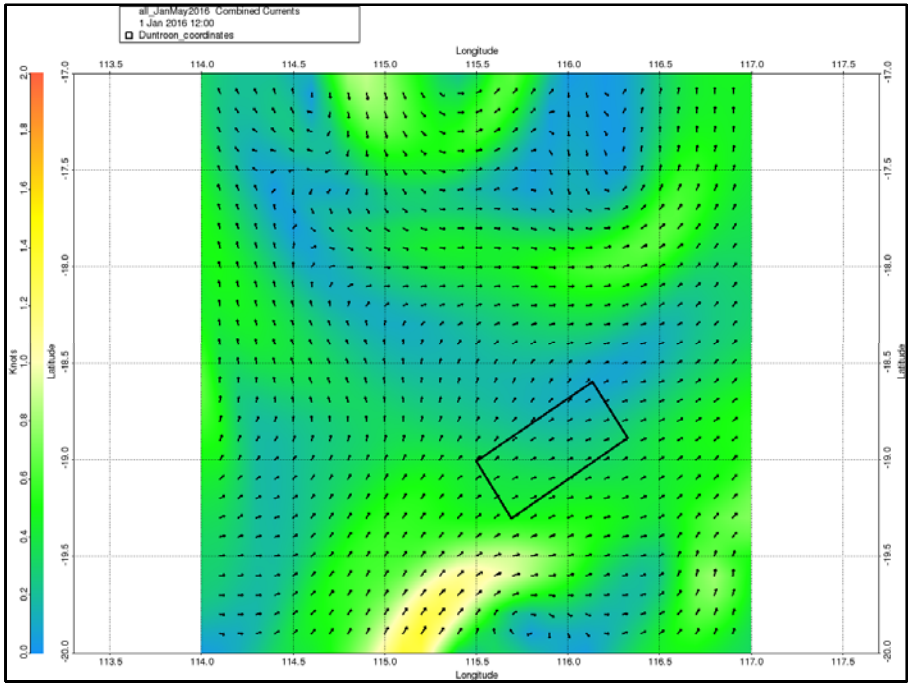


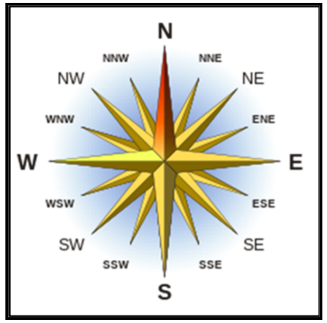




- This slide shows historical current at ***PC*** reference point from ***Jan 1st – May 30th.***
- Maximum tidal currents' strength is less than ***~0.25 Knots*** with the dominant azimuth of ***~80⁰*** and ***~260⁰***
- Maximum combined currents' (tidal + circulation) strength is up to ***~1.0 Knots***.
- Dominant azimuth for the currents is the ***South West*** direction.

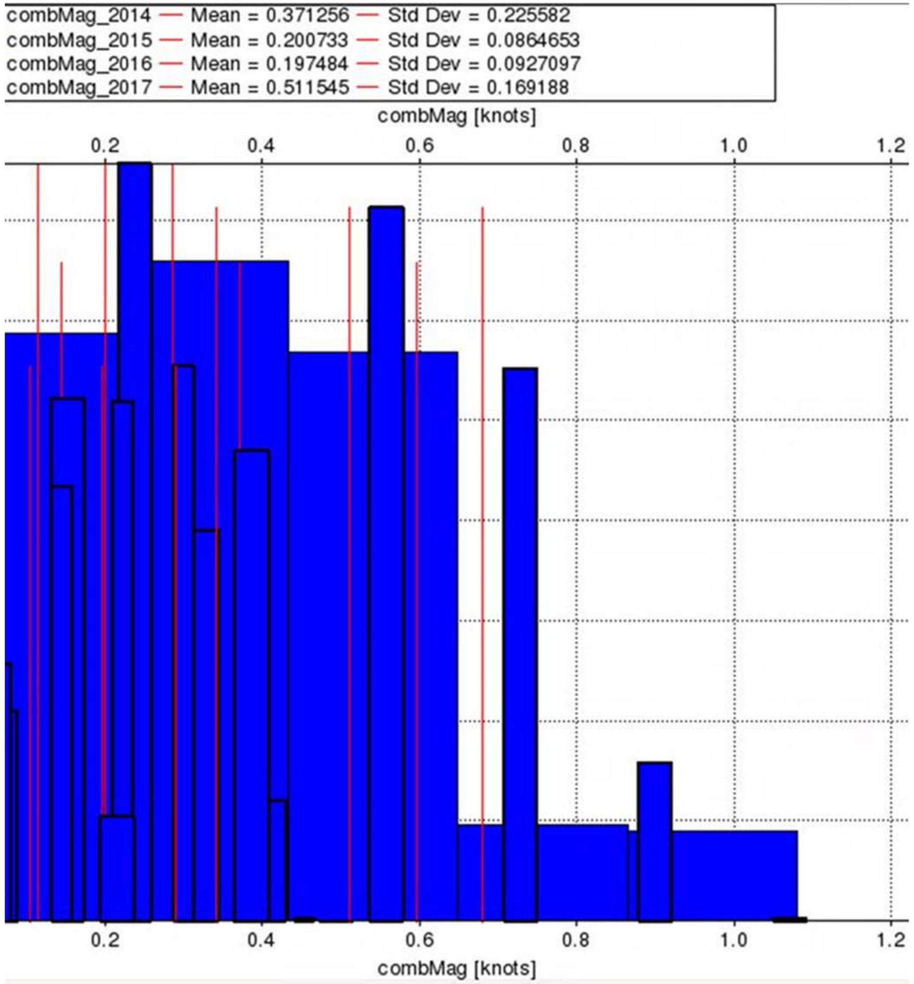
Regional Currents (North West Shelf)





- This slide shows regional currents around Offshore North West Shelf for Jan 1st - May 30th, 2017.
- The current strength around the survey area is up to ***~1.0 Knots***.

Regional Currents (North West Shelf) Average



- Average Current (2014-2017) (Jan to May) is 0.3195 knots (0.59 km/hr)

Appendix L: SSV Methodology (Talis Methodology)

talis
delivering solutions

Assets | Engineering | Environment | Noise | Spatial | Waste

Seismic Survey Underwater Sound Exposure Levels

METHODOLOGY AND ANALYSIS

PGS

Prepared for PGS

December 2016

Project Number: TN16013

Table of Contents

Version	Description	Date	Author	Reviewer
0	Internal Draft for Review	18/10/16	GB	RK / LA
1	Draft for Client Review	18/10/16	GB	TV/MC/JFW
2	First Issue	12/12/16	LA	GB

Approval for Release

Name	Position	File Reference
Granger Bennett	Principal Consultant	TN16013
Signature		

Tables

Figures

1 Introduction

Talis Consultants Pty Ltd (Talis) have been engaged by PGS to develop a methodology for determining received Sound Exposure Levels (SEL's) from seismic survey streamer data.

1.1 Aim

The aim of this document is to describe the methodology that will be used to determine received Sound Exposure Level (SEL) from a seismic source array using data from seismic streamer hydrophone sections.

1.2 Scope

The scope of this methodology only includes the determination of received SEL at a streamer hydrophone section. It does not include the determination of the source level of the source array or the prediction of noise levels beyond the extent of the streamers.

The methodology is general and is not written with any particular streamer in mind. It can therefore be applied to a number of different streamer combinations.

The methodology takes into account a number of underwater acoustic, marine environment and seismic survey factors that must be considered when determining a received SEL from seismic streamer hydrophone sections. These considerations are discussed in section 2, and used to develop the method described in section 3.

1.3 General

Seismic survey vessels use a seismic source array to generate an acoustic pulse and a set of towed streamers to measure the reflected subsurface waves (see Figure 1). These surveys are used to understand the seabed strata, so that potential oil and gas reservoirs can be identified.

The in-field determination of seismic survey received noise levels is becoming increasingly important in order to verify model predictions and determine potential impacts on marine fauna.

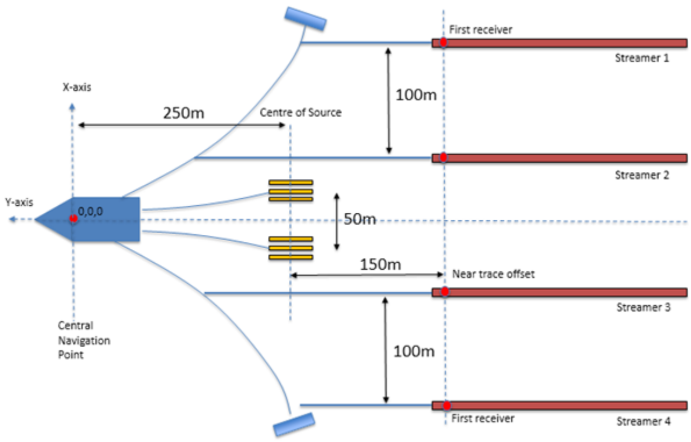


Figure 1 General Arrangement - Seismic Survey Setup

2 Considerations

In order to develop this methodology, an analysis of the following components of a seismic survey has been undertaken;

Acoustic Environment
Section 2.1 Acoustic Environment

Seismic Survey Systems
Section 2.2 Streamer Configuration
Section 2.3 Hydrophones
Section 2.4 Seismic Source Array

Data Processing Modules
Section 2.5 Data Processing Modules

2.1 Acoustic Environment

Underwater noise measurement of a seismic survey's SEL using streamers is challenging in a number of ways. To gain a better understanding of some of the challenges it is important appreciate the complex multipath acoustic environment in which the seismic survey vessel operates.

The source array generates an acoustic wave which travels through the ocean and as it travels it reflects off the seabed and surface which results in the measured signal from the source array consisting of a combination of a direct wave as well as surface and bottom reflected waves (see Figure 2). Due to the different length in transmission paths these waves are separated temporally (i.e. there is a time delay) and spatially (i.e. they arrive at different angles) when they are received at the streamer hydrophone section. Additionally, depending on the depth of the water and the distance that the wave travels, the angle at which these waves arrive at the streamer hydrophone section is affected by the sound speed profile within the water column which refracts the wave. These considerations become important when considering the directionality of the streamer hydrophone section (see Section 2.2).

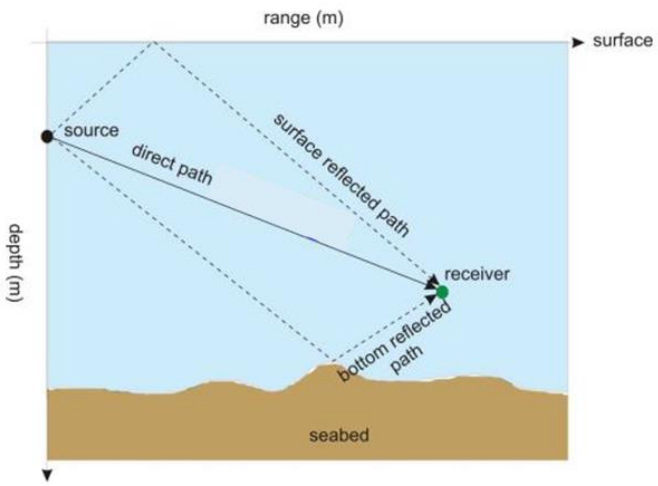


Figure 2 Underwater Noise Multipath Environment

Additionally, the source array signal at the hydrophone is combined with background noise such as waves, wind, flow noise, survey vessel noise and marine fauna vocalisations. Some of the background noise can be removed by filtering out high and low frequency components, but in instances where the background noise is of the same frequency as the seismic source array it will not be possible to remove the background noise.

Implications and considerations:

- The streamer is divided up into hard wired hydrophone sections, which results in a beam pattern forming for each hydrophone section (see section 2.2). This implies that the different arrival angles of the direct and reflected waves will be attenuated differently depending on their arrival angle. This attenuation needs to be compensated for in the measurement signal.
- As it is difficult to separate the reflected waves, and hence their arrival angles, a conservative approach has been adopted by assuming that the reflected waves are arriving horizontally at the hydrophone section. This approach allows for a conservative estimate of the SEL of the arriving acoustic pulse.
- Flow noise generated by the streamer as it moves through the water and background noise can affect the measurement. This needs to be determined and as far as possible removed from the measurement record.

2.2 Streamer Configuration

The seismic streamer uses high sensitivity devices called hydrophones which detect the very low reflected energy that travels from the source array, through the water and earth layers, and back to the surface. The streamer hydrophones convert reflected pressure signals into electrical signals, which are digitised and transmitted along the seismic streamer to a digital recording device on-board the support vessel.

The main streamer components include;

1. Hydrophones - normally spaced approximately 1 metre apart and electrically coupled in groups of 12.5m or 25m lengths.
2. Electronic Modules - Digitise or amplify and transmit the hydrophone seismic data for each hydrophone group.
3. Stress Members - Steel members that provide the rigidness and physical strength for the streamer being towed in potentially rough seas.
4. Electrical Transmission System - Power for the streamer electronic modules and ancillary devices.
5. Streamer Skin - The housing for all of the items listed above.

The streamer length and operating depth depends on the depth and type of geological target for that particular survey. The typical streamer depth vary from 4-6 metres for shallow, high resolution surveys in most areas of the world and 8-30 meters for deeper penetration low frequency targets.

Implications and considerations:

- As the individual hydrophones are electrically grouped together, this results in each group forming a frequency dependent beam pattern[1] (i.e. spatial filtering or directivity). This means that depending on the signal arrival angle some arrival signals are attenuated while others are not.
- This attenuation needs to be accounted for in the processing of the direct and reflected waves. The arrival angle of the different waves will be dependent on the depth of the streamer, the water column depth and the refraction of the sound due to the water columns sound speed profile.
- The hydrophones in a grouping are usually spaced ~1 m apart. This spacing results in spatial aliasing at wavelengths less than half the distance between hydrophones. These frequencies should be filtered out of the measurement record.
- If the streamer electronic module does not digitise the signal then the signal transmission loss over the length of the streamer needs to be taken into account.

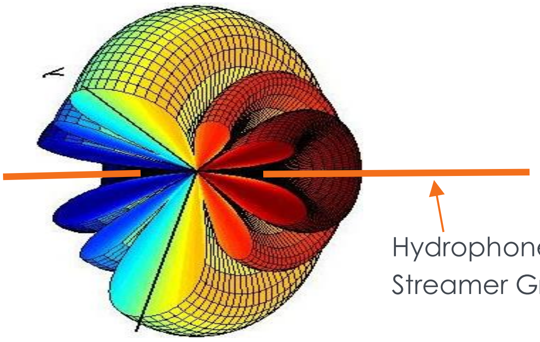


Figure 3 Cutaway of a typical beam pattern formed from a streamer hydrophone group

2.3 Hydrophones

Hydrophones are highly sensitive piezoelectric devices that convert small pressure changes into an electrical signal. Hydrophones can be directional and their response to a pressure fluctuation is frequency dependent. The response curve and directionality is usually provided by the manufacturer of the hydrophone. Hydrophones can also have a preamp that boosts the signal.

Implications and considerations:

- Hydrophones have varied frequency responses depending on their specification and manufacturer. It is therefore important that the hydrophone calibration frequency response curves be obtained from the supplier. The frequency response curve (if not accounted for in the electronic modules) needs to be accounted for in the processing of the acoustic data from the hydrophone group.
- If a preamp exists, the amplification of the preamp (if not accounted for in the electronic modules) needs to be taken into account.
- If the hydrophone diameter is a lot less than half the wavelength of the measured signal, then the signal can be assumed to be omni-directional. If not, directionality

[1] If each hydrophone is weighted equally in the group a sync beam pattern will be formed.

needs to be considered. Considering that most of the energy of the signal is low frequency it can be assumed that the hydrophone is omni-directional.

2.4 Seismic Source Array

The seismic source array generates a high pressure air bubble which expands and contracts as it moves to the surface. The expansion and contraction of the air bubble results in a pressure wave forming which then propagates through the water.

As more than one source element is used in the array (see Figure 4), the phases of the pressures waves generated by the airguns combine to result in constructive and destructive interference of the pressure waves. This interference results in a beam pattern (i.e. directionality) of the source array. A typical directivity pattern of the source array is shown in Figure 5.

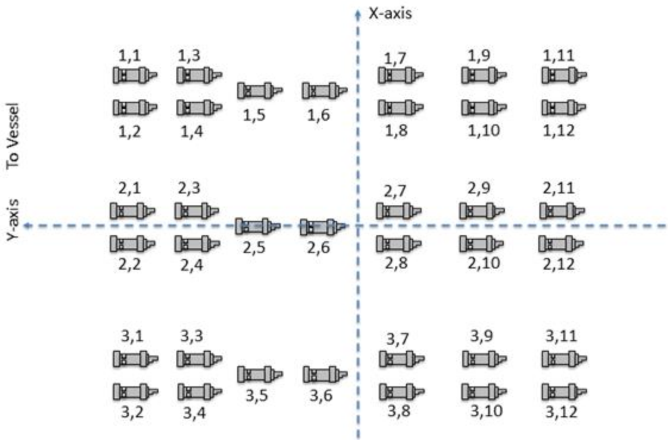


Figure 4 Source Array Configuration Example

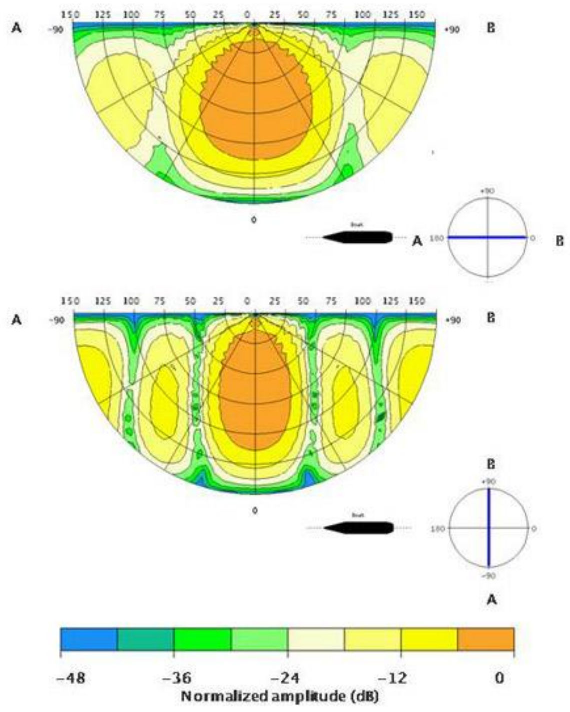


Figure 5 Seismic Array Beam Forming

Implications and considerations:

- If an estimated SEL is to be determined at any other bearing relative to the vessels forward/aft line other than the bearing of the streamer hydrophone grouping that was used to calculate the SEL then the difference between the source array directivity gain at the hydrophone grouping and the new bearing should be applied to the measured signal.

2.5 Data Processing Modules

Data processing can occur at the streamer electronic module or on any on-board system before the signal is stored. This processing can include frequency filtering and/or the addition of a gain to the signal.

Implications and considerations:

- It is important to understand any processing (be it digital or electronic) that is applied to the measured signal that has been stored. This processing must be defined so that it can it be either compensated for or the limitations fully understood.

3 Methodology

Taking account of the considerations listed in section 2, the applied methodology for analysis of the seismic survey data is as follows;

Table 1 Proposed Methodology

Steps	Description
1	Determine; a. The fauna offset ranges relevant to the survey (i.e. the shutdown, reduced power zone, exclusion or observation zones). b. Water column depths within the survey area. c. Sound speed profiles. d. Streamer grouping and Hydrophone spacing within these groups. e. Seismic source element layout/configuration. f. Hydrophone directionality and calibration curves. g. Any processing or manipulation of acoustic data that has been applied before it is stored on-board the seismic survey vessel.
2	Determine relevant streamer groupings for offset ranges.
3	Collect samples of streamer data for different offset ranges and water depths.
4	Convert the acoustic data from voltage to pressure to SPL (RMS) if required.
5	Adjust the data to compensate for; a. Transmission loss over the streamer (if not digitised at the streamer grouping). b. Frequency filtering to remove any spatial aliasing of the signal streamer grouping (if required). c. Hydrophone directionality and calibration curves (if not already applied).
6	Calculate or obtain seismic source element directionality. Determine the directivity gain for direction of the hydrophone streamer groupings (only required if an estimate of received SEL is required for bearings other than the relative bearing of the hydrophone section to the vessel).
7	Calculate or obtain streamer group beam pattern. The calculation will be based on the length of the group and the number of hydrophones within the groups. It is to be assumed, unless otherwise indicated, that no gain is added to any of the hydrophones in the streamer group.
8	Calculate expected acoustic refraction curves (using the sound speed profile) and arrival angles for the direct and reflected subsurface waves from surface and bottom.
9	Determine horizontal directional gain due to hydrophone group beam patterns.
10	Apply relevant directional gain in point 7.
11	Calculate Sound Exposure Level (SEL) for the measured acoustic pulse.

4 Definitions

Sound Exposure Level (SEL):

SEL is the Logarithmic measure of the Sound Pressure Level squared and integrated over a stated period of time or event, relative to a reference sound pressure value and normalized over 1 second. SEL in the context of this methodology is the estimate of the SEL for a single acoustic pulse arriving at a hydrophone section from the seismic source array.

$$SEL = \int_{t1}^{t2} \left(\frac{P}{Pref}\right)^2 dt$$

where;

t1 = start time

t2 = end time

P = measured pressure in Pascals

Pref = reference pressure (i.e. 1μPa)

Integration Time:

The integration time used to determine the SEL is the time of the measurement record for a single acoustic pulse arriving at a hydrophone section from the seismic source array.

Hydrophone:

A highly sensitive piezoelectric transducer that converts small pressure changes into an electrical signal.

Seismic Array:

A seismic array is a grouping of source elements that are towed behind a seismic survey vessel and are used to generate a high pressure air bubble which excites a propagating acoustic wave in the ocean.

Appendix M: Oil Spill – Terrestrial Parks Conservation Value/ Management Objectives Assessment & South-East Marine Reserve Management Plan Assessment

Assessment of the Duntroon against the stated objectives of the South-west Marine Parks Network Management Plan (DNP, 2018)

Context:

- Contact with the **Western Eyre CMP** during routine operations. For spill event: Predicted contact with surface hydrocarbons (>10µm) and entrained hydrocarbons (> 70.5 ppb x 96 hrs) from an 850 m^3 diesel spill and possible sheen contact.
- No contact with the **Western Kangaroo Island CMP** during routine operations. For spill event: Predicted contact with surface hydrocarbons (>0.5µm) and entrained hydrocarbons (>70.5 ppb x 96 hrs) from an 850 m^3 diesel spill and possible sheen contact.
- No contact with the **Southern Kangaroo Island CMP** during routine operations. For spill event: Predicted contact with surface hydrocarbons (>0.5µm) and entrained hydrocarbons (>70.5 ppb x 96 hrs) from an 850 m^3 diesel spill and possible sheen contact.
- No contact with the **Great Australian Bight CMP** during routine operations. For spill event: Predicted contact with surface hydrocarbons (>0.5µm) and entrained hydrocarbons (>70.5 ppb x 96 hrs) from an 850 m^3 diesel spill and possible sheen contact

Management Prescriptions	Assessment of Duntroon Impacts on management strategy
2.4.1 General use, access and waste management	
4.2.1.1 The Director may make, amend and revoke prohibitions, restrictions and determinations under rr.12.23, 12.23A, 12.26, 12.56 and 12.58 of the EPBC Regulations where it is considered necessary: a) to protect and conserve biodiversity and other natural, cultural and heritage values; or b) to ensure human safety or visitor amenity; or c) where it is otherwise necessary to give effect to this plan; and the Director may issue an authorisation for an activity that would otherwise be prohibited by such an instrument. This Section applies despite the prescriptions in Sections 4.2.3 to 4.2.12.	PGS acknowledges this authorisation power of the Director.
4.2.1.2 Waste from normal operations may be disposed of from vessels to which the International Convention for the Prevention of Pollution from Ships (MARPOL) (Schedule 1) applies, in accordance with the requirements of MARPOL	PGS has adopted all MARPOL related pollution control measures. Refer to: Section 6.3 – Treated Bilge Water Section 6.4 – Sewage Section 6.5 – Food-scraps Section 6.6 - Air Emissions Section 6.13 – Solid Waste Disposal Note for all MARPOL-related discharges excluding Air Emissions, there will be no discharge of pollutants from vessels within the Western Eyre CMP during Duntroon survey activities. *This exceeds the requirement of the management plan.*
4.2.1.3 Disposal of waste in connection with activities authorised under Section 4.2.9 (Structures and works) will be managed in accordance with that Section	Structures and works section is not applicable to Duntroon Survey activities.

Management Prescriptions	Assessment of Duntroon Impacts on management strategy
4.2.1.4 Ballast water may be discharged or exchanged subject to compliance with: a) the Australian ballast water management requirements and relevant state ballast water management arrangements; and b) relevant Commonwealth and state legislation or international agreements (if any) relating to ballast water management.	PGS has adopted ballast water controls as outlined within this requirement. Refer to: Section 6.7 – Invasive Marine Species *The Duntroon Survey EP meets with these requirements*
4.2.1.5 A person may camp in areas above the high-water mark in accordance with a permit. Note: Camping in connection with commercial tourism activities must be authorised under Section 4.2.6 (Commercial tourism)	Item is not relevant to Duntroon survey activities.
4.2.1.6 Overnight stays on vessels do not require a permit to camp.	Item is not relevant to Duntroon survey activities.
4.2.1.7 Remote piloted aircraft may be operated for non-commercial purposes in accordance with a permit, relevant provisions of Part 8 of the EPBC Regulations, and applicable aviation safety laws. Note: Operation of remote piloted aircraft in connection with commercial media activities, commercial tourism activities, or research and monitoring must be authorised under Section 4.2.5, Section 4.2.6 or Section 4.2.10 respectively.	Item is not relevant to Duntroon survey activities (no remote pilot activities).
4.2.2 Commercial Shipping (other than Commercial fishing and Commercial Aquiculture vessels)	
4.2.2.1 Commercial ships may transit through the South-west Network subject to compliance with the prescriptions in Section 4.2.1 (General use, access, and waste management) and relevant prescriptions in Sections 4.2.5 to 4.2.12 relating to the activity in which shipping is involved.	Refer to Assessment of Section 4.2.1 & Section 4.2.8 requirements.
4.2.2.2 Commercial ships may stop and anchor in a: a) Special Purpose Zone (Trawl) (VI); b) Special Purpose Zone (VI); c) Special Purpose Zone (Mining Exclusion) (VI); d) Multiple Use Zone (VI); and e) Habitat Protection Zone (IV), and National Park Zone (II) in anchoring areas determined under r.12.56 of the EPBC. Note: This Section does not prevent stopping and anchoring outside a determined anchoring area in an IUCN category (IV) or (II) zone due to circumstances of force majeure or distress or for the purpose of rendering assistance to persons, ships or aircraft in danger or distress	Item is not relevant to Duntroon survey activities (however it is acknowledged that anchoring can be undertaken in Multi-use zone VI and Special Purpose Zone VI).
4.2.3 Commercial Fishing	Not relevant to Duntroon survey activities
4.2.4 Commercial Aquaculture	Not relevant to Duntroon survey activities
4.2.5 Commercial Media	Not relevant to Duntroon survey activities
4.2.6 Commercial tourism (includes charter fishing tours, scuba diving, nature watching tours)	Not relevant to Duntroon survey activities
4.2.7 Recreational Fishing	Not Relevant to Duntroon survey activities
4.2.8 Mining Operations (including exploration)	

Management Prescriptions	Assessment of Duntroon Impacts on management strategy
4.2.8.1 Mining operations may be conducted in the South-west Network in accordance with and subject to: a) a permit issued under Section 4.4.1 (Permits); or b) a class approval issued under Section 4.4.2 (Class approvals); or c) an activity licence issued under Section 4.4.3 (Activity licences and leases) for mining operations that are the construction and operation of pipelines; and d) the following prescriptions in this Section; e) the prescriptions in Section 4.2.1 (General use, access, and waste management); and f) the prescriptions in Section 4.2.2 (Commercial shipping).	Duntroon survey activities will be undertaken in accordance with the Class Approval for Mining Operations and Greenhouse Gas Activities issued by the Director of Marine Parks (25/6/18). Refer also to assessment made for Section 4.2.2 (General use, access and waste management) and Section 4.2.2 (Commercial shipping). *The Duntroon Survey EP meets with these requirements*
4.2.8.2 Mining operations may be conducted in a: a) Special Purpose Zone (Trawl) (VI); b) Special Purpose Zone (VI); or c) Multiple Use Zone (VI), except in the Multiple Use Zone (VI) of the Geographe Marine Park, in accordance with Sections 4.2.8.3 and 4.2.8.4.	Duntroon survey activities will be undertaken in a Special Purpose Zone (VI) or Multiuse Zone (VI). *The Duntroon Survey EP meets with these requirements*
4.2.8.3 Mining operations in a Special Purpose Zone (Trawl) (VI), Special Purpose Zone (VI) or Multiple Use Zone (VI): a) that have been approved under Part 9 of the EPBC Act, may be conducted in accordance with conditions of that approval and a class approval issued under Section 4.4.2; b) that are authorised by a policy, plan or program that has been endorsed under Part 10 of the EPBC Act may be conducted in accordance with the conditions of that authorisation and a class approval under Section 4.4.2; or c) that are the subject of a decision under Part 7 of the EPBC Act and are not a controlled action if taken in a particular manner may be conducted in that manner and in accordance with the conditions of a class approval issued under Section 4.4.2.	Duntroon survey activities will be undertaken in accordance with the Class Approval for Mining Operations and Greenhouse Gas Activities issued by the Director of Marine Parks (25/6/18). *The Duntroon Survey EP meets with these requirements*
4.2.8.4 Mining operations in a Special Purpose Zone (Trawl) (VI), Special Purpose Zone (VI) or Multiple Use Zone (VI) not authorised by a class approval referred to in Section 4.2.8.3 may be conducted in accordance with a permit issued under Section 4.4.1 (Permits) or a class approval issued under Section 4.4.2 (Class approvals).	Not applicable to Duntroon survey activity
4.2.8.5 Mining operations that are the construction and operation of pipelines and the carrying on of other activities for the purposes of those operations (e.g. surveys) may be conducted in a: a) Special Purpose Zone (Mining Exclusion) (VI); b) Multiple Use Zone (VI) of the Geographe Marine Park; c) Habitat Protection Zone (IV); or d) National Park Zone (II), in accordance with Section 4.2.8.6.	Not applicable to the Duntroon survey activity.

Management Prescriptions	Assessment of Duntroon Impacts on management strategy
4.2.8.6 The Director may issue an authorisation under Section 4.4 (Authorisation of allowable activities) for the construction and operation of pipelines and the carrying on of other activities for the purposes of those operations (e.g. surveys) through a: a) Special Purpose Zone (Mining Exclusion) (VI); b) Multiple Use Zone (VI) of the Geographe Marine Park; c) Habitat Protection Zone (IV); or d) National Park Zone (II), if the Director is satisfied that alternative routes are not feasible or practicable.	Not applicable to the Duntroon survey activity
4.2.8.7 Mining operations must be conducted in accordance with an authorisation (however described) under the OPGGS Act or the Offshore Minerals Act 1994 (to the extent those laws apply to the operations and are capable of operating concurrently with this plan).	Duntroon survey activities will be undertaken in accordance with the accepted EP for the activity. The Duntroon Survey EP meets with these requirements
4.2.8.8 Notwithstanding Section 4.2.8.1, actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act, may be conducted in all zones without an authorisation issued by the Director, provided that the actions are taken in accordance with an environment plan that has been accepted by NOPSEMA, and the Director is notified in the event of oil pollution within a marine park, or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken.	This requirement has been included in the following sections of the EP: Section 4.0 – Legislative Requirements Section 6.11 – Oil Spill Response Section 7.7.2.3 – OPEP – Initial Actions Section 7.7.2.5 – Scientific Monitoring The Duntroon Survey EP meets with these requirements.
4.2.8.9 Scientific research and environmental monitoring in connection with a particular mining operation may be conducted in all zones in accordance with Section 4.2.10 (Research and monitoring).	Not applicable to the Duntroon survey activity
4.2.9 Structures and Works	Not applicable to Duntroon survey activities
4.2.10 Research and Monitoring	Not applicable to Duntroon survey activities
4.2.11 National security and emergency response	Not applicable to Duntroon survey activities
4.2.12 New activities and authorisations	Not applicable to Duntroon survey activities
4.3.1 Decision-making	
4.3.1.1 Decisions about activities will be consistent with the objectives of this plan, objectives of the zone or zones in which the activity will be or is being conducted, and the applicable reserve management principles (Schedule 8 of the EPBC Regulations).	All activities have been assessed against the objectives of the zone and south-west Marine Park Networks Management Plan 2018.
4.3.1.2 Decisions will take into account the impacts and risks of the activity on the values of the South-west Network and/or specific marine park/s, acceptability of those impacts and risks, and potential impacts on marine park users, stakeholders and Indigenous people.	Impacts to conservation values have been undertaken in the EP to demonstrate the temporary, localised and recoverable impacts the activity may have on the CMP.
4.3.1.3 Impacts and risks of an activity will be assessed in accordance with the processes and policies established under the assessments and authorisations program (Section 2.5)	Process is relevant to assessment authorities.

Management Prescriptions	Assessment of Duntroon Impacts on management strategy
4.3.1.4 Before authorising a proposed activity the Director must be satisfied that: a) the proponent suitably understands the marine park values; b) environmental impacts and risks on marine park values are understood, evaluated and able to be avoided or reduced to as low as reasonably practicable; c) the proponent has the capacity to comply with the conditions of the authorisation; and d) that relevant regulatory requirements have been or will be met.	Activity does not relate to PGS
4.3.1.5 The Director will not authorise an activity unless satisfied that: a) the activity is consistent with the zone objectives for the zone or zones in which the activity will be conducted (Part 3); and b) the potential impacts and risks of the activity on marine park values will be avoided or reduced to as low as reasonably practicable; and c) the potential impacts and risks of the activity on marine park values and representativeness are acceptable.	Activity does not relate to PGS

Assessment of the Duntroon against the stated objectives of the South-East Commonwealth Marine Reserves Network Plan (DNP, 2015)

Context: No contact with the SE Marine CMR during routine operations.

Predicted contact with entrained hydrocarbons (low levels) from an 850 m^3 diesel spill and possible sheen contact.

Management Strategy	Assessment of impacts on management strategy
1. Improve knowledge and understanding of the conservation values of the marine reserves network and of the pressures on those values.	
A1: As part of a national-scale program for Commonwealth marine reserves, develop and implement a South-east Commonwealth Marine Reserves Network Research and Monitoring strategy that contribute to increased understanding of the values of the reserves and provides for ongoing reporting of their condition.	Action not applicable to PGS
A2: Develop and implement a framework for the long term scientific monitoring of changes in key conservation values protected by the Commonwealth marine reserves and on the pressures on those values.	Action not applicable to PGS, however PGS will align with its requirements in the event of a spill.
A3: Adopt standards and protocols for managing biophysical and ecological data collected within Commonwealth Marine Reserves	Action not applicable to PGS, however PGS will align with its requirements in the event of a spill
A4: Collaborate, including through developing partnerships, with national research facilities, science and academic institutions and, as appropriate, marine reserve users, to deliver on strategic information needs and to inform research programs and government and industry investment in marine research.	Action not applicable to PGS
2. Minimise impacts of activities through effective assessment of proposals, decision-making and management of reserve specific issues	
A5: Establish in consultation with relevant stakeholders, efficient, effective and transparent processes for assessment, decision-making and authorisation of activities, and implement within the marine reserves network	Action not applicable to PGS
A6: When the interests of a person or group are likely to be affected by a decision under this Management Plan, the Director will: a) as far as practicable consult them in a timely and appropriate way; b) provide an opportunity to comment on the proposed decision and associated actions; c) take any comments into account; d) give reasonable notice before decisions are taken or implemented (except in cases of emergency); and e) provide reasons for decisions	Action not applicable to PGS
A7: Comply with Division 14.3 of the EPBC Regulations in relation to reconsideration of decisions about permits	Action not applicable to PGS
A8: Reconsider a decision about a class approval when requested by a person whose interests are affected by the decision. A request for reconsideration must be made and considered in the same manner as provided by Divison14.3 of the EPBC Regulations. Subject to the Administrative Appeals Tribunal Act 1975, a person who has requested a reconsideration may apply to the Administrative Appeals Tribunal for review of the reconsideration	Action not applicable to PGS
A9: Consider further use of class approvals where there is a sound case for effectively assessing and efficiently approving users that carry out a class of activities in a uniform way.	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
A10: Identify reserve specific issues and develop, implement and evaluate management responses where appropriate.	Action not applicable to PGS
3. Protect the conservation values of the marine reserves network through management of environmental incidents.	
A11: Establish systems for timely reporting of, and assisting with responses to, environmental incidents	PGS will align with its requirements in the event of a spill
A12: Collaborate with responsible agencies and assist with responding to environmental incidents that threaten the values of the marine reserves network	Action not applicable to PGS
A13: Maintain effective liaison and partnerships with relevant environmental incident response agencies and organisations	Action not applicable to PGS
A14: Identify and assess potential incidents that may threaten conservation values of the Reserves and implement if feasible approaches to reduce the likelihood or consequence of such incidents.	Action not applicable to PGS
4. Facilitate compliance with this Management Plan through education and enforcement	
A15: Implement reliable methods for monitoring compliance with this Plan	Action not applicable to PGS
A16: Develop, maintain and disseminate appropriate information to assist users of the marine reserves network to comply with the provisions of this Plan.	Action not applicable to PGS
A17: Consult with users of the network to identify opportunities to improve the effectiveness and efficiency of compliance measures	Action not applicable to PGS
A18: Implement a risk-based annual compliance plan	Action not applicable to PGS
A19: Establish a reporting system that supports users and visitors of the marine reserves network to report suspected non-compliant activity	Action not applicable to PGS
A20: Build effective working partnerships and agreements with Commonwealth and state government agencies for the delivery of compliance services	Action not applicable to PGS
A21: Investigate and monitor suspected non-compliant activity and, where appropriate, take enforcement action.	Action not applicable to PGS
A22: Support initiatives and programs which promote best practice standards that guide use, and minimise impacts on the marine environment	Action not applicable to PGS
5.Promote community understanding of, and stakeholder participation in, the management of the marine reserves network	
A23: Develop and implement a communication and education plan that increases community understanding of the importance of the marine reserves network and meets reserve-specific needs for communication about the values protected and management arrangements and requirements	Action not applicable to PGS
A24: Maintain effective working relationships with user groups to facilitate the exchange of knowledge, understanding and participation in the management of the marine reserves network	Action not applicable to PGS
A25: Within the first 12 months of the Plan’s operation, establish consultative structures (e.g. committees) to guide and participate in the management of the marine reserves network	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
6. Support involvement of Indigenous people in management of Commonwealth Marine Reserves	
A26: Drawing on the significant body of knowledge built as part of sea country planning and similar initiatives across Australia, and in consultation with relevant representative organisations, consolidate and communicate information about cultural values protected in the South-east Commonwealth Marine Reserves Network	Action not applicable to PGS
A27: Identify, and where feasible support, opportunities for Indigenous people to engage in the management of sea country in Commonwealth marine reserves, for example through the delivery of critical management services, such as monitoring surveillance, compliance and research.	Action not applicable to PGS
A28: Build effective partnerships with Indigenous communities and organisations that have an interest in the marine reserves network.	Action not applicable to PGS
A29: Comply with the requirements of the Native Title Act 1993	Action not applicable to PGS
7.Evaluate and report on the effectiveness of this Management Plan through monitoring and review	
A30: Within the first twelve months of the Plan's operation, design and initiate a program to measure and monitor progress on Actions and outcomes	Action not applicable to PGS
A31: Report annually on the South-east Commonwealth Marine Reserves Network in the Director of National Parks annual report	Action not applicable to PGS
A32: Evaluate and report on the implementation of the Management Plan before its expiry. The report will consider: a. An assessment of the existing measures to protect the South-east Commonwealth Marine Reserves Network; b. Progress of the strategies and actions towards achieving the stated outcomes; c. options for improving management of the marine reserves network	Action not applicable to PGS

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of Seal Bay and Cape Grantheaume CPs (NPWS, 1977)

Context: CP: Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
1. The protection and maintenance of the Sea Lion colony at Seal Bay	
Population closely monitored Prohibited zones set aside Aquatic Reserve exits along Seal Bay foreshore	Action not applicable to PGS
2. The improvement of public access to the seal bay colony with provision of greater protection to the sea lion	
Proposed development to improved sign-posting and access while minimising visitor access	Action not applicable to PGS
3. The preservation of wilderness character of the southern part of the park	
The southern mallee section should be preserved as a wilderness zone. No controlled burning carried out.	Action not applicable to PGS
4. The maintenance of grasslands for macropod grazing and fire protection purposes	
Management strategies for retaining grasslands bur requires thorough evaluation onsite and subsequent monitoring to assess any changes which occur.	Action not applicable to PGS
5. The preservation of the waterfowl habitat around Murray's lagoon	
The waters of Murray lagoon may be rising and this needs to be investigated. The phenomena should be investigated and remedial measures considered if the water fowl habitat is threatened. Shooting is not permitted on the lagoon and fences should be removed from across the lagoon.	Action not applicable to PGS
6. The encouragement of public use for recreation compatible with other management objectives.	
Apart from two prohibited zones at Sea Bay the parks should be open to the public. The park is primarily for conservation and only certain activities are compatible with that (sightseeing, bushwalking, nature study, bush camping, picnicking). Activities deleterious to the park should be prohibited.	Action not applicable to PGS
7. The provision for park users of information relating to features of interest in the area.	
Directional signs should be provided through the park on road network to indicate points or interest. In conjunction with the lookout and viewing facilities which should be developed at Seal Bay and Murrays Lagoon some explanatory signs or printed leaflets should be available to inform visitors about the significance of animal populations they are viewing.	Action not applicable to PGS
8. The control of wildfire in the park	
The mallee vegetation presents a serious fire risk. Grassland present as a very high fire risk Grasslands should be maintained but methods used should limit the fire risk. Where grasslands adjoin the property adequate firebreaks should be provided.	Action not applicable to PGS

Source: Seal Bay and Cape Grantheaume CPs Management Plan (NPWS, 1977)

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of the Cape Torrens and Western River WPA (DEH, 2005)

Context: WPA: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
4. **Wilderness Protection:** Maximise the wilderness quality of the reserve..	
Manage the reserve in accordance with the Wilderness Code of Management	Action not applicable to PGS. No Conflicts
5.1 Geology, Soils and Landform Limit soil erosion in the wilderness protection areas.	
Control the population of feral goats to reduce disturbance, such as trampling and erosion	Action not applicable to PGS. No Conflicts
5.2 Hydrology Maintain the water quality and flows of Western River	
Liaise with neighbouring landowners to reduce impacts on the river systems of Western River.	Action not applicable to PGS. No Conflicts
5.3 **Native Vegetation:** Conserve native vegetation, especially species of conservation significance, and prevent the spread of Phytophthora into the wilderness protection areas.	
Monitor populations of conservation significance and implement management actions, if required, for their conservation, consistent with the maintenance of wilderness quality	Action not applicable to PGS. No Conflicts
Map the distribution and condition of the remaining Manna Gum to allow for future monitoring and management as required	Action not applicable to PGS. No Conflicts
Monitor the Koala population within the reserves and undertake suitable management strategies; this may include sterilisation within Western River Wilderness Protection Area, and translocation programs, to reduce the impacts on the wilderness and biodiversity values	Action not applicable to PGS. No Conflicts
Promote awareness amongst DEH staff and park users of the potential for introduction and establishment of PC, the plant species susceptible to it and indicators of its presence.	Action not applicable to PGS. No Conflicts
Comply with PC hygiene protocols in undertaking management operations within the reserves.	May be applicable if scientific monitoring is required. PGS will observe these requirements. No Conflicts
Monitor for the existence of PC within the reserves, and take appropriate steps to limit its spread, including the restriction of visitors in the reserves.	Action not applicable to PGS. No Conflicts
Maintain the existing PC hygiene station at the commencement of the walking trail to Waterfall Creek Falls in Western River Wilderness Protection Area.	Action not applicable to PGS. No Conflicts
Work in liaison with the local council to maintain the PC hygiene station on Jump Off Road, and minimise the spread of PC along Jump Off Road, for example by grading away from the reserve	Action not applicable to PGS. No Conflicts

Management Strategy	Assessment of impacts on management strategy
5.4 Native Fauna: Conserve native fauna, especially species of conservation significance	
Manage the habitat of the South Australian Glossy Black-Cockatoo in accordance with the Glossy Black-Cockatoo recovery plan	Action not applicable to PGS. No Conflicts
Minimise the disturbance of nests of the White-bellied Sea-eagle and Osprey, for example by restricting all access along the cliff tops during the breeding season (from June until early December).	Action not applicable to PGS. No Conflicts
Undertake more intensive surveys to confirm the presence or absence of threatened species (for example, the Kangaroo Island Dunnart, the Heath Rat and the Southern Brown Bandicoot) within the wilderness protection areas	Action not applicable to PGS. No Conflicts
5.5 Introduced Plants Control and eliminate, where possible, the spread of weed species, in accordance with the Wilderness Code of Management.	
Develop a regional weed management plan, including Cape Torrens and Western River Wilderness Protection Areas	Action not applicable to PGS. No Conflicts
Develop strategies with neighbouring landowners to control weeds.	Action not applicable to PGS. No Conflicts
Implement targeted control programs for priority weed species and infestations, particularly thistles.	Action not applicable to PGS. No Conflicts
Monitor for the presence of pine within Western River Wilderness Protection Area and remove as required	Action not applicable to PGS. No Conflicts
Work with Forestry SA to develop protocols to ensure forest managers are accountable for the monitoring and removal of escaped pine seedlings along common boundaries	Action not applicable to PGS. No Conflicts
5.6 Introduced Animals Control and eradicate, where possible, all introduced fauna established within the reserve that significantly impacts on the wilderness and biodiversity values.	
Continue regional programs for the control of pest animal species, particularly deer and feral goats.	Action not applicable to PGS. No Conflicts
Investigate options for the control and eradication of Marron populations within the reserves	Action not applicable to PGS. No Conflicts
6. Managing Fire Maintain the wilderness and biodiversity values in the reserves through effective fire management.	
Develop, implement and review a fire management plan for Cape Torrens Wilderness Protection Area and Western River Wilderness Protection Area in association with the CFS and other stakeholders	Action not applicable to PGS. No Conflicts
Engage adjacent landowners in a landscape scale fire management planning process.	Action not applicable to PGS. No Conflicts
Continue to work with the relevant District Bushfire Prevention Committee and the CFS to minimise risk to life and property within and surrounding the reserves.	Action not applicable to PGS. No Conflicts
Undertake prescribed burning between the fire access break and Colemans Road on a frequent basis	Action not applicable to PGS. No Conflicts
Monitor the impacts on wilderness values of fire break construction, rehabilitating any areas where necessary.	Action not applicable to PGS. No Conflicts

Management Strategy	Assessment of impacts on management strategy
7.1 Indigenous Heritage: Conserve and protect significant Indigenous and non-indigenous cultural heritage sites	
Identify and protect any Aboriginal sites, objects and remains in cooperation with the traditional owners, DAARE, and relevant authorities.	Action not applicable to PGS. No Conflicts
Consult the Ngarrindjeri, Kaurna and Narungga people who have a traditional association with the land, potential Native Title Claimants and relevant State and Federal Aboriginal Heritage authorities, in decisions regarding the management of Aboriginal cultural heritage	Action not applicable to PGS. No Conflicts
Promote discussion with Aboriginal people who have a traditional association with the land comprising the reserves to better understand and appreciate their culture, lifestyle and knowledge of the reserves	Action not applicable to PGS. No Conflicts
8.1 Managing Visitor Access: Minimise the impact of vehicle use on wilderness quality. Maintain existing trails to provide safe walking access to the reserves consistent with maintaining wilderness quality.	
The track to Waterfall Creek Falls, in Western River Wilderness Protection Area, will be retained for public use as a walking trail. Vehicle use will be restricted to infrequent management purposes such as emergency or fire management and introduced plant and animal control operations	Action not applicable to PGS. No Conflicts
Monitor the Waterfall Creek Hike track condition for degradation, and should the wilderness values be sufficiently threatened, restabilise and maintain or re-route and rehabilitate the existing track	Action not applicable to PGS. No Conflicts
Maintain the small car park at the start of the Waterfall Creek Hike trail head adjacent to the boundary of Western River Wilderness Protection Area.	Action not applicable to PGS. No Conflicts
Maintain partnerships with Forestry SA to maintain the track on the western boundary of Western River Wilderness Protection Area.	Action not applicable to PGS. No Conflicts
Restrict vehicle access to both reserves for management and emergency purposes only	Action not applicable to PGS. No Conflicts
Maintain low frequency, low impact and self reliant visitor access to the wilderness protection areas.	Action not applicable to PGS. No Conflicts
Maintain the Waterfall Creek Hike and lookout to Australian Standard Class 4, consistent with the wilderness setting.	Action not applicable to PGS. No Conflicts
Provide opportunities for visitors to enjoy the solitude, scenic and natural values of Western River Wilderness Protection Area, consistent with maintaining wilderness values.	Action not applicable to PGS. No Conflicts
Erect signs and/or barriers to control the use of perimeter tracks in Western River Wilderness Protection Area for purposes other than reserve management	Action not applicable to PGS. No Conflicts
8.Commercial Tourism Minimise the impact of tour operators on the wilderness values of the wilderness protection areas	

Management Strategy	Assessment of impacts on management strategy
Ensure licence conditions of commercial tour operators accessing Western River Wilderness Protection Area include a maximum number per group, and a maximum frequency consistent with the wilderness setting, and the provision that they must comply with the Minimum Impact Code for visitors to wilderness areas.	Action not applicable to PGS. No Conflicts
Limit commercial tour operator use of the Waterfall Creek Hike and lookout to one group with a maximum of five clients at any one time, consistent with the wilderness setting and the physical capacity of the lookout.	Action not applicable to PGS. No Conflicts
Monitor and review annually the impact on wilderness values of the commercial use by tourism operators and their customers	Action not applicable to PGS. No Conflicts
9.1 Managing Infrastructure Maintain current infrastructure necessary for essential reserve management, ensuring minimal impact on the wilderness values of the reserves in keeping with the Wilderness Code of Management.	
Where fences are to be maintained negotiation should occur with neighbouring land owners to exclude stock and to reduce the movement of feral animals.	Action not applicable to PGS. No Conflicts
Maintain signs, barriers and PC hygiene stations while minimising their impact on wilderness values.	Action not applicable to PGS. No Conflicts
9.2 External Influences Ensure that external influences do not negatively impact on the biodiversity values of the wilderness protection area.	
Liaise with neighbouring land owners with a view to establish cooperative management arrangements that contribute to the maintenance of wilderness values of the reserves.	Action not applicable to PGS. No Conflicts
9.3 Research Ensure management is based on the best information, including scientific information	
Encourage research that improves wilderness and conservation management while not detracting from wilderness quality.	Action not applicable to PGS. No Conflicts
10. Involving the Community Encourage and maintain neighbouring land owner and local council input in reserve management and biodiversity conservation. Support partnerships with organisations and statutory bodies to assist with the management of the reserves.	
Liaise with neighbouring landowners and the local council to encourage their input	Action not applicable to PGS. No Conflicts
Encourage the development of partnership arrangements to integrate biodiversity conservation management in the region	Action not applicable to PGS. No Conflicts

Source: Cape Torrens and Western River WPA (DEH, 2005)

Note the following Parks do not have Management Plans:

- Gambier Islands Conservation Parks
- Sir Joseph Banks Group Conservation Park
- Tumby Bay Conservation Park

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of the Parks of Coffin Bay (DEH, 2004)

Context: NP: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
4.2 Natural Resources: Native Vegetation Protect vegetation associations and undertake actions necessary for the conservation of significant species where necessary	
Integrate vegetation rehabilitation and habitat restoration programs with regional pest plant and feral animal control	Action not applicable to PGS
Continue revegetation where necessary to improve visitor amenity and undertake rehabilitation of degraded vegetation	Action not applicable to PGS
Identify and monitor populations of rare, vulnerable and endangered plant species. Develop and implement plans, if required, for their conservation.	Action not applicable to PGS
Monitor impacts on vegetation, and implement remedial management programs where necessary.	Action not applicable to PGS
Re-establish Drooping Sheoak-Dryland Tea-tree woodland in areas where this association has been degraded.	Action not applicable to PGS
4.2 **Native Fauna:** Protect and enhance the quality and diversity of wildlife habitats within the parks to maintain and, where feasible restore, the diversity of native fauna populations. Ensure wildlife programs are based on best available knowledge and are implemented in consultation with wildlife specialists. Minimise human disturbances to wildlife.	
Integrate regional pest plant and feral animal control with vegetation rehabilitation and habitat restoration, and where feasible, reintroduce locally extinct or endangered native animal populations.	Action not applicable to PGS
Identify and monitor populations of rare, vulnerable and endangered animal species and, if necessary, develop and implement plans for their conservation.	Action not applicable to PGS
Monitor population trends and impacts of Western Grey Kangaroos within the mainland parks and if necessary, reduce the kangaroo population to a sustainable level by targeted culling	Action not applicable to PGS
Monitor and manage the impact of vehicle access on beach-nesting bird species (eg Hooded Plover).	PGS will liaise with NP to undertake monitoring. No conflicts
Continue to survey and monitor populations of the Australian Sea-lion and New Zealand Furseal on offshore islands, in conjunction with the CSIRO.	PGS will liaise with NP to undertake monitoring. No conflicts
Monitor and manage the impact of recreational activities on key wildlife species (eg Osprey and White-bellied Sea-eagle).	Action not applicable to PGS
Encourage scientific research to enhance wildlife management.	Action not applicable to PGS
4.2.5 Introduced Plants: Reduce the negative impacts of pest plants on wildlife habitats in the parks. Prioritise pest plant programs to ensure maximum park and community benefit. Promote community understanding of pest plant impacts on the natural environment and encourage participation in regional programs.	

Management Strategy	Assessment of impacts on management strategy
Undertake, where practicable, control of invasive pest plant species as part of the regional integrated wildlife restoration programs.	Action not applicable to PGS
Continue programs to eradicate invasive weeds (eg African Boxthorn, Aleppo Pine, Bridal Creeper, Olive and Myrtle-leaved Milkwort) from the parks of the Coffin Bay area.	Action not applicable to PGS
Monitor the effectiveness of weed eradication programs and implement new techniques when available..	Action not applicable to PGS
Increase awareness in the local community of the invasive nature of some ornamental plants in gardens (eg Myrtle-leaved Milkwort), and encourage their replacement with suitable indigenous species.	Action not applicable to PGS
Control non-invasive pest plant species in sites subject to disturbance.	Action not applicable to PGS
4.2.6 Introduced Pathogens Prevent the introduction and spread of introduced pathogens in the reserve.	
Comply with the provisions of the Threat Abatement Plan For Dieback Caused By The Root-Rot Fungus Phytophthora cinnamomi (Environment Australia, 2001)	No conflicts. PDS would adopt measures in the event of a spill.
Increase DEH staff awareness of the potential for introduction and establishment of Phytophthora cinnamomi, susceptible plant species and indicators of its presence	Action not applicable to PGS
Ensure that all soil is removed from all earth-moving and construction equipment entering the reserve, to reduce the risk of Phytophthora introduction.	Action not applicable to PGS
Provide boot-cleaning stations for track users if necessary.	Action not applicable to PGS
4.2.7 Introduced Animals Restore wildlife habitat and minimise the impacts of feral animals on the parks	
Encourage the restoration of wildlife habitats by developing an integrated control program for pest plants and animals.	Action not applicable to PGS
Continue the program to eradicate rabbits, foxes and cats from mainland parks	Action not applicable to PGS
Investigate methods of feral bee control and initiate where appropriate.	Action not applicable to PGS
4.3.1 Aboriginal Heritage: Conserve and protect significant cultural heritage sites and provide appropriate interpretive material. Develop and strengthen Aboriginal involvement in the Coffin Bay Area. In conjunction with nominated Aboriginal representatives, protect and interpret Aboriginal culture and cultural sites	
Consult Aboriginal people who have a traditional association with the land, Native Title Claimants and relevant State and Federal Aboriginal heritage authorities, in decisions regarding the management of cultural heritage.	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
Identify, record, protect, conserve and monitor known or relocated sites and items of archaeological, anthropological, cultural and historical significance located in the park, in cooperation with the local Aboriginal communities, Department of Aboriginal Affairs and Reconciliation, Heritage branch, DEH, and other relevant authorities and organisations. Aboriginal and historic cultural heritage sites require conservation plans to facilitate appropriate management.	Action not applicable to PGS
In consultation with the Aboriginal community, Heritage branch, DEH, and other relevant authorities, research and record cultural and historic sites and stories that relate to the park and, where appropriate, develop interpretive material and tourism programs for visitors. Interpretive material may include web-site, brochures, site signage and displays.	Action not applicable to PGS
All archaeological, anthropological and historic studies within the park should be developed in consultation with Heritage branch, DEH, and/or DAARE and submitted for inclusion on the State Heritage Register and/or the DAARE Central Archive	Action not applicable to PGS
With the assistance of the local Aboriginal people, identify all local Aboriginal community groups with an interest in the parks of the Coffin Bay area. Contact, develop and support forums that achieve an ongoing dialogue with all groups.	Action not applicable to PGS
Seek local Aboriginal community support to improve DEH staff understanding of local Aboriginal people's traditional connections with the park and its surrounding areas.	Action not applicable to PGS
Continue to support Aboriginal interest in employment in park operations	Action not applicable to PGS
Identify post-colonial cultural sites and provide for their protection and interpretation.	Action not applicable to PGS
4.4 Fire Management Manage fire to ensure the protection of life and property, the maintenance of biodiversity and the protection of natural, cultural and built values.	
Develop, implement and review fire management plans in association with CFS and other stakeholders.	Action not applicable to PGS
Until a fire management plan is developed : - - maintain existing fire access tracks and only create new tracks if there is no alternative means to prevent the loss of life, property or biodiversity assets; - - undertake strategic hazard reduction burning in order to protect life and property.	Action not applicable to PGS
Provide campfire sites in Coffin Bay National Park and restrict use to these sites..	Action not applicable to PGS
Prohibit the collection of local firewood, investigate alternative fuel sources for campfires and develop a strategy to make them available to park visitors	Action not applicable to PGS
4.5 Recreation and Tourism: Provide appropriate vehicle access in Coffin Bay National Park.	
Restrict public vehicle access to the roads and tracks shown in Figure 1, monitor vehicle use and address public risk and environmental issues	Action not applicable to PGS
Close inappropriate vehicle tracks and rehabilitate where necessary.	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
Maintain conventional vehicle access roads and upgrade where possible	Action not applicable to PGS
Using in-situ materials, maintain where possible, the designated 4WD access tracks, realigning sections where necessary to avoid low-lying swampy environments subject to inundation.	Action not applicable to PGS
Maintain the Gunyah Beach access route through the dune field by marking the appropriate vehicle corridor. Access along the beach is limited to 3 km in either direction from entry point.	Action not applicable to PGS
4.5.2 Boat Access Ensure that beaches are managed in accordance with the National Parks and Wildlife Act and objectives of this plan.	
Ensure visitors who enter the park by boat comply with the National Parks and Wildlife Act, its Regulations and with the provisions of this plan.	Action not applicable to PGS
4.5.3 Walking Trails Provide and maintain appropriate walking trails within Coffin Bay National Park and Kellidie Bay Conservation Park. Increase visitor understanding and appreciation of park values and management.	
Maintain and improve existing walking trails within Coffin Bay National Park and Kellidie Bay Conservation Park.	Action not applicable to PGS
Provide additional walking trails where appropriate to cater for a range of walkers.	Action not applicable to PGS
Provide signs for the trailhead of each walking trail and interpretive material where appropriate.	Action not applicable to PGS
Monitor the use of walking trails to assist with future management.	Action not applicable to PGS
4.5.4 Entry & Camping Fees Maintain the effective collection of entry and camping fees within Coffin Bay National Park.	
Monitor and ensure compliance with the self-registration system at the Coffin Bay National Park entrance station	Action not applicable to PGS
Establish and maintain a database of visitor statistics	Action not applicable to PGS
Ensure that park visitors have adequate opportunity to purchase annual vehicle passes within the Coffin Bay township.	Action not applicable to PGS
Inform park visitors of projects funded through entry and camping fee revenue.	Action not applicable to PGS
4.5.5 Camping and Day Visit Areas Ensure that visitors may enjoy sites of interest and stay at suitable campsites without compromising natural values.	
Provide access to, and suitable interpretive material and facilities at, popular campsites and sites of interest without compromising natural values.	Action not applicable to PGS
Monitor the impacts of vehicles and campers at Sensation Beach and modify the level of access if necessary to ensure wilderness values are not compromised.	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
4.6.1 Commercial Activities and Other Land-use Regulate commercial activities within the parks of the Coffin Bay area to ensure they are compatible with park values and comply with the objectives of the National Parks and Wildlife Act 1972 and this plan.	
Issue Commercial Licences to tour operators, subject to compliance with this plan and the provisions of the National Parks and Wildlife Act 1972.	Action not applicable to PGS
4.6.2 Other Commercial Activities Allow abandoned apiary sites to regenerate within Kellidie Bay Conservation Park. Have regard to leases conditions and the DEH shack site policy for national parks and reserves.	
Prohibit the re-opening of abandoned apiary sites within Kellidie Bay Conservation Park and allow the sites to regenerate	If scientific monitoring occurs PGS will comply with these requirements. No Conflicts.
Enforce shack lease covenants.	Action not applicable to PGS
4.6.3 Public Utilities Ensure both SA Water and ETSA Utilities have regard to DEH policies, Regulations under the National Parks and Wildlife Act 1972 and the provisions of this plan.	
Liaise with public utilities to ensure that their activities do not compromise park values and that they have regard to the objectives of the National Parks and Wildlife Act and this plan.	Action not applicable to PGS
4.6.4 Marine Navigation Aids Ensure that maintenance of marine navigation aids does not impact negatively on the natural assets of the parks	
Ensure relevant authorities liaise with DEH with regard to the maintenance of marine navigation aids, where impacts to the parks may occur.	Action not applicable to PGS
4.3.4 Aquaculture Ensure that aquaculture activities do not compromise park values.	
Liaise with PIRSA (Fisheries) and the aquaculture industry to assist with the appropriate implementation of the Lower Eyre Peninsula Aquaculture Management Plan and its amendments.	Action not applicable to PGS
Review new applications for aquaculture tenure and monitor the impacts of existing aquaculture to ensure there is minimal impact upon the biological and scenic values of Coffin Bay area.	Action not applicable to PGS
4.6.7 Mining	
Not relevant to PGS	
4.7.1 Management Arrangements	
Not Relevant to PGS	

Management Strategy	Assessment of impacts on management strategy
4.7.2 Community and Volunteer Develop and encourage community support for management for Coffin Bay Area.	
Provide administrative support for the activities of the DEH Eyre Consultative Committee	Action not applicable to PGS
Provide opportunities for volunteer and community groups by facilitating the implementation of programmed activities..	Action not applicable to PGS

Source: Lincoln National Park Management Plan (DEH, 2004)

Note the following Parks do not have Management Plans:

- Gambier Islands Conservation Parks
- Sir Joseph Banks Group Conservation Park
- Tumby Bay Conservation Park

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of the Innes NP (DEH, 2003)

Context: NP: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
4.2.1 Natural Resources: Geology and Landform Protect geological and geomorphological features of the park and interpret them for visitors. Protect and interpret the gypsum lake environments currently external to park boundaries	
Include geological and mining information in visitor programs and materials	Action not applicable to PGS. No Conflicts
Investigate the possibility of incorporating the excluded gypsum lakes in the park	Action not applicable to PGS. No Conflicts
4.2.2 Natural Resources: Soils Protect soils from adverse impacts and limit erosion to natural weathering	
Consider the potential for soil erosion when planning visitor access or undertaking management activities and development works.	Action not applicable to PGS. No Conflicts
Progressively provide a system of walking trails and beach-access paths, the final routes dependent on the preparation and implementation of a walking trail plan	Action not applicable to PGS. No Conflicts
Provide interpretive material to inform visitors of the fragile nature of sand dune vegetation and encourage visitors to use the walking trails provided.	Action not applicable to PGS. No Conflicts
Monitor the impact of foot traffic in dune areas. If an educational approach fails to prevent excessive intrusion into Sand Dune Protection Zones, consider gazetting the zones as Prohibited Areas under section 42 of the National Parks and Wildlife Act 1972	Possible application to Scientific Monitoring. No Conflicts
4.2.3 Natural Resources: Natural Vegetation Conserve native vegetation, maximise biodiversity and minimise threats, particularly to plants of conservation significance.	
Direct and confine visitor access so that vehicles and walkers do not cause unacceptable impact on sensitive dune vegetation. Initially, this will be done with appropriate and low-key barriers and by interpretive signs that explain the issue for visitors	Action not applicable to PGS. No Conflicts
Undertake comprehensive vegetation mapping to determine key associations and wildlife habitats and to provide a strategic basis for threat abatement programs	Action not applicable to PGS. No Conflicts
Record on a database the location and distribution of plants of conservation significance, monitor the populations and implement species management programs if necessary	Action not applicable to PGS. No Conflicts
Encourage natural regeneration, undertaking revegetation in disturbed sites in association with pest plant control if necessary.	Action not applicable to PGS. No Conflicts
4.2.4 **Native Fauna:** Conserve and manage all native fauna currently inhabiting or using the park by habitat protection and threat abatement.	
Encourage appropriate volunteer groups and individuals to conduct fauna surveys and population monitoring.	Action not applicable to PGS. No Conflicts
Record on a database with GIS capability, animal species and habitats, including opportunistic sightings of rare and endangered fauna. Monitor populations of species of conservation significance and, where necessary, develop and implement management plans to ensure their conservation.	Action not applicable to PGS. No Conflicts

Management Strategy	Assessment of impacts on management strategy
Comply with and contribute to the National Recovery Plan for Malleefowl, as required under the Environment Protection and Biodiversity Conservation Act 1999	Action not applicable to PGS. No Conflicts
Continue to monitor kangaroo numbers, assess population trends and endeavour to understand their contribution to the total grazing pressure on vegetation in the park.	Action not applicable to PGS. No Conflicts
Contribute to an integrated regional kangaroo management program, culling if necessary, to maintain a sustainable population that is considered natural for the vegetation types of the park.	Action not applicable to PGS. No Conflicts
4.2.5 Introduced Plants: Control and, where feasible, eradicate introduced plants from the park.	
Record the location of introduced plant populations on a database with GIS capability and monitor their spread.	Action not applicable to PGS. No Conflicts
Undertake control measures and where feasible, eradicate introduced plants, initially directing resources towards protecting areas that are currently least affected.	Action not applicable to PGS. No Conflicts
Initiate and maintain communication with local government, district Animal and Plant Control Board, and neighbouring landowners, with the aim of integrating pest plant management programs on a regional basis	Action not applicable to PGS. No Conflicts
4.2.6 Introduced Animals: Control and where possible, eradicate introduced animals from the park.	
Undertake effective introduced animal control programs and undertake systematic monitoring of populations.	Action not applicable to PGS. No Conflicts
Encourage and contribute to regional introduced animal control programs	Action not applicable to PGS. No Conflicts
4.3 Cultural Heritage: Conserve and protect significant cultural heritage sites and provide appropriate interpretive material.	
Consult Narungga people who have a traditional association with the land, Native Title Claimants and relevant State and Federal Aboriginal heritage authorities, in decisions regarding the management of Narungga cultural heritage.	Action not applicable to PGS. No Conflicts
Before proceeding with any development works within the reserve, obtain an assessment and clearance from the appropriate authority, under the provisions of the Aboriginal Heritage Act 1988.	Action not applicable to PGS. No Conflicts
Identify, record, protect, restore and monitor known or relocated sites and items of archaeological, anthropological, cultural and historical significance located in the park, in cooperation with the Department for Aboriginal Affairs and Reconciliation, the Heritage branch of DEH and other relevant authorities and organisations. Narungga and historic cultural heritage sites require conservation plans to facilitate appropriate management	Action not applicable to PGS. No Conflicts
In consultation with the Narungga community, the Heritage branch of DEH and other relevant authorities, research and inventory, cultural and historic sites and stories that relate to the park and where appropriate, develop interpretive material and tourism programs for visitors. Interpretive material may include web-site, brochures, site signage and displays	Action not applicable to PGS. No Conflicts
Consult Narungga people who have a traditional association with the land comprising the park to determine the appropriateness of naming park features using both Narungga and existing names.	Action not applicable to PGS. No Conflicts

Management Strategy	Assessment of impacts on management strategy
Seek funding to employ an historian to gather the available oral history of the park.	Action not applicable to PGS. No Conflicts
Encourage and support archaeological, anthropological and historic studies within the park. All sites located should during these surveys should be recorded to the standards set by the Heritage branch of DEH and/or DAARE and submitted for inclusion on the DAARE Central Archive and/or State Heritage Register	Action not applicable to PGS. No Conflicts
Establish, with professional guidance, a priority action list for site conservation at Inneston and Stenhouse Bay to conserve and manage heritage buildings and objects in accordance with the Burra Charter (Australia ICOMOS 1981).	Action not applicable to PGS. No Conflicts
Commission a conservation plan for the heritage of the park as a sub-section of a visitor infrastructure and services plan.	Action not applicable to PGS. No Conflicts
4.4 Fire Management Protect lives and property and limit the spread of bushfire within the park.	
Comply with provisions of the Country Fires Act 1989.	Action not applicable to PGS. No Conflicts
Develop and regularly update a bushfire prevention plan for the park, in association with local CFS officers and neighbouring landowners.	Action not applicable to PGS. No Conflicts
Establish and regularly review a park visitor protection and evacuation plan to be implemented in the event of a serious bushfire.	Action not applicable to PGS. No Conflicts
Maintain existing fire access tracks and only create new tracks if there is no alternative means to prevent the loss of life or property.	Action not applicable to PGS. No Conflicts
Maintain water points, windmills, tanks and other water sources necessary for bushfire suppression	Action not applicable to PGS. No Conflicts
Ensure visitors comply with fire restrictions during the fire danger season	Action not applicable to PGS. No Conflicts
Provide well defined campfire sites within camping areas.	Action not applicable to PGS. No Conflicts
Prohibit the collection of local firewood and provide interpretive material to explain its importance to wildlife.	Action not applicable to PGS. No Conflicts
Encourage visitors to supply their own fuel and continue to make alternative fuel available for sale	Action not applicable to PGS. No Conflicts
Monitor the impact of campfires and in the event that damage to biodiversity, habitat or visual amenity becomes significant, implement a more sustainable regime.	Action not applicable to PGS. No Conflicts
4.5 Infrastructure and Built Assets Comply with the appropriate procedures for undertaking development works and ensure that DEH exercises a reasonable duty of care for park visitors	
Comply with provisions of the Development Act 1993.	Action not applicable to PGS. No Conflicts
Maintain a Risk Register for Innes National Park.	Action not applicable to PGS. No Conflicts
4.6.1 Recreation and Tourism Ascertain visitor requirements to guide the provision of visitor services	
Continue to undertake surveys to ascertain visitor requirements.	Action not applicable to PGS. No Conflicts

Management Strategy	Assessment of impacts on management strategy
Develop programs to address visitor needs that provide education and enjoyment without compromising the conservation of park values.	Action not applicable to PGS. No Conflicts
4.6.2 Vehicle Access Provide appropriate access for park visitors and for management and emergency purposes	
Maintain 2WD bitumen-sealed access road from the park entrance to Pondalowie Bay and upgrade carparks within the park.	Action not applicable to PGS. No Conflicts
Progressively improve access and landscape vistas by bitumen-sealing the secondary roads to Cape Spencer, the Gap and West Cape	Action not applicable to PGS. No Conflicts
Continue to maintain the tertiary road and carparks from Pondalowie Bay to Browns Beach. Consideration will be given to upgrading this road to minimise public risk issues, environmental impact and maintenance costs	Action not applicable to PGS. No Conflicts
Maintain a system of fire and management access tracks.	Action not applicable to PGS. No Conflicts
Encourage visitors to use designated walking trails, particularly through the dune areas	Action not applicable to PGS. No Conflicts
Monitor foot traffic in the dune areas and if current measures fail to confine walkers to designated routes, contemplate the possibility of formally gazetting a Prohibited Area (see 4.1 Zoning) under the provisions of section 42 of the National Parks and Wildlife Act. Visitors who continue to sand board and walk in the dunes, causing increased erosion and vegetation loss, would then be liable for prosecution as part of a compliance strategy	Action not applicable to PGS. No Conflicts
Progressively provide a system of walking trails and beach-access paths within the park, with final routes to be chosen following detailed planning.	Action not applicable to PGS. No Conflicts
4.6.3 Boat Access Ensure that vehicle access and boat launching does not compromise natural values or impinge on visitor enjoyment.	
Monitor boat use at Pondalowie Bay and implement measures considered necessary to maintain biodiversity values and visitor experiences.	Action not applicable to PGS. No Conflicts
4.6.4 Horse Access	
Activity not relevant to PGS Activities – No conflicts	
4.6.5 Walking Trails Progressively design, develop and maintain a limited number of formal walking trails	
Develop and implement a delegate plan for walking trails that safeguards environmental values and provides quality visitor experiences.	Action not applicable to PGS. No Conflicts
4.6.6 Visitors Facilities Provide appropriate experiences and facilities for visitors, and address public risk issues associated with visitor use of the park	
Discusses park Upgrades. Not relevant to any PGS Actions	

Management Strategy	Assessment of impacts on management strategy
4.6.7Entry & Camping Fees Generate funding for the management of visitors and the provision of facilities.	
Ensure that adequate funding is available to provide and maintain a range of recreational opportunities and facilities.	Action not applicable to PGS. No Conflicts
Investigate the possibility for all accommodation (cottages, cabins and campgrounds) to be operated under lease by a contractor.	Action not applicable to PGS. No Conflicts
Monitor and ensure compliance with permit requirements	Action not applicable to PGS. No Conflicts
4.6.8 Information and Interpretation Provide information to visitors to enhance their experience and to ensure their behaviour does not compromise natural values.	
Develop an interpretation plan that will incorporate the following; upgrade visitor information facilities at Stenhouse Bay Headquarters, incorporating the new visitor centre and selected locations throughout the park; and appropriate interpretive material such as interpretive panels, brochures and other information. 4	Action not applicable to PGS. No Conflicts
4.7.1 Commercial Activities and Other Land-use (Tour Operators) Ensure that commercial tours provide quality visitor experiences that do not compromise park values or the experience of other visitors.	
Issue permits to commercial tourism operators, provide information, assistance and training to ensure they are able to offer quality experiences to their clients.	Action not applicable to PGS. No Conflicts
Monitor the impact of commercial tourism on park values.	Action not applicable to PGS. No Conflicts
4.7.2 Stenhouse Bay General Store, Tavern and Hall Manage all commercial leases in a manner that is mutually beneficial to all parties. Manage all commercial leases in a professional manner in accordance with government policy and practices to ensure governance and other legislative requirements are addressed.	
Monitor and regularly review lease conditions as required	Action not applicable to PGS. No Conflicts
Ensure assets are maintained in optimum condition	Action not applicable to PGS. No Conflicts
4.7.3 Bee Sites Progressively phase out bee sites within Innes National Park under the current agreed policy and management framework.	
Implement and monitor the current agreed Bee Site Policy for National Parks and Wildlife Act and Crown Lands Act Conservation Reserves (DEH 1997).	Action not applicable to PGS. No Conflicts
Utilise bee site lease fees to assist with management of reserves where the sites are located and to facilitate research.	Action not applicable to PGS. No Conflicts
Negotiate with existing lessee to progressively remove bee sites from the park.	Action not applicable to PGS. No Conflicts

Management Strategy	Assessment of impacts on management strategy
4.7.4 Leases and Licences Achieve effective, on-going partnerships with lessees that are mutually beneficial to all parties. Manage leases and licences in a professional manner in accordance with government policy and practices to ensure governance and other legislative requirements are addressed..	
Activity not relevant to PGS Activities – No conflicts	
4.7.5 Public Utilities Ensure that ongoing service of utilities is compatible with park values and that utilities are not impacted by park development and maintenance works.	
Maintain liaison with utility companies and periodically review maintenance programs.	Action not applicable to PGS. No Conflicts
Maintain accurate records of underground and overhead services to minimise damage through park maintenance and development work	Action not applicable to PGS. No Conflicts
4.7.6 Marine Navigation Aids Ensure that operation and maintenance of navaids within park boundaries does not compromise the values of the park.	
Continue the established partnership arrangements with the operators of navaid facilities within the park	Action not applicable to PGS
4.7.7 Mining	
Activity not relevant to PGS Activities – No conflicts	
4.8.1 Management Arrangements	
Activity not relevant to PGS Activities – No conflicts	
4.8.2 Community and Volunteer	
Activity not relevant to PGS Activities – No conflicts	

Source: Innes National Park Management Plan (DEH, 2003)

Note the following Parks do not have Management Plans:

- Gambier Islands Conservation Parks
- Sir Joseph Banks Group Conservation Park
- Tumby Bay Conservation Park

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of the Lincoln NP (DEH, 2005)

Context: NP: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
4.2 Natural Resources: Native Vegetation Protect vegetation associations and species of conservation significance.	
Integrate vegetation rehabilitation and habitat restoration programs with regional pest plant and feral animal control.	Action not applicable to PGS
Identify and monitor populations of plants of conservation significance and develop and implement management programs for their conservation if necessary.	Action not applicable to PGS
Continue revegetation where necessary to improve visitor amenity and address degraded vegetation.	Action not applicable to PGS
4.2 **Native Fauna:** Maintain and enhance where feasible the diversity of native fauna in the parks by the protection and enhancement of the quality and diversity of wildlife habitats. Ensure wildlife programs are based on best available knowledge and are implemented in consultation with wildlife specialists. Minimise human disturbances to wildlife.	
Collate information on species of conservation significance, monitor populations and if necessary, develop and implement management programs for their conservation	Action not applicable to PGS
Integrate regional pest plant and feral animal control with vegetation rehabilitation and habitat restoration, and where feasible, reintroduce locally extinct or endangered native animal populations.	Action not applicable to PGS
Promote the positive outcomes of the "Ark on Eyre" program in the parks to the wider community to encourage regional participation, maximising biodiversity outcomes	Action not applicable to PGS
Monitor population trends and impacts of Western Grey Kangaroos within the mainland parks and if necessary, reduce the kangaroo population to a sustainable level by targeted culling	Action not applicable to PGS
Monitor and manage the impact of recreational activities on key wildlife species (eg Hooded Plover, Osprey and White-bellied Sea-eagle).	PGS will liaise with NP to undertake monitoring. No conflicts
Continue the study of the Bush Stone-curlew to provide baseline population data for use as an indicator species to determine the success of the fox baiting program	Action not applicable to PGS
Encourage scientific research to enhance wildlife management	Action not applicable to PGS
4.2.5 Introduced Plants: Reduce the negative impacts of pest plants on wildlife habitats in the park. Prioritise pest plant programs to ensure maximum park and community benefit. Promote community understanding of pest plant impacts on the natural environment and encourage participation in regional programs.	

Management Strategy	Assessment of impacts on management strategy
Undertake, where practicable, control of invasive pest plant species as part of the regional integrated wildlife restoration programs.	Action not applicable to PGS
Continue the programs to eradicate African Boxthorn, Aleppo Pine and Myrtle-leaved Milkwort, Dolichos Vine, Horehound and Bridal Creeper from the park	Action not applicable to PGS
Monitor the effectiveness of weed eradication programs and implement new techniques when available.	Action not applicable to PGS
Increase awareness in the local community of the invasive nature of some ornamental garden plants (eg Myrtle-leaved Milkwort and Dolichos Vine) and encourage replacement with suitable indigenous species.	Action not applicable to PGS
Control non-invasive pest plant species in sites subject to disturbance.	Action not applicable to PGS
4.2.6 Introduced Pathogens Prevent the introduction and spread of Phytophthora cinnamomi in the reserve	
Comply with the provisions of the Threat Abatement Plan For Dieback Caused By The Root-Rot Fungus Phytophthora cinnamomi (Environment Australia, 2001)	No conflicts. PDS would adopt measures in the event of a spill.
Increase public and staff awareness of the potential for introduction and establishment of Phytophthora cinnamomi, the plant species susceptible to it and indicators of its presence	Action not applicable to PGS
Ensure that all soil is removed from all earth-moving and construction equipment entering the reserve, to reduce the risk of Phytophthora introduction.	Action not applicable to PGS
Provide boot-cleaning stations for track users if necessary.	Action not applicable to PGS
4.2.7 Introduced Animals Restore wildlife habitat and minimise the impacts of feral animals on the parks..	
Encourage the restoration of wildlife habitats by developing an integrated control program for pest plants and animals.	Action not applicable to PGS
Continue the program to eradicate rabbits, foxes and cats from mainland parks	
Investigate methods of feral bee control and initiate where appropriate.	Action not applicable to PGS
4.3.1 Aboriginal Heritage: Conserve and protect significant cultural heritage sites and provide appropriate interpretive material. Develop and strengthen Aboriginal involvement in Lincoln National Park. In conjunction with nominated Aboriginal representatives, protect and interpret Aboriginal culture and cultural sites	
Consult Barngarla/Nauo people who have a traditional association with the land, Native Title claimants and relevant State and Federal Aboriginal heritage authorities, in decisions regarding the management of Barngarla/Nauo cultural heritage and before proceeding with any significant development works within the reserve, obtain a cultural heritage survey from the appropriate authority, under the provisions of the Aboriginal Heritage Act 1988	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
In cooperation with the Department of Aboriginal Affairs and Reconciliation, the Heritage Branch of DEH and other relevant authorities and organisations, identify, record, protect, restore and monitor known or relocated sites and items of archaeological, anthropological, cultural and historical significance located in the park and establish a priority action list for site conservation. Barngarla/Nauo and historic cultural heritage sites require conservation plans to facilitate appropriate management.	Action not applicable to PGS
In consultation with the Barngarla/Nauo community, the Heritage Branch of DEH and other relevant authorities, research cultural and historic sites and stories that relate to the park. All sites should be recorded to the standards set by the Heritage Branch of DEH and/or DAARE and submitted for inclusion on either the DAARE Central Archive and/or the State Heritage Register.	Action not applicable to PGS
Where appropriate, develop interpretive material and tourism programs for visitors. Interpretive material may include web site, brochures, site signage and displays.	Action not applicable to PGS
With the assistance of the local Aboriginal people, identify all local Aboriginal community groups with an interest in Lincoln National Park. Contact, develop and support forums that achieve an ongoing dialogue with all groups.	Action not applicable to PGS
Continue to support Aboriginal interest in employment in park operations	Action not applicable to PGS
Seek comment and endorsement from Aboriginal people for all park literature containing reference to Aboriginal culture or sites.	Action not applicable to PGS
Upgrade Stamford Hill and walking trail facilities	Action not applicable to PGS
Continue to develop and maintain Donington Cottage for rental accommodation.	Action not applicable to PGS
4.4 Fire Management Manage fire to ensure the protection of life and property, the maintenance of biodiversity and the protection of natural, cultural and built values.	
Review the DEH Eyre District Fire Response Plan and Lincoln National Park Fire Management Plan as required in association with CFS and other stakeholders.	Action not applicable to PGS
Provide information about Park Fire Bans to visitors	Action not applicable to PGS
Maintain strategic fire breaks within the park.	Action not applicable to PGS
Provide campfire sites within the park and permit the use of fire only at these sites by visitors who have supplied their own fuel from outside the park.	Action not applicable to PGS
Investigate off-park fuel sources and develop a strategy to make this available to visitors.	Action not applicable to PGS
Prohibit the collection of firewood from the park.	Action not applicable to PGS
4.5 Recreation and Tourism: Provide appropriate vehicle access in Lincoln National Park.	
Restrict public vehicle access to the roads and tracks shown in Figure 3.	Action not applicable to PGS
Maintain the designated conventional access roads and upgrade if possible	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
Maintain all other designated vehicle access roads to a safe, satisfactory standard	Action not applicable to PGS
Close inappropriate vehicle tracks and rehabilitate where necessary.	Action not applicable to PGS
Monitor vehicle use and address public risk and environmental issues.	Action not applicable to PGS
4.5.2 Boat Access Ensure that beaches are managed in accordance with the National Parks and Wildlife Act and objectives of this plan.	
Ensure visitors who enter the park by boat comply with the National Parks and Wildlife Act, its Regulations and with the provisions of this plan.	Action not applicable to PGS
4.5.3 Walking Trails Provide and maintain appropriate walking trails within Lincoln National Park	
Develop and implement a Lincoln National Park Walking Trail Plan in consultation with the community..	Action not applicable to PGS
Provide signs for the trailhead of each walking trail and interpretive material where appropriate..	Action not applicable to PGS
• Monitor the use of walking trails to assist with future management.	Action not applicable to PGS
4.5.4 Entry & Camping Fees Provide effective means for the collection of entry and camping fees within Lincoln National Park	
Monitor and ensure compliance with the self-registration system at the Lincoln National Park entrance station	Action not applicable to PGS
Establish and maintain a database of visitor statistics	Action not applicable to PGS
Ensure that park visitors have adequate opportunity to purchase annual vehicle passes within the Port Lincoln township.	Action not applicable to PGS
Inform park visitors of projects funded through entry and camping fee revenue.	Action not applicable to PGS
4.5.5 Camping and Day Visit Areas Provide appropriate facilities at camping and day visit sites within Lincoln National Park..	
Maintain and improve existing camping and day visit areas within Lincoln National Park in accordance with Parks on Eyre: Lincoln and Coffin Bay National Parks Landscape and Facility Plan (DEH 2002).	Action not applicable to PGS
Undertake rehabilitation of camping and day visit areas where necessary.	Action not applicable to PGS
Operate Donington Cottage as rental accommodation for park visitors while taking its inherent heritage values into account	Action not applicable to PGS
Utilise revenue generated from Donington Cottage to maintain and improve the building and surrounds in keeping with its historic character.	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
4.6.1 Commercial Activities and Other Land-use Regulate commercial tours within the park to ensure their activities are compatible with park values and comply with the objectives of the National Parks and Wildlife Act 1972.	
Issue Commercial Licences to tour operators, subject to compliance with this plan and the provisions of the National Parks and Wildlife Act 1972.	Action not applicable to PGS
Utilise revenue generated from Commercial Licence fees to improve visitor services and facilities within the parks.	Action not applicable to PGS
4.6.2 Other Commercial Activities Regulate commercial activities within Lincoln National Park to ensure they are compatible with park values and comply with the objectives of this plan and the National Parks and Wildlife Act 1972.	
Issue Commercial Licences/Leases for commercial activities, subject to compliance with this plan and the provisions of the National Parks and Wildlife Act 1972.	If scientific monitoring occurs PGS will comply with these requirements. No Conflicts.
Issue Commercial Filming Agreements for filming and photography within Lincoln National Park where appropriate.	Action not applicable to PGS
Utilise revenue generated from commercial licence fees to improve visitor services and facilities within Lincoln National Park	Action not applicable to PGS
4.6.3 Public Utilities Ensure that SA Water, ETSA and Department of Transport have regard to DEH policies and the Regulations under the National Parks and Wildlife Act 1972. Ensure that maintenance of the marine navigation aids does not impact negatively on the natural assets of the parks. Have regard to leases conditions and the DEH shack site policy for national parks and reserves.	
Require SA Water and ETSA Utilities to obtain licences for the maintenance of infrastructure and access to facilities which exist on parks but are not subject to existing easements or agreements.	Action not applicable to PGS
Ensure relevant authorities liaise with DEH with regard to the maintenance of marine navigation aids.	Action not applicable to PGS
4.3.4 Aquaculture Minimise the impacts of aquaculture activities on park values.	
Liaise with PIRSA (Aquaculture) and the aquaculture industry to assist with the appropriate implementation of the Lower Eyre Peninsula Aquaculture Management Plan (PIRSA 1997 and as amended).	Action not applicable to PGS
Review new applications for aquaculture tenure and monitor the impacts of existing aquaculture to ensure there is minimal impact upon the biological and scenic values of Lincoln National Park.	Action not applicable to PGS
4.7.1 Management Arrangements	
Not Relevant to PGS	

Management Strategy	Assessment of impacts on management strategy
4.7.2 Community and Volunteer Develop and encourage community support for management of Lincoln National Park.	
Provide opportunities for volunteer and community groups by facilitating the implementation of programmed activities.	Action not applicable to PGS

Source: Lincoln National Park Management Plan (DEH, 2004)

Note the following Parks do not have Management Plans:

- Gambier Islands Conservation Parks
- Sir Joseph Banks Group Conservation Park
- Tumby Bay Conservation Park

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of the Memory Cover WPA (DEH, 2005)

Context: WPA: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
4. **Wilderness Protection:** Maximise the wilderness quality of the reserve..	
Manage the reserve in accordance with the Wilderness Code of Management	Action not applicable to PGS
5.1 **Native Vegetation:** Maintain and restore natural processes, communities and habitats. Prevent the introduction and spread of Pc in the wilderness protection area	
Survey, identify, monitor and develop action plans for threatened flora and vegetation communities within the reserve	Action not applicable to PGS
Continue to promote awareness among DEH staff and the wider community of the potential for introduction and establishment of Pc, the plant species susceptible to it and indicators of its presence.	Action not applicable to PGS
Undertake a Pc survey of the wilderness protection area and continue to repeat this survey periodically. Programs should be put in place to contain this pathogen and to restrict the movement of visitors and management of staff through infected areas	Action not applicable to PGS
5.2 Native Fauna: Maintain and restore natural processes, communities and habitats.	
Identify, monitor and develop action plans for rare, vulnerable and endangered species	Action not applicable to PGS
Use the reserve for the reintroduction of rare or endangered species.	Action not applicable to PGS
Monitor the population of Western Grey Kangaroos, and if necessary reduce the kangaroo population to a sustainable level by targeted culling, as part of control programs within Lincoln National Park	Action not applicable to PGS
Monitor the population of the Australian Sea-lion on Hopkins Island.	Action not applicable to PGS
5.3 Introduced Plants Control and eradicate, where possible, all introduced flora already established within the reserve that impact on the wilderness and biodiversity values. Prevent the establishment of introduced flora within the reserve where possible..	
Survey and monitor the extent of weeds in the reserve	Action not applicable to PGS
Undertake control measures for eradicating weed infestations, in particular Box Thorn and Hore Hound, using methods that do not impact on the wilderness values of the reserve.	Action not applicable to PGS
5.4 Introduced Animals Control and eradicate, where possible, all introduced fauna established within the reserve that significantly impacts on the wilderness and biodiversity values.	

Management Strategy	Assessment of impacts on management strategy
Monitor the impact of introduced fauna on wilderness and biodiversity values and develop and implement control program.	Action not applicable to PGS
Continue fox baiting in accordance with regional programs and monitor the results.	Action not applicable to PGS
5. Managing Fire Manage fire to ensure the protection of life and property, the maintenance of wilderness and biodiversity, and the protection of natural, cultural and built values	
Develop, implement and review the fire management plan in accordance with the Wilderness Code of Management, and in association with CFS and other stakeholders	Action not applicable to PGS
Continue to work with the relevant District Bushfire Prevention Committee and CFS to minimise risk to life and property within and surrounding the reserve.	Action not applicable to PGS
To limit the introduction of Pc into the wilderness protection area as a result of fighting fires, vehicles, plant and equipment used during the fire suppression methods will undergo Pc hygiene practices as per DEH policy prior to entering the wilderness protection area.	Action not applicable to PGS
Where possible, undertake fire-fighting activities in the Lincoln National Park	Action not applicable to PGS
7.1 Indigenous Heritage: Ensure that any Aboriginal sites, objects and remains are protected and preserved in accordance with the Aboriginal Heritage Act 1988.	
Consult with the traditional owners in decisions regarding the management of Aboriginal heritage in the reserve.	Action not applicable to PGS
Identify and protect any Aboriginal sites, objects and remains in cooperation with the traditional owners, DAARE, and relevant authorities	Action not applicable to PGS
In consultation with the traditional owners, submit Aboriginal sites, objects and stories that relate to the reserve for inclusion on the DAARE Central Archive.	Action not applicable to PGS
7.2: Non-indigenous Heritage Conserve and protect significant European cultural heritage sites.	
Identify, record, protect, restore, conserve and monitor sites of non-indigenous cultural and historical significance located in the reserve in cooperation with the Heritage branch of DEH.	Action not applicable to PGS
8.1 Managing Visitor Access: Minimise the impact of all forms of visitor access on the wilderness quality of the park. Provide walking opportunities for visitors to enjoy the natural values of the reserve consistent with maintaining wilderness quality. Review public risk issues associated with public access into the park.	
Close the track to West Point to vehicle access for visitor safety reasons, and maintain the remaining four-wheel drive tracks to their current standard	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
Maintain existing walking trails.	Action not applicable to PGS
Monitor all visitor access to assist with future management.	Action not applicable to PGS
Continue to permit boats to anchor at Memory Cove and Williams Island, in accordance with the Wilderness Protection Regulations 1992	Action not applicable to PGS
Continue to permit recreational fishing, in accordance with the Wilderness Protection Regulations 1992.	Action not applicable to PGS
8.2 Visitor Activities and Facilities Review the standard of camping for the enjoyment of visitors.	
Redesign the existing camp ground to a more accessible and useable camp ground for visitors.	Action not applicable to PGS
Install an information sign at the boat ramp to inform people of the dangers associated with fire, of the areas total fire ban, and to reinforce that only gas stoves are permitted in the area.	Action not applicable to PGS
8.3 Commercial Tourism: Provide for the use of the reserve by approved, licensed tourism operators	
Issue licenses for approved commercial tourism operators to bring visitors to the reserves and, by agreement, permit parties to visit selected locations.	Action not applicable to PGS
Ensure all commercial tour operators conducting tours in the wilderness protection area comply with the Minimum Impact Code for visitors to wilderness areas.	Action not applicable to PGS
Regulate the number of commercial tours in the wilderness protection area to ensure that the enjoyment of visitors is not compromised	Action not applicable to PGS
8.4 Information and Interpretation: Promote the understanding of the reserve's role in conservation.	
Provide interpretive information for visitors that enhances the importance of wilderness, but does not impact on the wilderness quality of the area, including maintaining the self-guided tour currently in use.	Action not applicable to PGS
Only install signs that are necessary to assist with visitor risk management or essential management operations within the reserve.	Action not applicable to PGS
9.1 Managing Infrastructure Maintain infrastructure that is necessary for reserve management, and visitor safety and enjoyment.	
Undertake regular maintenance of interpretive and risk management signs and fencing.	Action not applicable to PGS
9.2 External Influences Ensure that external influences do not negatively impact on the wilderness values of the wilderness protection area.	
Where possible, undertake essential management operations in Lincoln National Park.	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
Monitor activities in the waters surrounding the Memory Cove Wilderness Protection Area and their impact on the wilderness qualities of the land.	Action not applicable to PGS
9.3 Research Only undertake research that will not affect the wilderness quality of the area, and that will assist in the implementation of the management plan	
Allow for access to undertake geological and biodiversity research and investigations, for the purpose of implementing the objectives stated in this management plan, which do not impact on the wilderness quality of the area.	If scientific monitoring occurs PGS will comply with these requirements. No Conflicts.
Allow for access to undertake geological and biodiversity research and investigations that can not be carried out elsewhere, and that will not affect the wilderness quality of the area.	Action not applicable to PGS
9.4 Public Utilities Ensure that maintenance of the beacon does not impact on the wilderness or wildlife on Williams Island.	
Liaise with the Australian Maritime Safety Authority regarding access to Williams Island and the maintenance of the beacon	Action not applicable to PGS
Ensure that the Australian Maritime Safety Authority is kept informed of relevant wilderness and wildlife issues which may affect the maintenance of the beacon.	Action not applicable to PGS
10. Involving the Community Maintain partnerships with Friends and other volunteer groups to assist with the management of the wilderness protection area and help fulfil the reserve's potential without compromising its natural values	
Consult with the local council, relevant management boards, the local community and other relevant bodies to explore the benefits of partnership arrangements that will support future management decisions on issues of common interest.	Action not applicable to PGS
Encourage and contribute to the development of partnership arrangements to integrate biodiversity and recreation management in the region, with organisations that have an interest in contributing to the sustainable management of the reserve.	Action not applicable to PGS
Provide opportunities for volunteer and community groups to assist in the management and monitoring of the reserve by facilitating the implementation of programmed activities.	Action not applicable to PGS

Source: Memory Cove Wilderness protection Area Management Plan (DEH, 2005)

Note the following Parks do not have Management Plans:

- Gambier Islands Conservation Parks
- Sir Joseph Banks Group Conservation Park
- Tumby Bay Conservation Park

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of Vivonne Bay CPs (NPWS, 1988)

Context: CP: Low Levels Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
OBJECTIVES: 1. Conserve the native vegetation and native fauna of the park 2. Control wildfires in the park and protect park from fire, 3. Limit the impact on the park of the Council rubbish dump on a portion of the Section 106. 4. Limit the impact on the park of housing development adjacent to Point Ellen. 5. Inform the public of the existence of the park. 6. Limit public access to the park to foot traffic only.	
ACTIONS:	
1. Construct a fire access track along the northern boundary in the park.	Action not applicable to PGS. No conflict.
2.Maintain existing fencing in good repair	Action not applicable to PGS. No conflict.
3. Construct a fence around the existing Council rubbish dump to prevent windblown rubbish entering the park and ultimately relocate the rubbish dump outside the park.	Action not applicable to PGS. No conflict.
4. Construct a fence along the park boundary adjacent to the housing development at Point Ellen	Action not applicable to PGS. No conflict.
5. Erect a name sign and Conservation Park sign near the Point Ellen car parking area and triangular Reserve signs along the roadside adjacent to Section 106.	Action not applicable to PGS. No conflict.
6. Close existing 4 wheel drive track along Sections 107, 108, and 109 to use by public vehicles and convert to a walking track.	Action not applicable to PGS. No conflict.
7. Erect signpost at the start of the walking track indicating its length.	Action not applicable to PGS. No conflict.
8. Monitor the impact of visitors on the park environment.	Action not applicable to PGS. No conflict.
9. Undertake research to obtain more detailed baseline data on the park's fauna, vegetation and ecology.	Action not applicable to PGS. No conflict.
10. Establish whether the rare species Achnophera tatei grows within the parks and take steps to ensure their populations within and outside the park are adequately conserved.	Action not applicable to PGS. No conflict.
11. Implement the fire protection plan	Action not applicable to PGS. No conflict.
12. Investigate adjoining uncleared land for possible purchase and addition to the park.	Action not applicable to PGS. No conflict.

Source: Conservation Parks of Kangaroo Island Management Plan (NPWS, 1988)

Assessment of the Duntroon 850 m^3 MDO spill against the stated objectives of the Conservation Parks of the Western Eyre Peninsula (DEH, 2006)

Context:

Waldegrave Island CP: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Investigator Group CP: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Cap Island CP: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Greenly Island CP: Possible sheens >10µm MDO intersection and medium level entrained phase hydrocarbons, no shoreline accumulation, scientific monitoring potential

Rocky Island North: Sheens and Low Level Entrained Hydrocarbons, no shoreline accumulation, scientific monitoring potential

Rocky Island South: Possible sheens >10µm MDO intersection and medium level entrained phase hydrocarbons, no shoreline accumulation, scientific monitoring potential

Management Strategy	Assessment of impacts on management strategy
5.1 **Geology, Soils & Landform:** Protect and maintain soils through the management of native flora, and by controlling the impacts of invasive plants, animals and human activities.	
Take soil stability into account when planning for and undertaking management activities	Action not applicable to PGS
5.2 **Native Vegetation:** Protect vegetation associations and undertake actions necessary for the conservation of significant species where necessary	
Monitor recruitment of native vegetation on islands where historic clearing has occurred.	Action not applicable to PGS
Identify and monitor populations of rare and endangered plant species. Develop and implement plans, if required, for their conservation	Action not applicable to PGS
Encourage research into impacts of herbivory by native and introduced species on vegetation, and implement remedial management programs where necessary.	Action not applicable to PGS
Encourage research into the impacts of the accidental introductions of Pearson Island Black-footed Rock-wallabies to Central and South Pearson Islands.	Action not applicable to PGS
Ensure that raw materials brought onto the islands are free of Phytophthora and that vehicles, equipment and footwear are clean.	PGS will observe requirements if scientific monitoring from a spill is required. No conflicts.
Opportunistically re-photograph from established photo points to assist ongoing management of vegetation	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
5.3 Native Fauna: Protect the breeding and haul-out habitats of the Australian Sea-lion and the New Zealand Fur seal and minimise the threats and disturbance factors for Sea-lions and Fur-seals. Conserve key threatened species through the protection of breeding areas and important habitat. Encourage research into dynamics of populations of threatened species, including genetic variability, for their ongoing management.	
Restrict access to seal breeding sites during the breeding season to keep pup mortality rates as low as possible	Action not applicable to PGS
Encourage research to refine knowledge of the basic biology, genetic structure, distribution, behaviour and movements and resource requirements (e.g. critical habitat) of populations.	Action not applicable to PGS
Assist with the recovery of Australian Sea-lions and New Zealand Fur-seals through assisting with relevant educational and management initiatives outlined in The Action Plan for Australian Seals and other plans and programs.	Action not applicable to PGS
Develop and implement management programs for protected species.	Action not applicable to PGS
Monitor all populations of Greater Stick-nest Rats, Brush-tailed Bettongs, Southern Brown Bandicoots and the Pearson Island population of Black-footed Rock Wallabies	Action not applicable to PGS
Avoid disturbance during breeding periods, especially for the White-bellied Sea-eagle, and restrict access to sites where necessary.	Action not applicable to PGS
Monitor the impact of Silver Gull populations on breeding colonies.	Action not applicable to PGS
Monitor reptile populations to establish trends in populations over time, threatening processes and other ecological aspects of the species	Action not applicable to PGS
Encourage research into the effect on native vegetation of the introduced Tammar Wallaby population on Greenly Island and future management strategies	Action not applicable to PGS
Increase community awareness of species and their conservation requirements	Action not applicable to PGS
Encourage research into island biogeography and evolution, including genetic variability for restocking purposes.	Action not applicable to PGS
Encourage research into the distribution and status of marine fauna within close proximity of the park boundaries.	Action not applicable to PGS
5.4 Introduced Plants Control exotic plants within the parks, especially those known to invade native vegetation.	
Control African Boxthorn on St Peter Island to prevent infestations to areas of native vegetation	Action not applicable to PGS
Map the locations of invasive pest plants as an integral part of vegetation mapping in the reserves, undertaking control if required.	Action not applicable to PGS
Fulfil the obligations of the Natural Resources Management Act 2004 and investigate funding opportunities to support pest plant control.	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
Ensure that visitors to the islands are aware of protocols to avoid weed dispersal	PGS will observe requirements if scientific monitoring from a spill is required. No conflicts.
5.5 Introduced Animals Control and manage introduced fauna within the Island Parks of Western Eyre Peninsula	
Monitor introduced animal populations within the parks and devise control programs in accordance with priorities, taking into account the benefits to biodiversity versus the costs of possible adverse impacts on native wildlife and other off-target impacts of such programs.	Action not applicable to PGS
Monitor the impacts of introduced fauna on the islands, including herbivory, seed dispersal and competition for resources with native wildlife.	Action not applicable to PGS
Provide information on the adverse impacts of introduced animals to increase community awareness.	Action not applicable to PGS
5. Managing Fire Manage fire to ensure the maintenance of biodiversity and the protection of natural, cultural and built values	
Monitor the incidence of fire and impacts on fauna habitats.	Action not applicable to PGS
Re-sample and photograph fire monitoring photo points on North Pearson Island opportunistically and lodge data with DEH	Action not applicable to PGS
7.1 Indigenous Heritage: Conserve and protect significant Aboriginal cultural heritage sites. Develop and strengthen Aboriginal involvement in the Island Parks of the Western Eyre Peninsula area.	
Consult with the traditional owners in decisions regarding the management of Aboriginal heritage	Action not applicable to PGS
Identify and protect any Aboriginal sites, objects and remains in cooperation with the traditional owners, DAARE and relevant authorities.	Action not applicable to PGS
In consultation with the traditional owners, submit Aboriginal sites and stories that relate to the parks for inclusion on the DAARE Central Archive.	Action not applicable to PGS
Seek local Aboriginal community support to improve DEH staff understanding of local Aboriginal people's traditional association with the parks and their surrounding areas.	Action not applicable to PGS
7.2: Non-indigenous Heritage Gain a better understanding of the extent of non-indigenous heritage within the Island Parks of Western Eyre Peninsula	
Survey and document sites of cultural heritage significance with emphasis on the location and protection of early sealing and whaling sites.	Action not applicable to PGS
Manage, stabilise or restore buildings on St Peter, St Francis and Franklin Islands as deemed necessary	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
8.1 Managing Visitor Access: Minimise visitor impacts on islands, while ensuring that reasonable access is provided to the islands in a way that does not compromise natural values or the objectives of the management plan	
Monitor access to islands to ensure that natural values are not compromised.	Action not applicable to PGS
Monitor numbers of visitors, their impacts and personal interests for future management.	Action not applicable to PGS
Maintain the existing 4WD tracks on St Peter Island.	Action not applicable to PGS
Areas of high conservation value within Nuyts Archipelago and Isles of St Francis Conservation Parks should be prohibited to tourism activities.	Action not applicable to PGS
Declare Jones Island a Prohibited Area	Action not applicable to PGS
8.2 Visitor Activities and Facilities Ensure appropriate visitor access to island parks is maintained while ensuring conservation values are not compromised	
Restrict visitor use of the islands to those in the Nuyts Archipelago, and manage accordingly.	Action not applicable to PGS
Educate the public to the dangers of venomous snakes on many of the islands of Nuyts Archipelago	Action not applicable to PGS
Maintain the visitor infrastructure on St Peter Island to provide opportunities for minimal impact tourism.	Action not applicable to PGS
Monitor impacts caused by recreational fishers and promote awareness of the possible dangers to animal populations	Action not applicable to PGS
8.3 Commercial Tourism: Regulate commercial tours within the parks to ensure their activities are compatible with park values and comply with the objectives of the National Parks and Wildlife Act 1972 and this management plan	
Promote awareness amongst tour operators and encourage communication with DEH staff	Action not applicable to PGS
Issue Commercial Licences to tour operators, subject to compliance with this plan and the provisions of the National Parks and Wildlife Act 1972.	Action not applicable to PGS
9.1 Aquaculture and Commercial Fishing: Ensure that aquaculture activities do not compromise park values.	
Liaise with PIRSA (Aquaculture) and the aquaculture industry to assist with the appropriate implementation of the Lower Eyre Peninsula Aquaculture Management Plan and its amendments.	Action not applicable to PGS
Review new applications for aquaculture tenure outside of the parks and monitor the impacts of existing aquaculture to ensure there is minimal impact upon the biological values of the parks	Action not applicable to PGS
Encourage aquaculture farming to incorporate a buffer zone around park boundaries to minimise risk of harmful interactions with seal and sea lion breeding colonies	Action not applicable to PGS

Management Strategy	Assessment of impacts on management strategy
Assess applications for commercial fishing within park boundaries on a case by case basis	Action not applicable to PGS
9.2 Exploration and Mining Ensure that park values are not compromised by any exploration or mining activities	
Prohibit access to all islands in this management plan for any activities associated with exploration and mining.	Action not applicable to PGS
9.3 Leases and Licences Ensure that the shack site on St Peter Island does not compromise park values.	
Enforce shack lease covenants for the term of the lease.	Action not applicable to PGS
9.4 Public Utilities Ensure that maintenance of marine navigation aids does not impact negatively on the natural assets of the parks	
Ensure relevant authorities liaise with DEH with regard to the maintenance of marine navigation aids.	Action not applicable to PGS
Liaise with AMSA and TSA to minimise affect on wildlife during servicing of infrastructure (eg avoid servicing during breeding seasons).	Action not applicable to PGS
9.5 Management Infrastructure Maintain infrastructure necessary for effective park management.	
Maintain the homestead, shack and sheds on St Peter and Franklin Island as required for ongoing management purposes.	Action not applicable to PGS
10. Involving the Community Develop and encourage community support for the management of island parks off the western Eyre Peninsula	
Provide opportunities for volunteers and community groups by facilitating the implementation of programmed activities.	Action not applicable to PGS
Encourage research into the natural and cultural heritage of the island parks.	Action not applicable to PGS
Involve representative Wirangu and Nauo Aboriginal traditional owners in the management of the park and in the preservation of their cultural heritage.	Action not applicable to PGS
11. Managing Reserve Tenure	
No Items Relevant to PGS	

Source: Island Parks of Western Eyre Peninsula Management Plan (DEH, 2006)

Note the following Parks do not have Management Plans:

- Gambier Islands Conservation Parks
- Sir Joseph Banks Group Conservation Park
- Tumby Bay Conservation Park