ConocoPhillips

Sequoia 3D Marine Seismic Survey Environment Plan

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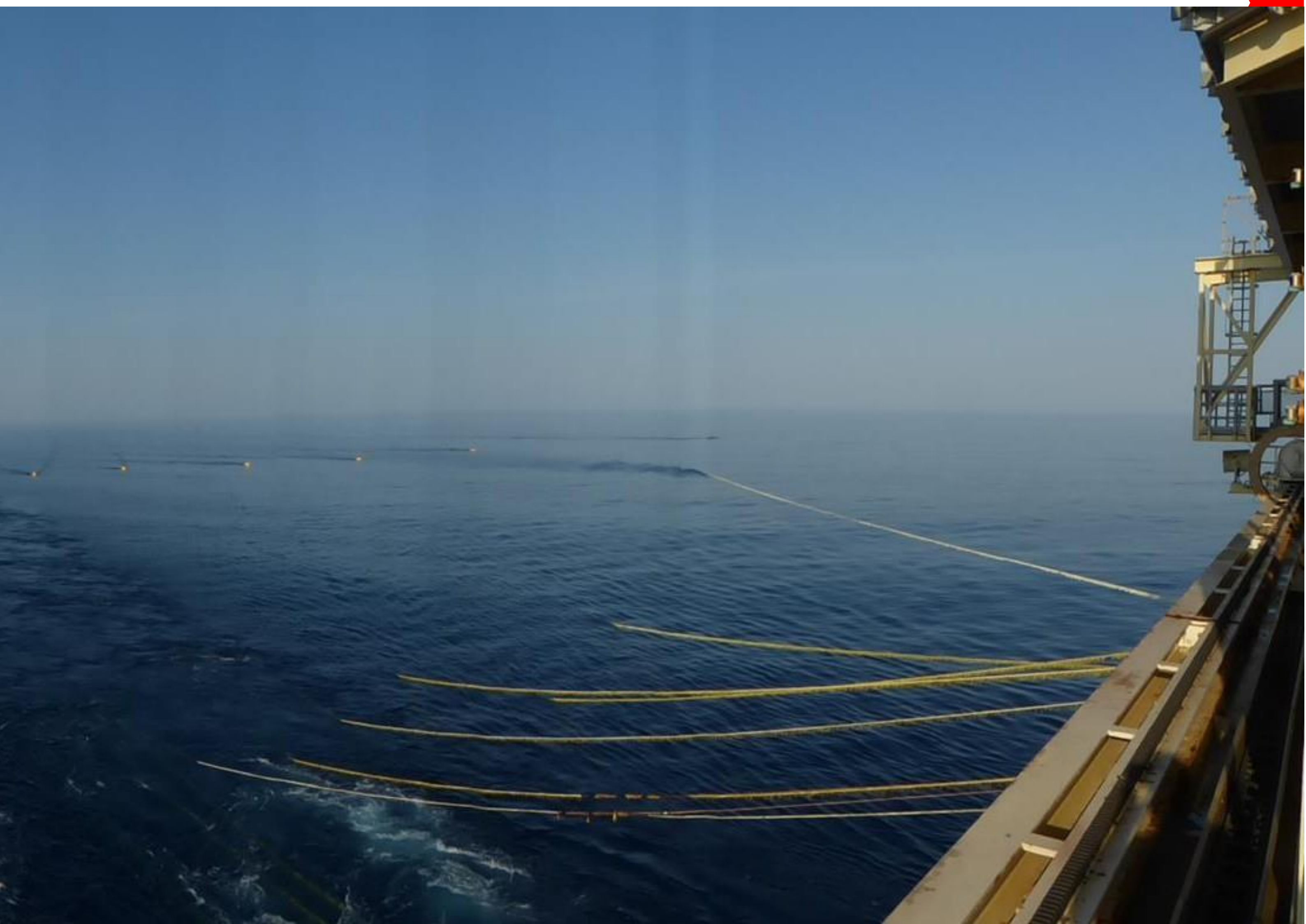

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Abbreviations

Acronym	Definition
2D	Two-dimensional
3D	Three-dimensional
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHO	Australian Hydrographic Office
AIS	Automatic Identification System
ALA	Atlas of Living Australia
ALARP	As Low As Reasonably Practicable
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
APASA	Asia-Pacific Applied Science Associates
APPEA	Australian Petroleum Production and Exploration Association
ASBTIA	Australian Southern Bluefin Tuna Industry Alliance
Bar(g)	Gauge pressure
BAT	Best Available Technique/s
BIA	Biologically important areas

BPEM	Best Practice Environmental Management
BSCZSF	Bass Strait Central Zone Scallop Fishery
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CAMBA	China-Australia Migratory Bird Agreement
CASA	Civil Aviation Safety Authority
CCTV	Closed Circuit Television
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973
CM&ER	Crisis Management and Emergency response
CMT	Crisis Management Team
CO_2	Carbon dioxide
CoEP	APPEA Code of Environmental Practice
Cth	Commonwealth
CSI	ConocoPhillips' Compressive Seismic Imaging (CSI) technology
CTS	Commonwealth Trawl Sector
DAWE	Department of Agriculture, Water and the Environment (Cth)
DCV	Domestic Commercial Vessels
DELWP	Department of Environment, Land, Water and Planning
DIRD	Department of Infrastructure and Regional Development
DJPR	Department of Jobs, Precincts and Regions (Vic)
DELWP	Department of Environment, Land, Water and Planning (Vic)
DoD	Department of Defence
DoEE	Department of the Environment and Energy (Cth) (former)
DPIPWE	Department of Primary Industries, Parks, Water and Environment
EIA	Environment Impact Assessment
EMAC	Eastern Maar Aboriginal Corporation
EMBA	Environment that May Be Affected
EMT	Emergency Management Team
ENVID	Environmental Identification
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Cth)
EPIRB	Emergency Position Indicating Radio Beacon
EPO	Environmental Performance Objectives

EPS	Environmental Performance Standards
ERA	Environmental Risk Assessment
ERP	Emergency Response Plan
ESD	Ecologically Sustainable Development
ESD	Emergency Shutdown
FFG Act	Flora and Fauna Guarantee Act 1988 (Vic)
GHaT	Gillnet Hook and Trap
GHG	Greenhouse Gas
GPS	Global positioning system
HAZID	Hazard Identification
HSE	Health Safety and Environment
HSEMS	Health, Safety and Environment Management System
IAGC	International Association of Geophysical Contractors
IAP	Incident Action Plan
IAPP	International Air Pollution Prevention Certificate
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IMO	International Maritime Organization
IOGP	International Association of Oil & Gas Producers
ISO	International Standards Organisation
ISPP	International Sewage Pollution Prevention
ITOPF	International Tanker Owners Pollution Federation Limited
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
JIP	IOGP's Joint Industry Programme
KEF	Key Ecological Features
LGA	Local Government Authority
LoC	Loss of Containment
LPG	Liquefied Petroleum Gas
MARPOL	IMO International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)
MDO	Marine Diesel Oil
MMO	Marine Mammal Observer
MNES	Matters of National Environmental Significance
MNP	Marine National Park

MO	Marine Orders
MOC	Management of Change
MP	Marine Park
MPa	Megapascal(s)
MRT	Mineral Resources Tasmania
MSs	Marine Seismic Survey
NatPlan	Australian National Plan for Maritime Environmental Emergencies
NCVA	National Conservation Values Atlas
NEBA	Net Environmental Benefits Analysis
NGO	Non-governmental Organisations
NIW	Nationally important wetlands
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administration
NP	National Park
NSW	New South Wales
NTM	Notice to Mariners
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone depleting substances
OEM	Original Equipment Manufacturer
OIW	Oil In Water
OPEP	Oil Pollution Emergency Plan
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Cth) & 2009 (Vic)
OPGGS(E)	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth)
OPGGS Regulations	Offshore Petroleum and Greenhouse Gas Storage Regulations 2011 (Vic)
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
POWBONS	Pollution of Waters by Oil and Noxious Substances Act 1986
PPE	Personal Protective Equipment

PTS	Permanent Threshold Shift
PTW	Permit To Work
RGPS	Relative Global Positioning System
RO	Reverse Osmosis
ROKAMBA	Republic of Korea–Australia Migratory Birds Agreement
SIV	Seafood Industry Victoria
SEL	Sound Exposure Level
SESSF	Southern and Eastern Scalefish and Shark Fishery
SETFIA	South East Trawl Fishing Industry Association
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	Short message Service
SPL	Sound Pressure Level
SRL	Southern Rock Lobster
SPRAT	Species Profile and Threats (database)
SRD	Streamer Retrieval Devices
SSJF	Southern Squid Jig Fishery
SST	Sea Surface Temperature
STLM	Sound Transmission Loss Modelling
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TARFish	Tasmanian Association for Recreational Fishing
TasPlan	Tasmanian Marine Oil and Chemical Spill Contingency Plan
TEC	Threatened Ecological Community
TICT	Tourism Industry Council of Tasmania
TRLFA	Tasmanian Rock Lobster Fisheries Association
TSIC	Tasmanian Seafood Industry Council
TTS	Temporary Threshold Shift
TRSC-SSSV	Tubing Retrievable Surface Controlled Sub-Surface Safety Valve
UHF	Ultra-High Frequency
VBA	Victorian Biodiversity Atlas
VFA	Victorian Fishing Authority
VHF	Very High Frequency
Vic	Victoria
VicPlan	Victorian State Maritime Emergencies (Non-search and Rescue) Plan

VRLA	Victorian Rock Lobster Fishing Association
WA	Western Australia

Units of Measurement

Acronym	Definition
cui	cubic inches
km	kilometres
m	Metre
M	million
nm	nautical mile
psi	Pounds per square inch

1. Introduction

ConocoPhillips Australia SH1 Pty Limited ('ConocoPhillips Australia') and 3D Oil T49P Pty Limited ('3D Oil') are proposing to undertake the Sequoia three-dimensional (3D) marine seismic survey (MSS) within Exploration Permit T/49P in the Otway Basin to investigate the potential to develop the gas prospects (Figure 1.1).

The content of this Environment Plan (EP) has been developed to address the elements required by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 ('OPGGS(E)'), following the Guideline for Environment Plan summaries (N04750-GL1566) released by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) on 17 April 2019.

1.1. Objectives of this EP

The objective of this EP is to demonstrate that the proposed activity meets the criteria of acceptance as defined by Regulation 10A of the OPGGS(E).

As required by Regulation 6 of the OPGGS(E), ConocoPhillips Australia will only undertake this offshore petroleum activity in compliance with the accepted EP.

1.2. Scope of this EP

This EP applies to a defined 'petroleum activity.' ConocoPhillips Australia defines this petroleum activity as:

The acquisition of seismic data by a survey vessel within the Sequoia acquisition area (Section 2.2) and any other activity immediately prior to or directly after the acquisition that is required to acquire seismic data that takes place within the operational area.

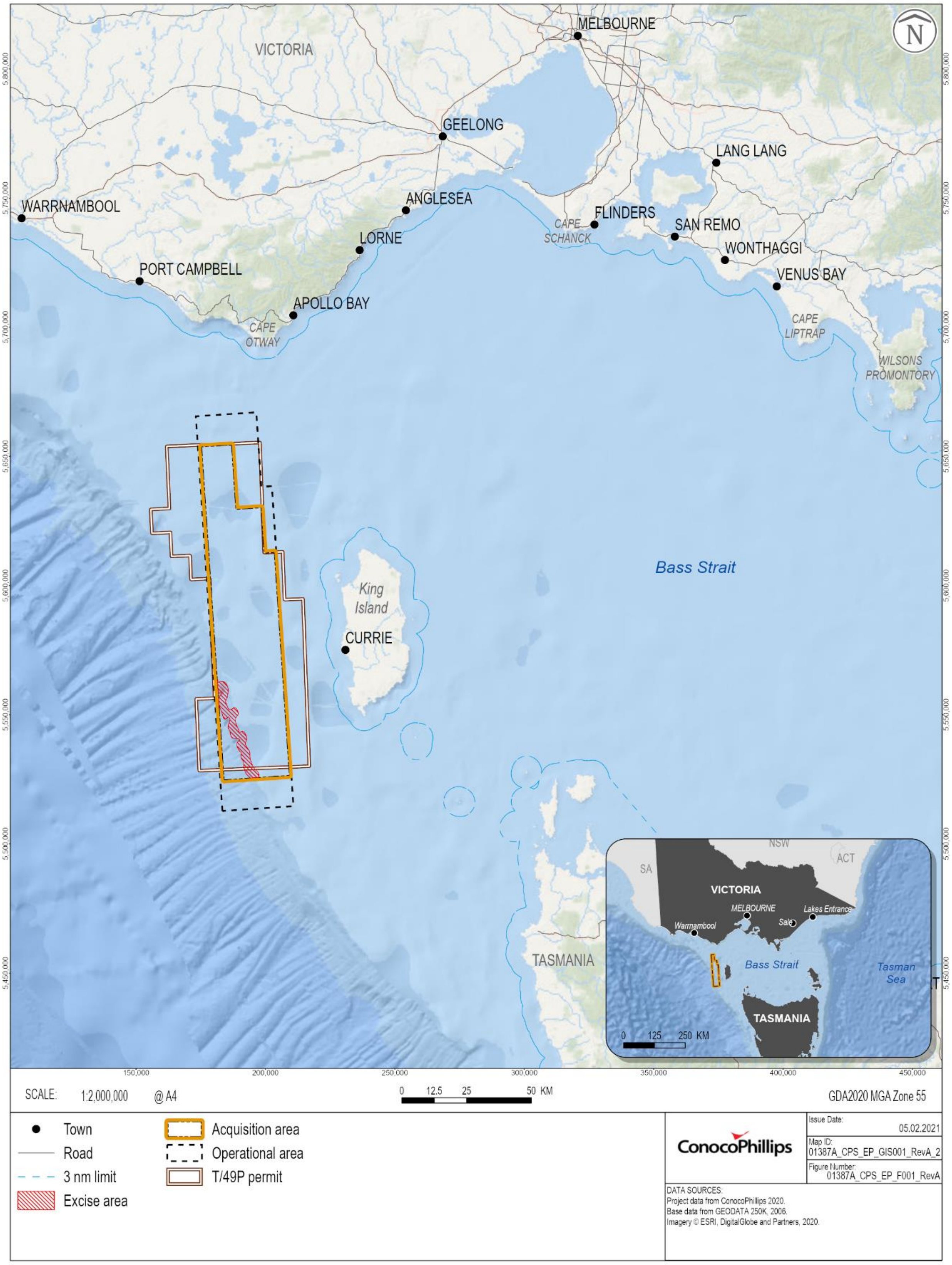
For the purposes of this EP, activities performed by the survey vessel when it is outside the operational area (e.g., transiting to or from location) are not covered by the OPGGS(E) and are therefore not addressed in this EP.

The activity is alternately referred to as the 'activity' or the 'survey' throughout this EP.

The activity occurs entirely within Commonwealth waters and this EP has been prepared to satisfy the requirements of Part 2 of the OPGGS(E), administered by NOPSEMA.

The EP describes emergency management arrangements and systems in place to manage these risks. Additionally, there will be survey contractor and vessel-specific documents that will interface with this EP, including the survey vessel-specific Shipboard Marine Pollution Emergency Plan (SMPEP) or equivalent.

Figure 1.1 Location of the Sequoia 3DMSS



1.3. EP Content

This EP includes a description of:

- The nature of the activity (location, layout, operational details);
- The legislative framework relevant to the activity;
- Stakeholder consultation activities;
- The environment affected by the activity;
- Environmental impacts and risks;
- Mitigation and management measures;
- Environmental performance outcomes, standards and measurement criteria;
- How impacts and risks will be reduced to be an acceptable level and be ALARP;
- The implementation strategy to ensure that the environmental impacts and risks are managed in a systematic manner; and
- Reporting arrangements.

1.4. T/49P Permit Background

3D Oil was initially granted the exploration permit T/49P in May 2013 and transferred it to 3D Oil T/49P Pty Limited in December 2013. T/49P covers an area of 4,960 km2 in water depths generally no greater than

150 m. The permit is lightly explored, covered by a broad grid of 2D seismic data of varying vintages and has two early exploration wells.

In January 2019, 3D Oil submitted its EP for the proposed Dorrigo 3DMSS in T/49P to NOPSEMA for approval. The EP was accepted by NOPSEMA in May 2019, but the survey did not proceed.

ConocoPhillips Australia farmed into an 80% share of T/49P with 3D Oil in March 2020, which was registered in June 2020. 3D Oil retains the remaining 20% share. Under the Joint Operating Agreement with 3D Oil, ConocoPhillips Australia is the operator of T/49P and responsible for preparing this EP.

1.5. The Titleholders

1.5.1. ConocoPhillips Australia

ConocoPhillips Australia SH1 Pty Limited (ConocoPhillips Australia) is a subsidiary company of ConocoPhillips Company (United States entity). ConocoPhillips is one of the world's largest independent exploration and production companies, with operations and activities in 16 countries, $63 billion of total assets, and approximately 9,700 employees as of June 30, 2020.

ConocoPhillips is committed to the efficient and effective exploration and production of oil and natural gas. Producing oil and natural gas and getting them to market takes ingenuity, technology and investment. Our innovative, collaborative efforts yield products that improve quality of life globally while producing economic benefits with far-reaching influence.

ConocoPhillips in Australia was established almost 20 years ago. Headquartered in Brisbane, Queensland, it is a 37.5% shareholder in Australia Pacific LNG and operator of the LNG facility on Curtis Island, Gladstone.

Until the recent sale to Santos in early 2020, ConocoPhillips had exploration activities, and operated assets in the Timor Sea, Northern Territory (NT) and Western Australia (WA). ConocoPhillips managed the operation of the Bayu-Undan gas condensate field in the Timor Sea, the Darwin liquified natural gas (DLNG) facility in the NT and the 502 km pipeline linking the two facilities. ConocoPhillips has also safely and successfully completed exploration and appraisal activities in its offshore acreage, including the Bonaparte Basin (Barossa appraisal drilling campaign in 2017, Caldita-Barossa 3DMSS in 2016, the Bonaparte Basin Barossa appraisal drilling campaign in 2013-14) and the Browse Basin (Browse exploration drilling campaign, 2012-14).

Further information about ConocoPhillips is available at its website: www.conocophillips.com.

1.5.2. 3D Oil

3D Oil T49P Pty Ltd is a part titleholder in T/49P and is a fully owned subsidiary of 3D Oil Limited (3D Oil).

3D Oil is an Australian Stock Exchange (ASX)-listed exploration company with a growing portfolio of exploration acreage. 3D Oil currently has interests in exploration permits in the offshore Gippsland (VIC/P57) and Otway Basins (T/49P) of southeast Australia and the Roebuck Basin offshore WA (WA-527-P).

3D Oil's focus on exploration on the southeast coast of Australia led to the award of the T/49P exploration permit in the highly prospective Otway Basin.

Further information about 3D Oil is available at its website: www.3doil.com.au.

1.5.3. Titleholder Information and Liaison Person

In accordance with the OPGGS(E)R Regulation 15(1&2) details of the titleholders and liaison person for this EP are provided below.

The titleholders for this activity are:

ConocoPhillips Australia SH1 Pty Ltd	3D Oil T49P Pty Ltd
Level 1, 33 Park Road, Milton, QLD 4064	Level 18, 41 Exhibition Street, Melbourne, VIC 3000
Phone: 07 3182 7122	Phone: 03 9650 9866
ABN: 18 116 771 450	ABN: 90 163 960 807

The nominated liaison person for this EP is:

Wayne Asnicar

Supervisor, HSE Systems & Programs ConocoPhillips

Email: sequoia@conocophillips.com

Phone: 07 3182 7122

ConocoPhillips Australia, as operator, will notify NOPSEMA of any change in titleholder, a change in the titleholder's nominated liaison person, or a change in the contact details for either the titleholder or the liaison person as soon as practicable after such a change takes place.

1.6. Environmental Plan Summary

Table 1.1 provides a summary of this EP as required by Regulation 11(4) of the OPGGS(E).

Table 1.1 EP Summary of material requirements

EP Summary requirement	EP Section
The location of the activity	Section 2.2
A description of the receiving environment	Chapter 5
A description of the activity	Chapter 2
Details of the environmental impacts and risks	Chapter 7
The control measures for the activity	Chapter 7
The arrangements for ongoing monitoring of the titleholder's environmental performance	Chapter 8
Response arrangements in the oil pollution emergency plan (OPEP)	Chapter 9
Consultation already undertaken and plans for ongoing consultation	Chapter 4
Details of the titleholder's nominated liaison person for the activity	Section 1.5.3

2. Activity Description

This chapter provides a description of the proposed Sequoia 3DMSS in accordance with Regulation 13(1) of the OPGGS(E).

2.1. Survey Objective

The objective of the Sequoia 3DMSS is to acquire geophysical data to provide a 3D image of the subsurface geology within the T/49P permit area in order to identify prospective commercially viable gas reservoirs for future development.

Both 2D and 3D seismic data has been acquired within the T/49P permit area historically and have indicated the potential for prospective geological structures to be present (Figure 2.1 and Figure 2.2). The existing data, due to the sparseness over the permit area and poor imaging (2D vs 3D imaging, data dates back to 1960's), does not provide sufficient imaging to adequately confirm the extent and integrity of these structures.

2D seismic data is generally poorer quality than 3D seismic data, which introduces uncertainty in the identification of prospective geological structures. The acquisition of high-quality 3D seismic data can also mitigate the risk of drilling unnecessary exploration wells if the geological structures are determined to be unprospective and may also reduce the total number of wells required to develop a petroleum reservoir through improved placement of production wells.

Figure 2.1 Prospects and leads within T/49P

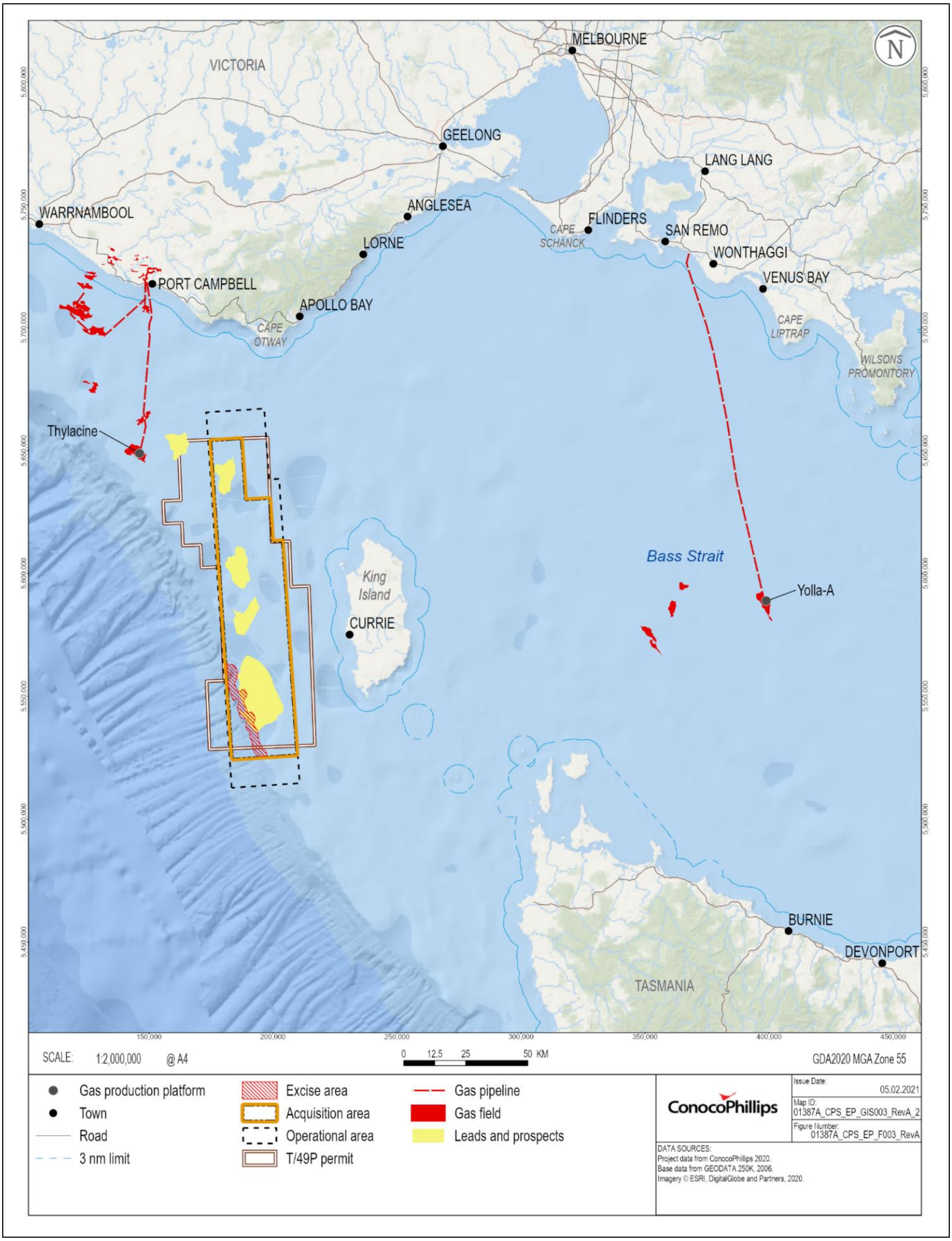
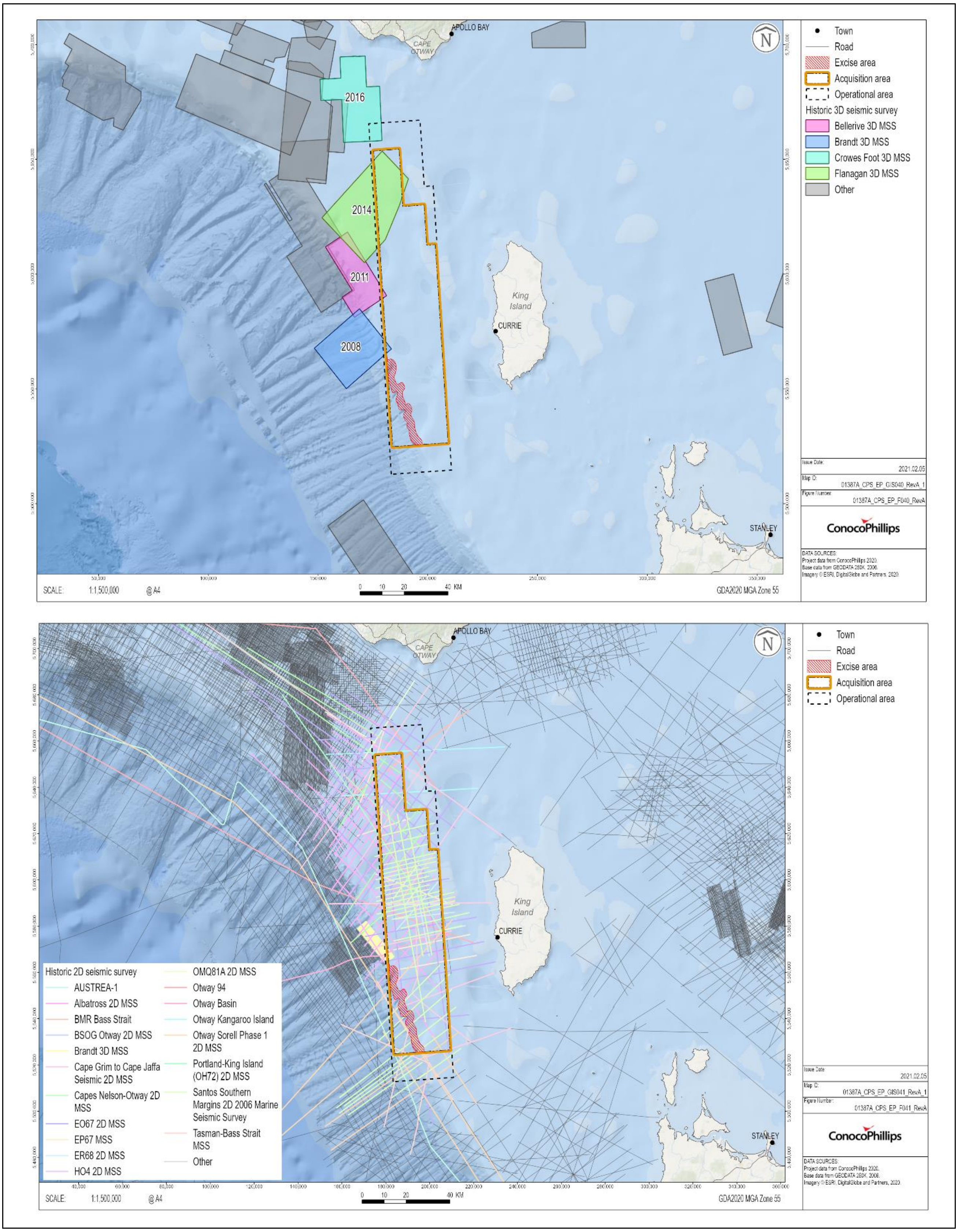


Figure 2.2 Historic 2D and 3D seismic acquisitions in T/49P



2.2. Activity Location

The proposed Sequoia 3DMSS will be conducted within exploration permit T/49P and is located entirely within Commonwealth waters west of King Island. Most of the acquisition area (90%) occurs in water depths of less than 150 m, with deeper waters in the southwestern corner where the continental shelf transitions into the continental slope.

The proposed Sequoia 3DMSS comprises two areas (Figure 2.3), these being the:

- 'Acquisition area' – the physical area in which the seismic source will operate (i.e., acquire full fold data), covering an area of 2,703 km2. The acquisition area measures 129 km long (north-south orientation) at its longest and 25 km wide (west-east orientation) at its widest.
    - Section 2.6.1.2 contains details on how the acquisition area was re-designed to account for concerns about potential effects on the giant crab fishery, which has resulted in the acquisition area being reduced in area by 4.9%.
- 'Operational area' – the physical area in which operations ancillary to achieving survey coverage will take place. This includes vessel approach, vessel line turns (16 km allowance), 'soft starts' of the seismic source, run-ins and run-outs of the seismic source and miscellaneous maintenance operations. The operational area measures 153 km long (north-south orientation) and 26.5 km wide (west-east orientation), covering an area of 4,089 km2. The operational area has been revised from the original design, following early consultation with stakeholders, to reduce impact on State fishing grids, not to overlap with the Apollo Australian Marine Park (AMP) and reduce impacts on the West Tasmanian Canyons Key Ecological Feature (KEF).

The acquisition and operational areas combined are simply referred to as the 'survey area'.

The operational and acquisition areas are located 24.5 km and 23.5 km from the west coast of King Island, respectively, and 26 km and 40 km off the closest point of the Victorian coast, respectively. The coordinates of the acquisition and operational areas are provided in Table 2.1 and distances from the acquisition and operational areas to nearby features are provided in Table 2.2.

Figure 2.3 Proposed Sequoia 3DMSS survey area

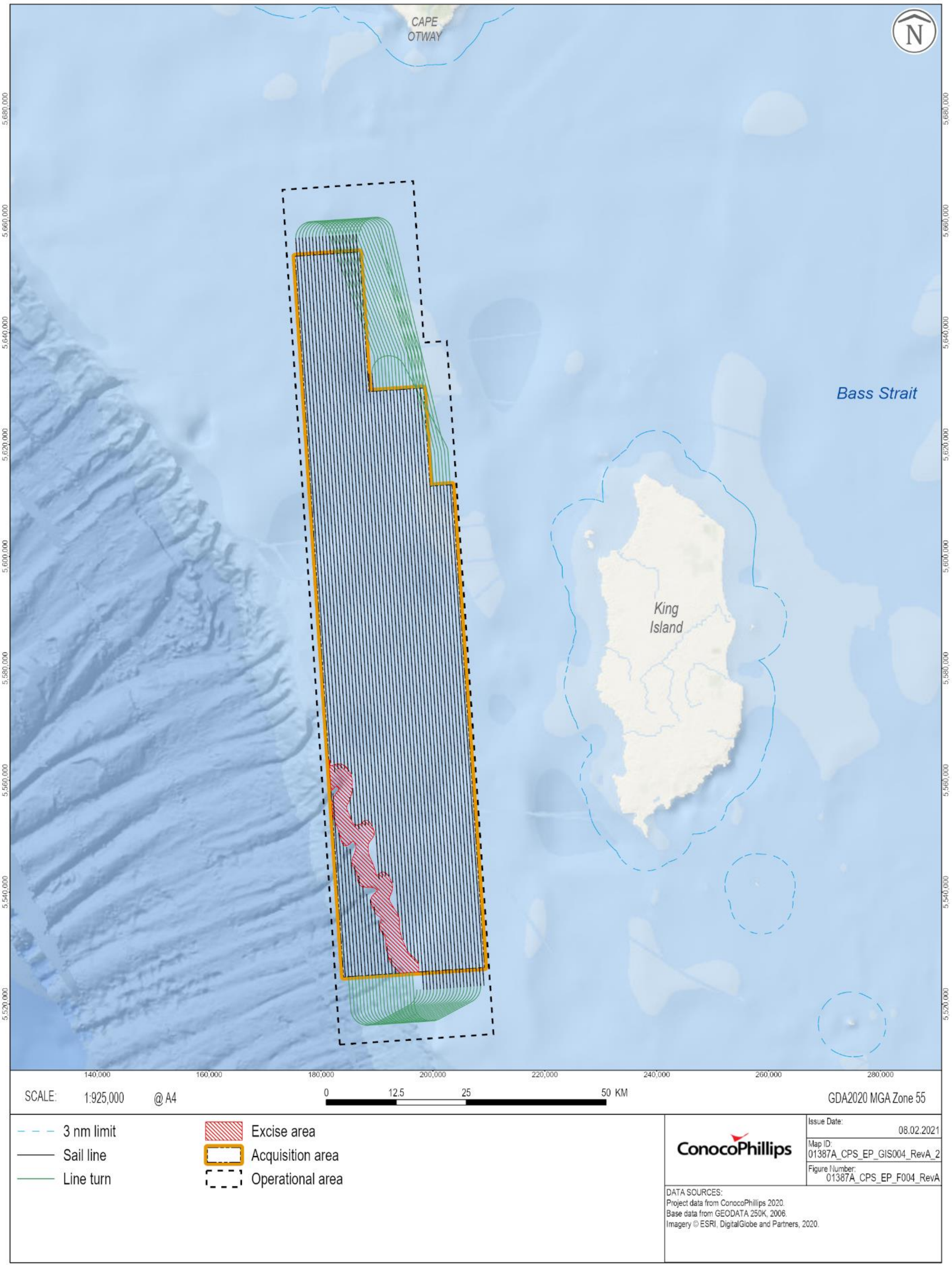


Table 2.1 Coordinates of the survey area

Point	Degrees, minutes, seconds		Grid	
	Latitude	Longitude	Easting	Northing
Acquisition Area*				
1	40° 22' 01.68" S	143° 16' 44.52" E	693,500.00	5,529,000.00
2	39° 12' 20.64" S	143° 14' 27.64" E	693,500.00	5,658,000.00
3	39° 12' 11.14" S	143° 22' 26.74" E	705,000.00	5,658,000.00
4	39° 25' 41.42" S	143° 22' 54.19" E	705,000.00	5,633,000.00
5	39° 25' 32.86" S	143° 29' 42.47" E	714,770.00	5,633,000.00
6	39° 35' 1.96" S	143° 30' 2.85" E	714,770.00	5,615,439.00
7	39° 34' 58.38" S	143° 32' 47.44" E	718,700.00	5,615,439.00
8	40° 21' 39.26" S	143° 34' 32.05" E	718,700.00	5,529,000.00
Operational Area				
A	40° 28' 31.82" S	143° 15' 54.00" E	692,000.00	5,517,000.00
B	39° 05' 52.85" S	143° 13' 12.91" E	692,000.00	5,670,000.00
C	39° 05' 33.17" S	143° 29' 26.23" E	715,400.00	5,670,000.00
D	39° 21' 09.79" S	143° 29' 59.41" E	715,400.00	5,641,100.00
E	39° 21' 06.07" S	143° 32' 50.56" E	719,500.00	5,641,100.00
F	40° 28' 07.30" S	143° 35' 20.83" E	719,500.00	5,517,000.00

GDA94, MGA Zone 54
**These coordinates include the exclusion area.*

Table 2.2 Distances to key features from the survey area

Feature	Distance and direction from the operational area to the nearest point of the feature	Distance and direction form the acquisition area to the nearest point of the feature
Towns		
Apollo Bay (Vic)	37 km northeast	56 km northeast
Lorne (Vic)	70 km northeast	90 km northeast
Port Campbell (Vic)	55 km northwest	68 km northwest
Warrnambool (Vic)	97 km northwest	111 km northwest
Currie (Tas, King Island**)**	14 km east	24 km east
Woolnorth (Tas)	94 km southeast	104 km southeast
Natural Features		
King Island	14 km east	24 km east
Cape Otway	26 km north-northeast	40 km north-northeast
Hunter Island	91 km east	98 km east-southeast
Port Phillip Bay (entrance)	126 km northeast	157 km northeast
Protected Areas		
Terrestrial		
Great Otway National Park	27 km north northeast	40 km north-northeast
Port Campbell National Park	44 km north-northwest	56 km north-northwest

Feature	Distance and direction from the operational area to the nearest point of the feature	Distance and direction form the acquisition area to the nearest point of the feature
Bay of Islands Coastal Park	62 km northwest	76 km northwest
Belfast Coastal Reserve	100 km northwest	115 km northwest
Port Fairy Coastal Reserve	111 km northwest	125 km northwest
Marine		
Twelve Apostles Marine National Park (MNP)	38 km north-northwest	50 km north-northwest
Point Addis MNP	87 km northeast	109 km northeast
Apollo AMP	Abuts in northeast	8 km northeast
Zeehan AMP	Intersects	Intersects
Franklin AMP	53 km southeast	64 km southeast
Boags AMP	101 km east	108 km east

2.3. Activity Timing

2.3.1. Timing

The survey is scheduled to take place during the window of 1st August – 31st October 2021. Even though the planned duration of the activity is 60 days, a window of approximately 90 days is nominated to allow schedule flexibility. Through stakeholder engagement, assessment of environmental impacts and learnings from the Dorrigo EP, ConocoPhillips Australia has selected a survey window that it believes balances operational requirements with environmental and socio-economic constraints.

Both ConocoPhillips Australia and 3D Oil are committed to meeting the preferred 2021 window. Contract negotiations with seismic vessel companies are well underway in preparation to acquire the survey in 2021 (refer Section 2.4.6).

Figure 2.4 outlines the key ecological processes and species presence in the southern Otway region throughout the year that supports the selection of this window of opportunity. This figure indicates:

- Closure of the Victorian southern rock lobster (SRL) and giant crab fishery;
- Closure of the Tasmanian SRL fishery;
- Low catch season for the Tasmanian giant crab fishery;
- Low likelihood of presence of the pygmy blue whale, southern right whale or humpback whales in the survey area.

2.3.2. Duration

Within the 1st August – 31st October window, the indicative duration of the survey is expected to take 60 days. The day of commencement is subject to factors such as vessel availability and sea state conditions. Table 2.3 provides detail of the tasks and their indicative duration during the 60-day survey.

The duration of the survey is influenced by factors such as sea state conditions, whale-instigated shutdowns and technical issues. Indicative planning proposes the acoustic pulses operating for approximately 30 days.

Table 2.3 Indicative survey tasks and timing

Task	Number of Days
Equipment deployment	5 days
Prime acquisition days	24 days
Prime line turn days	6 days
Infill acquisition days	6 days
Infill line turn days	2 days
Standby time (e.g., weather delays)	13 days
Contractor Downtime	2 days
Equipment Retrieval	2 days
Total Duration	60 days

2.4. Survey Program

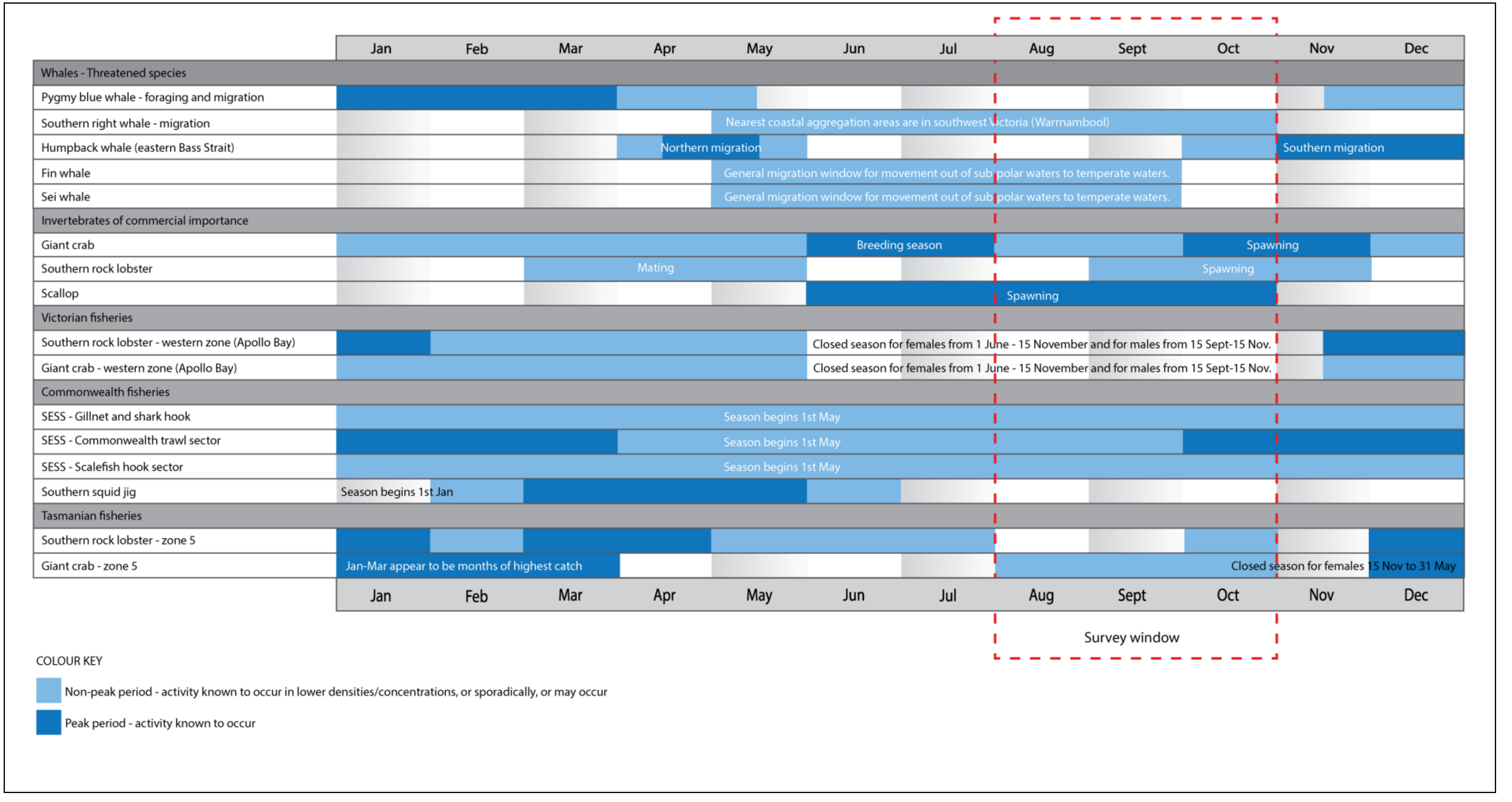
The Sequoia 3DMSS will be a high-resolution towed streamer survey which uses similar equipment to most other modern towed streamer seismic surveys conducted in Australian marine waters (Figure 2.5).

Seismic surveying is a widely used exploration method used to define and analyse subsurface geological structures in the marine environment. Seismic surveying uses a technique that directs acoustic energy into these subsurface geological structures beneath the seafloor from equipment deployed by marine vessel.

The survey vessel will acquire the seismic data by towing three acoustic source sub-arrays operating alternatively, one discharging as the others recompress. The lateral distance between each of the sources will be 25 m to 37.5 m. The source volume will be a maximum of 3,480 cubic inches (cui) with an operating pressure of 2,000 pounds per square inch (psi). There will be 12 to 18 hydrophone 'streamer' cables approximately 6,100 m long and tow depth will be 20-25 m for a multi-component streamer (containing recording elements that can detect both pressure and velocity) or towed at 7-8 m without a multi-component streamer.

The vessel will sail back and forth across the acquisition area along 42 sail lines (based on a 16-streamer configuration) that will vary in separation from 500 m to 900 m, primarily influenced on the sea conditions at the time of acquisition.

Figure 2.4 Proposed survey window of opportunity

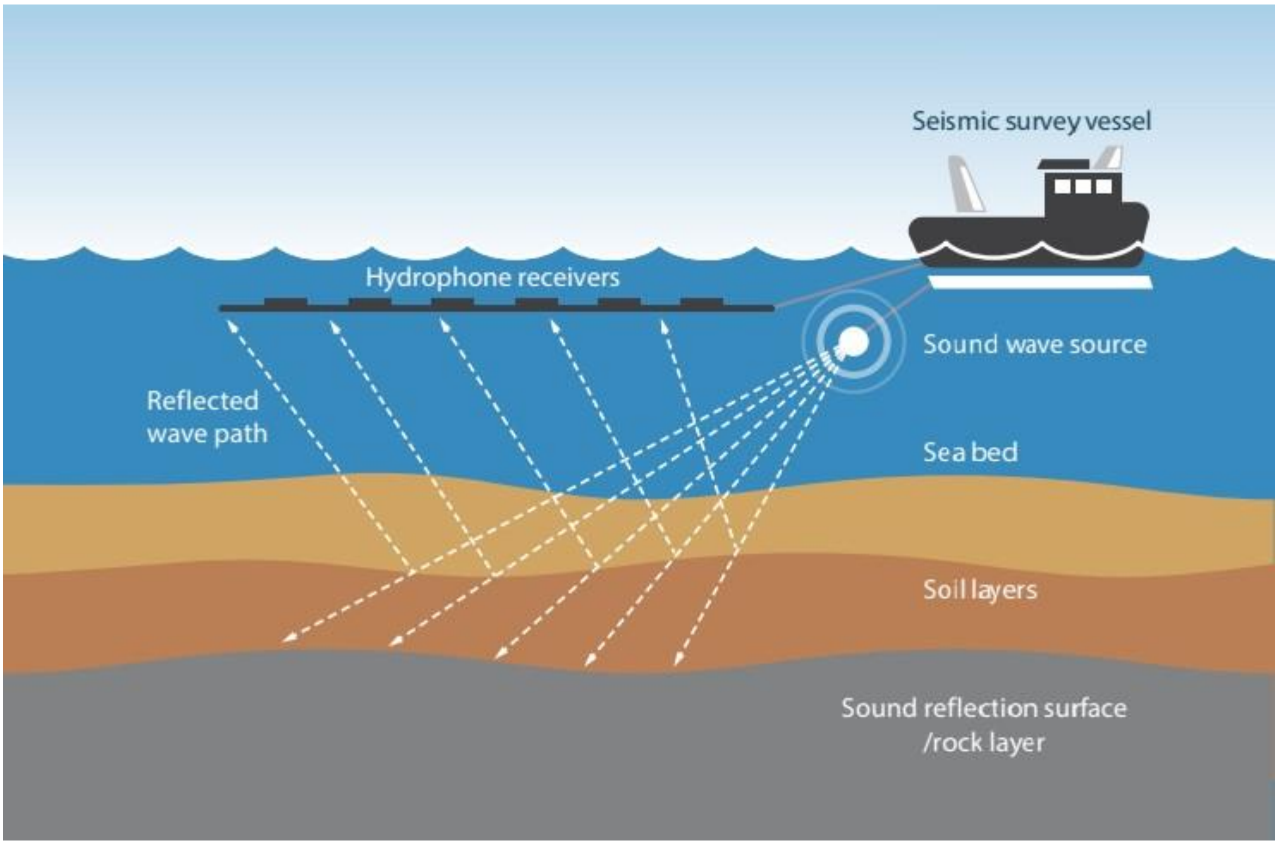


A series of acoustic pulses (discharged every 18.75 m) will be directed by the source down through the water column and seabed. The released sound will be attenuated and reflected at geological boundaries and the reflected signals are detected using hydrophones arranged along the streamers that are towed behind the vessel. The reflected sound is evaluated to provide information on the structure and composition of the geological formation.

The survey will use ConocoPhillips' Compressive Seismic Imaging (CSI) technology (see Section 2.4.1), which means that whilst the overall width of the streamer configuration remains consistent, the internal streamer separation will vary between 25 m and 100 m with a non-uniform interval distribution.

The survey will be conducted 24 hours a day.

Figure 2.5 Profile view of a typical MSS arrangement



2.4.1. ConocoPhillips' Compressive Seismic Imaging (CSI) Technology

ConocoPhillips developed Compressive Seismic Imaging (CSI) technology for marine seismic surveys on the back of our long history and global experience with seismic acquisition. The technology has been successfully used and proven across our global operations, including Australia, over the last decade. Our proprietary CSI technology generates the same information as conventional seismic surveying, however, processing of the CSI acquired data results in a higher resolution product.

To obtain the same higher resolution data set using conventional methods would require the seismic acquisition vessel to be in the water towing a greater number of streamers for a longer period of time. ConocoPhillips's CSI approach therefore significantly reduces the duration, risk and impact of the seismic acquisition program.

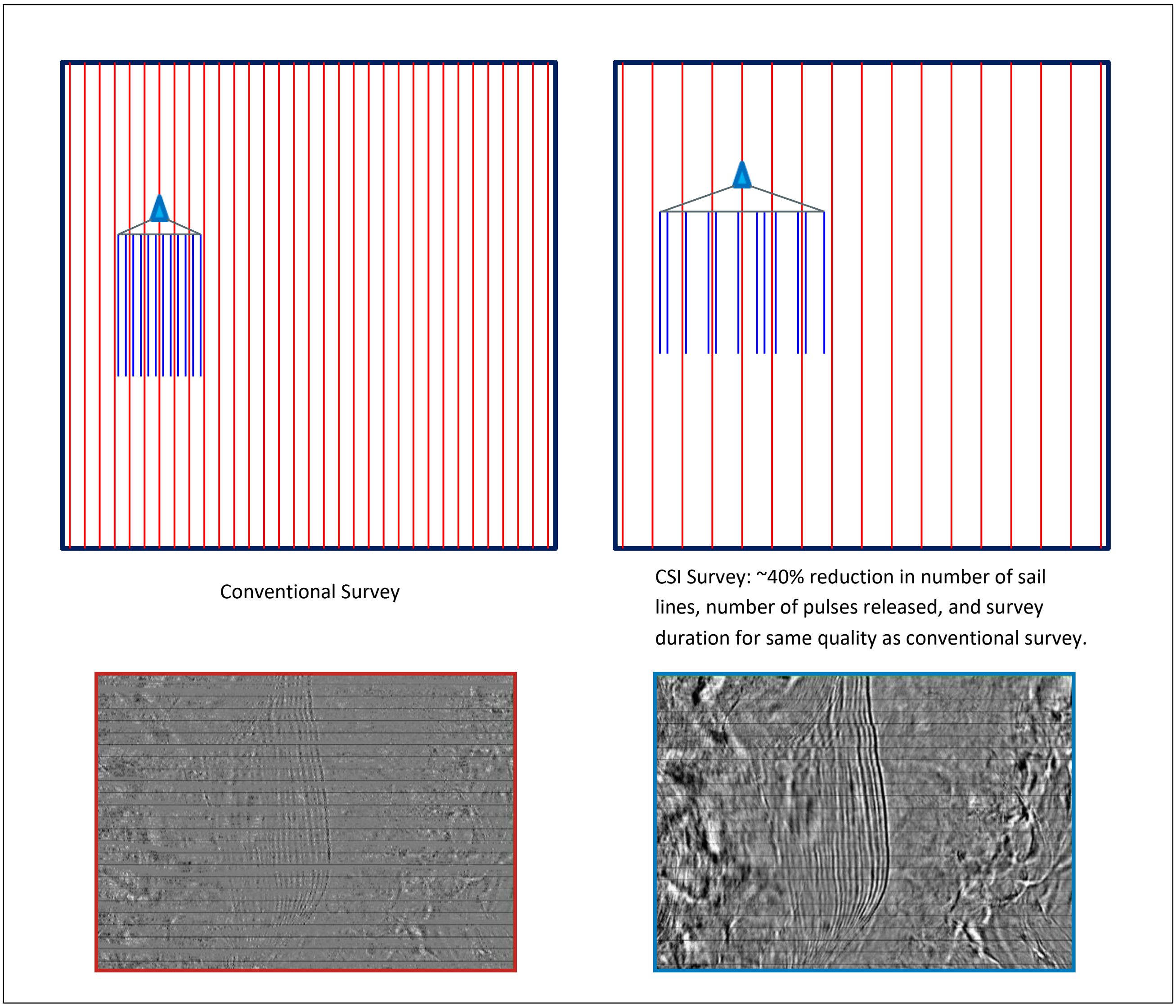
Further due to CSI's higher quality data, subsurface uncertainty is potentially reduced when compared with conventional seismic techniques. This has the potential to reduce the number of future seismic surveys required for the development of a gas project in the area.

2.4.1.1. How CSI Works

CSI applies compressive sensing technology which is a mathematical sampling theory first used by the medical industry to speed up imaging processes such as the medical imaging technique, Magnetic Resonance Imaging (commonly known as MRI). CSI enables geophysicists to reconstruct a higher quality, more accurate picture with less data compared to conventional seismic technology.

As illustrated in Figure 2.6, instead of uniform sampling, which involves data gathered from a regular dense grid, CSI uses algorithm processes to achieve a fuller picture and improved outcomes from non-uniform or irregular grid with less data collection points.

Figure 2.6 CSI versus conventional surveys



2.4.1.2. CSI Efficiencies

During CSI data processing, the data acquired is reconstructed to look like it was acquired with twice as many streamers than deployed. This is due to the streamers being deployed in a non-uniform pattern rather than a regular pattern. Using the proprietary CSI processing, ConocoPhillips is able to use the data acquired from the non-uniform streamers to reconstruct a higher resolution data set.

Comparing CSI technology to conventional acquisition and processing technology to obtain a similarly sized survey and obtain the same high-resolution data, a conventional survey design would require the seismic acquisition vessel to be in T/49P for longer while sailing a greater distance (Table 2.4).

Table 2.4 CSI Technology versus Conventional Technology for T/49P acquisition

	CSI technology	Conventional technology
Indicative survey size	2,840 km^2	2,840 km^2
Indicative survey duration	60 days	98 days
Number of streamers	16	16
Indicative distance travelled (sail line kms)	~5,600 km^2	10,000 km^2

2.4.2. Sound Source

The acoustic source array will consist of three sub-arrays (each array with 12 individual marine acoustic source elements) spaced 7 m apart. Figure 2.7 shows the anticipated layout of the source array.

Each individual marine acoustic source element is essentially a stainless-steel cylinder charged with high-pressure air. An acoustic signal is generated when the air is released into the water column. Activating the acoustic source generates an oscillating bubble in the surrounding water (the pressure of the air inside the cylinder far exceeds the outside pressure in the surrounding water). This pressure difference causes the bubble to rapidly expand in the water around the acoustic source, generating a broadband seismic pulse (Jasco, 2020) (Figure 2.8).

A minimum 75 bar-m peak-to-peak amplitude is required to undertake the Sequoia 3DMSS, which will be sufficient to provide the penetration required to image the deepest target with current technology. This amplitude can be achieved using a seismic source with a maximum volume of 3,480 cui and an operating pressure of 2,000 psi. The exact parameters of the arrays will be finalised after ConocoPhillips Australia has selected its survey contractor.

The source array will be towed astern of the survey vessel at a typical depth range of 6 m below the sea surface. The distance between the acoustic source array and the streamers will be less than 100 m. Figure 2.9 shows a typical CSI towing arrangement with non-uniform streamer separation. Photo 2.1 shows a typical acoustic source used for MSS.

Figure 2.7 Anticipated source array arrangement for the Sequoia 3DMSS

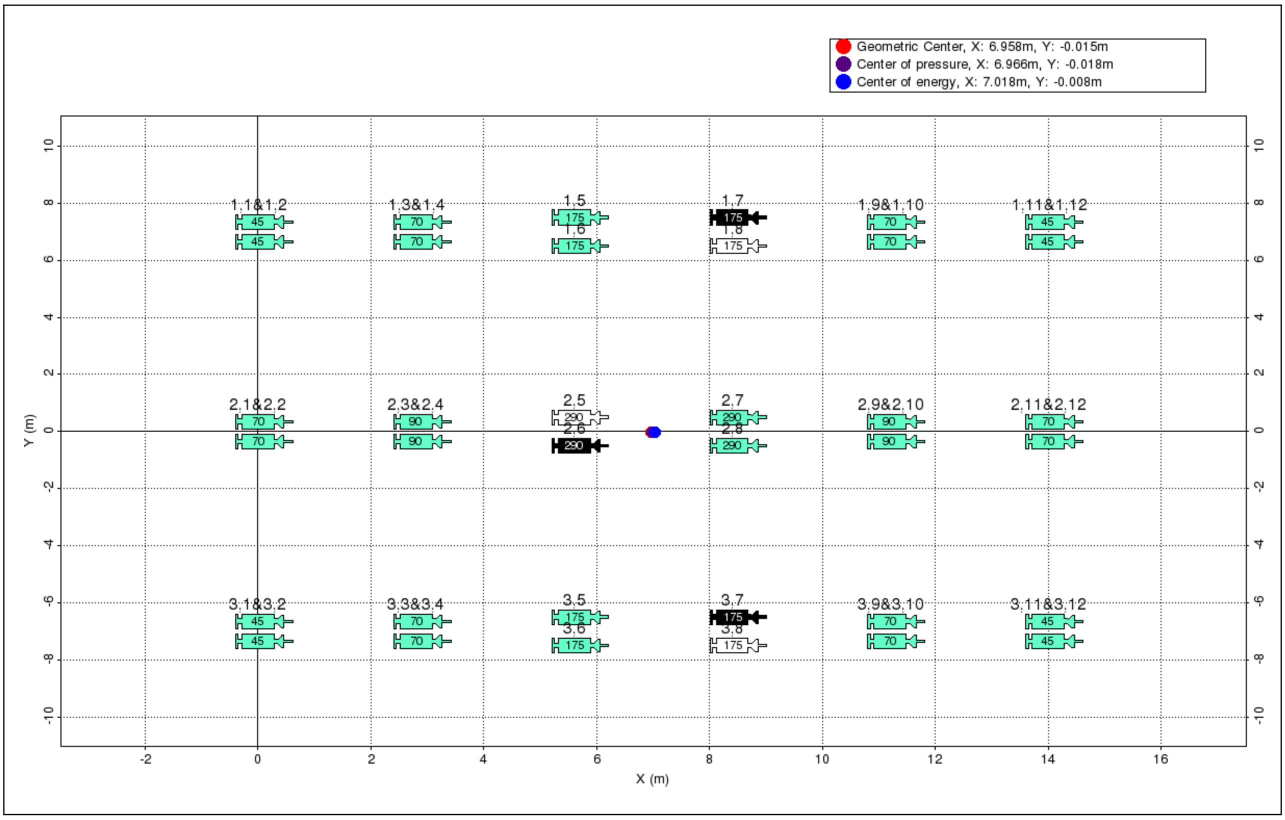


Figure 2.8 Functioning of a marine acoustic source

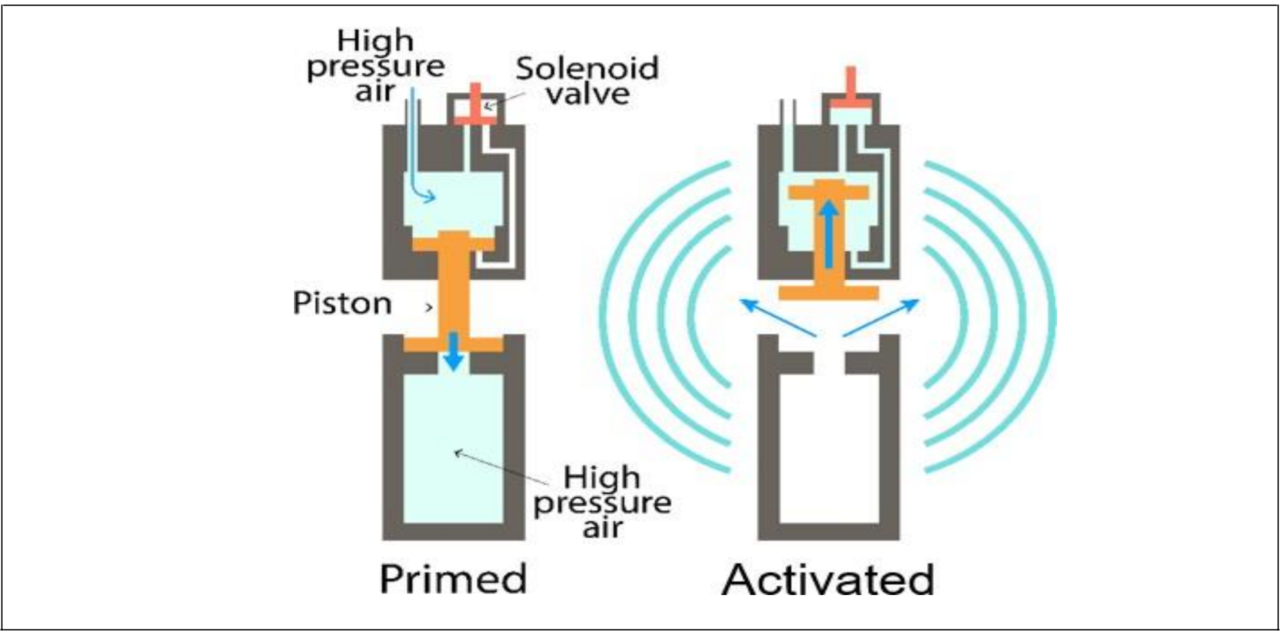
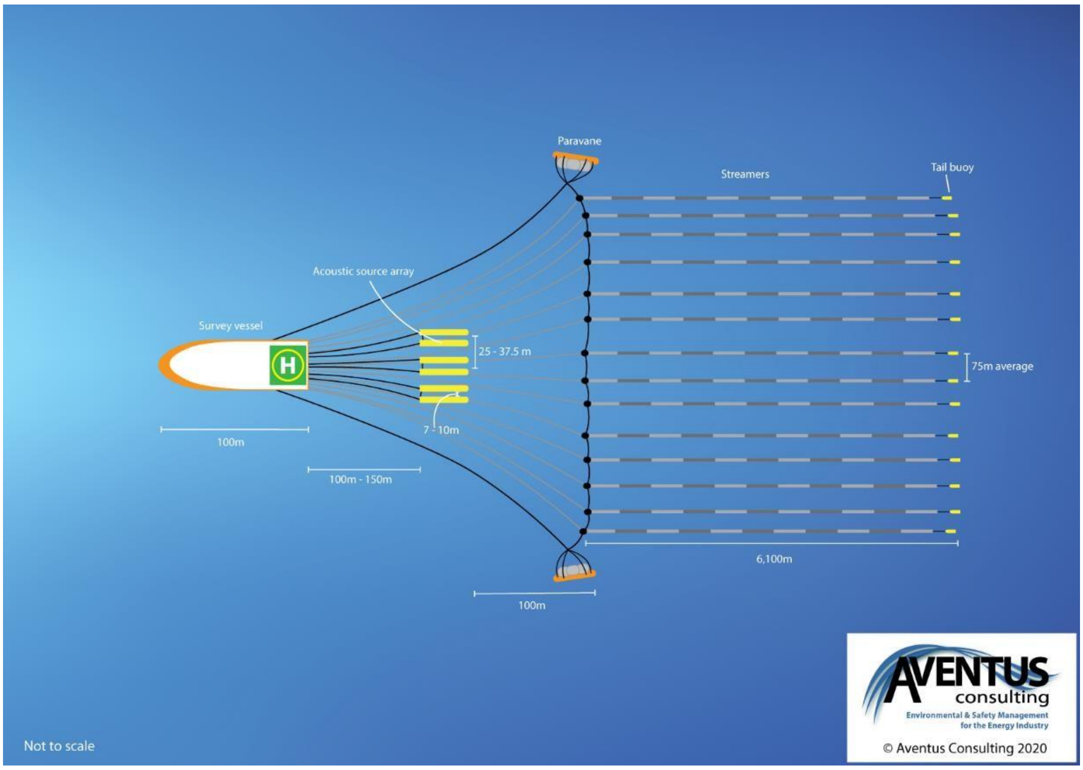


Photo 2.1 Typical marine acoustic source used for a 3DMSS (as part of the array)

Figure 2.9 Plan view of a typical MSS arrangement



Arrays are strategically arranged to direct most of the energy vertically downward rather than sideways. The acoustic source point intervals will be 18.75 m. The data will be recorded in continuous mode. The total number of source pulses is estimated to be approximately 53 pulses per kilometre.

The underwater Sound Transmission Loss Modelling (STLM) undertaken for this project uses a 3,480 cui array. Table 2.5 provides the peak and per-pulse Sound Exposure Level (SEL) source levels for the acoustic source array in the end-fire (parallel to the travel direction of the source), broadside (perpendicular to the travel direction of a source) and vertical directions.

Table 2.5 Source level specifications for the 3,480 cui array for a 6 m tow depth

	Peak source pressure level ($L_{S,pk}$) (dB re 1 µPa m)	Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa^{2}m^{2}s)	
		10-2,000 Hz	2,000 – 25,000 Hz
Broadside	248.6	225.3	185.7
Endfire	247.5	225.1	190.6
Vertical	258.1	230.9	197.9
Vertical (surface affected source level)	258.1	233.5	200.9

2.4.3. Sail lines

There are 42 sail lines proposed for the survey (based on using 16 streamers). The longest 19 sail lines are 132.2 km long in the western part of the acquisition area; 16 sail lines through the middle are 107.2 km long and the seven shortest lines in the eastern part of the acquisition area are 89.6 km long. The distance of these lines does not factor in the exclusion area.

The sail lines will vary in separation from 500 m to 900 m. The total sail line distance will be 4,854 km.

Line turns are planned to extend for a distance of 6 km outside the acquisition area (in the north) and 9 km outside the acquisition area (in the south), and with the turning circle included, are likely to be 12 km long and take 3.5 hours to achieve (based on a vessel speed of 4 knots [7.4 km/hr] and calm seas).

All sail lines will stay within the operational area.

2.4.4. Streamers

Sixteen (16) streamers are expected to be used for the survey (though the number could range from 12 to 18). The streamers will be 6,100 m in length with a variable separation of 25 m to 100 m between each streamer (Photo 2.2).

Each streamer will be fitted with streamer retrieval devices (SRD) that inflate when the SRD reaches a maximum depth (Photo 2.3). The tail of each streamer has a Relative Global Positioning System (RGPS) tail buoy (Photo 2.4). If a streamer is lost, then the RGPS position of the tail buoy combined with the visual presence of the SRDs would be used to locate and retrieve it. The sources are all suspended from floats and each float will be fitted with an RGPS unit.

The tow depth will be 20-25 m for a multi-component streamer or towed at a depth of 7-8 m without a multi-component streamer.

Given the deep waters of the operational area, spot checks of bathymetry will not need to be conducted by the survey vessel as there will be no obstructions on the seabed at such depths that could interfere with the streamers and acoustic source arrays. At the shallowest point of the proposed acquisition area (90 m), there will be a vertical separation of between 65 m and 83 m between the streamers and the seabed, depending on whether multi-component or non multi-component streamers are used.

The streamers may be actively steered to improve survey acquisition efficiency and minimise survey time if that technology is available on the contracted vessel.

The streamers are made of a solid core construction, with either a solid foam core or a solid gel core used for internal ballast. The streamers will display appropriate navigational safety measures such as lights and reflective tail buoys.

A paravane (Photo 2.5 and Photo 2.6) is effectively a water kite, connected to each of the outer most streamers (see Figure 2.9). Paravanes comprise a float, a frame suspended from the float, deflectors affixed to the frame and a bridle coupled to the frame at selected positions. The paravanes assist in maintaining the separation of the streamers and acoustic sources.

Depth monitoring and control devices, referred to as 'birds' (Photo 2.7), are also attached to the streamers at regular spacings (e.g., every 300 m). These devices are powered by their own batteries or via the streamer itself and can control the depth of the streamer to an accuracy of +/- 0.5 m. The wings on the bird are electronically controlled to pivot in response to the depth measured by the pressure transducer inside the bird. If the streamer is too deep, the wing is rotated up to provide lift; if too shallow, the wing is rotated down.

The view of the streamer and equipment spread from the stern (rear) of a survey vessel is shown in Photo 2.8.

Photo 2.2 Streamer on reels

Photo credit: G. Pinzone

Photo 2.3 Streamer recovery devices

Photo credit: Polarcus

Photo 2.4 Tail buoy (with navigation light at top)

Photo credit: ConocoPhillips

Photo 2.5 Paravane stored alongside vessel

Photo credit: G. Pinzone

Photo 2.6 Paravane in the water

Photo credit: ConocoPhillips

Photo 2.7 Birds

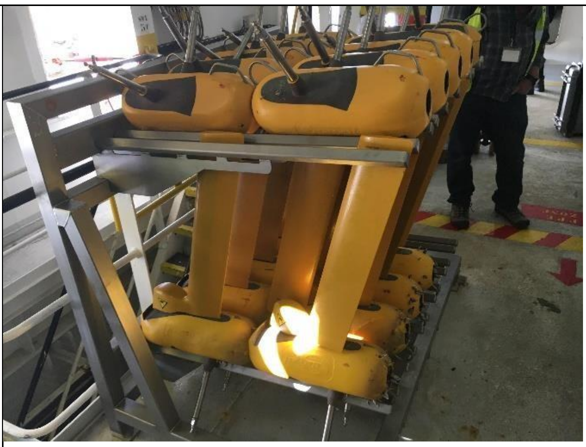


Photo credit: G. Pinzone

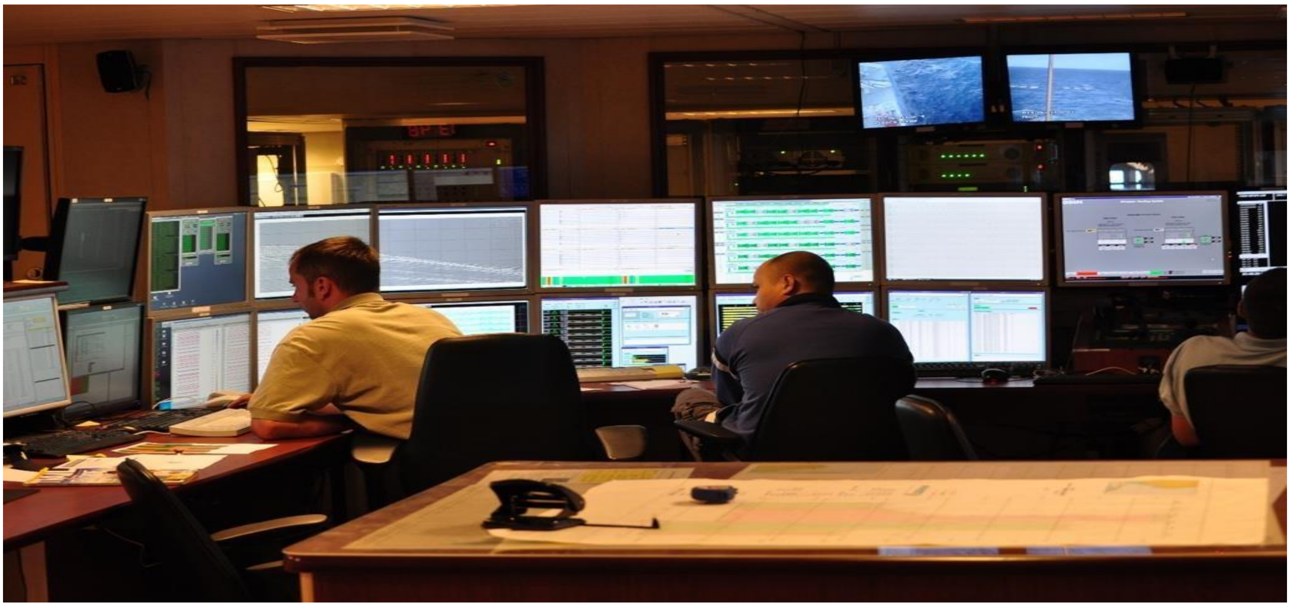
Photo 2.8 Streamer and equipment spread form stern of acquiring seismic vessel

2.4.5. Data Collection and Analysis

The seismic data is measured by hydrophones in the streamers and transmitted by fibre optics to the recording room on the survey vessel (Photo 2.9). The data is checked by the processing department for quality control and merged with navigation data to correctly position the data in time and space. The processing methods conducted onboard check that the data has been acquired to a satisfactory quality.

After the data is successfully acquired it will be further processed to obtain 3D images of the sub-surface geology. The 3D images are then interpreted by ConocoPhillips' geoscience team to assess prospectivity for natural gas accumulations.

Photo 2.9 Part of the data room on a typical survey vessel



2.4.6. Survey Contractor

ConocoPhillips Australia issued an Invite to Tender (ITT) for a seismic survey contractor in Q3 2020. A contractor will be appointed in Q1 2021 now that ConocoPhillips Australia has undertaken its contractor review process in line with the ConocoPhillips' Marine Risk Management Standard (Section 2.5.1) and the project Implementation Strategy (Chapter 8).

2.5. Survey Vessel

The survey will be conducted using a purpose-built seismic survey vessel (similar to Photo 2.10), with support from at least two dedicated support vessels (see Section 2.5.4). The survey vessel is likely to be in the order of 90 to 130 m in length and 40 to 70 m wide and carry up to 70 people. The same or similar vessels have been used recently throughout Australia and specifically in offshore Victoria within the last few years.

Photo 2.10 Marine seismic survey vessel used in a recent ConocoPhillips campaign

While the specific survey vessel that will be used for this survey is yet to be determined, all candidate vessels have the 'Clean' class notation and multiple levels of redundancy in its operating systems. Clean notation demonstrates compliance with all mandatory MARPOL requirements regardless of any exemption granted by a flag state administration. In addition, it contains additional requirements to prevent oil pollution. It also requires a vessel to have improved technical and management procedures to reduce discharges to sea and emissions to air.

As some of the candidate vessels cannot hold enough fuel for a 60-day survey, refuelling during the survey may be required. If refuelling is required, this will occur at sea using the candidate vessel contractor's refuelling procedures to minimise stand down time. Refuelling at sea allows the survey window to remain to the 60-day window, as undertaking refuelling at port would require retrieval of the streamers, travel time and redeployment of streamers, adding approximately 2 weeks to the overall survey duration.

Crew changes and restocking the vessels will occur at sea using a support vessel and helicopters.

The deep waters of the operational area mean there is no risk of the survey vessel colliding with submerged features that result in a hull breach and a fuel spill. Due to the location and depth of the survey area the use emergency anchoring is not considered necessary.

The crew on board the survey vessel will consist of a marine crew and a survey crew. The marine crew operate the vessel by performing duties in the bridge, engine room, galley and hotel services, internal and external deck areas and safety craft. They are also responsible for safe navigation, lookout and communications.

The survey crew operate and run the survey equipment and are responsible for its deployment and recovery and data acquisition. The seismic crew is responsible for the planned and continued maintenance of all towed equipment to ensure there is minimum risk of electrical or mechanical failure resulting in the damage or loss of equipment during the deployment, acquisition and recovery period of the survey.

The survey crew consists of four departments (navigation, recording, source and processing) responsible for individual duties during the survey and combining teamwork during the deployment, acquisition and recovery periods.

In addition to the marine and survey crew, ConocoPhillips Australia will have a Client Representative (to provide a quality assurance role) and Marine Mammal Observers (MMOs) onboard.

2.5.1. Vessel Selection

ConocoPhillips utilises a robust framework to ensure its marine operations are conducted in a safe and environmentally sound manner. The Marine Risk Management Standard (MRMS) provides a corporate wide framework and approach for developing a risk-based set of barriers to prevent marine incidents (Figure 2.10). The core of the MRMS is the marine vetting process, ensuring all vessels and technical operators undergo a thorough suitability assessment prior to contracting by ConocoPhillips.

ConocoPhillips undertakes a pre-qualification of all contractors in which their HSE systems are reviewed to ensure that the contractor's Health, Safety and Environmental Management System (HSEMS) is adequate for meeting their legal obligations and has identified the significant risks and control measures related to the scope of work being undertaken for ConocoPhillips Australia. This process includes verifying evidence of HSEMS implementation.

Because of the smaller size of the support vessels, undertaking due diligence for the support vessels will use the ConocoPhillips MRMS coupled with the Marine Inspection for Small Workboats (IMCA, 2012) or similar (small boats being defined as less than 50m in length and <500 gross tonnes). This document provides a standardised format for inspection and reporting (by a competent inspector) and assists in reducing the number of repeat inspections on individual vessels by prospective vessel clients.

The survey vessel and support vessels will be subject to a risk assessment procedure as part of the MRMS to ensure that there is a low risk of introducing invasive marine species to the survey area from foreign or interstate waters. This process takes into account the vessel's hull anti-fouling paint status, hull fouling condition and recent ports of visitation.

Figure 2.10 ConocoPhillips Marine Risk Management Standard

2.5.2. Vessel Environmental Credentials

Due diligence regarding the survey vessel's environmental records and performance will be conducted by ConocoPhillips Australia prior to contract award through inspection of the vessel operator's Common Marine Inspection Document (as developed by the International Marine Contractors Association, IMCA) or similar.

The survey vessel will generate routine emissions and discharges in compliance with international and local regulations and, depending on the vessel chosen, the 'Clean Design' notation of the vessel. The survey vessel will meet pollution prevention requirements under the MARPOL Convention. As such, it will be required to have current and valid environmental credentials as listed in Table 2.6.

Table 2.6 Key vessel environmental certifications

Certificate	Complies with
IOPP	MARPOL Annex I, enacted under Marine Orders Part 91 (Marine Pollution Prevention – Oil)
SMPEP	MARPOL Annex I, enacted under AMSA Marine Orders Part 91 (Marine Pollution Prevention – Oil)
IPP	MARPOL Annex II, enacted under AMSA Marine Orders Part 93 (Marine Pollution Prevention – Noxious Liquid Substances)
GMP	MARPOL Annex V, enacted under AMSA Marine Orders Part 95 (Marine Pollution Prevention – Garbage)
ISPP	MARPOL Annex IV, enacted under AMSA Marine Orders Part 96 (Marine Pollution Prevention – Sewage)

IAPP, EIAPP, IEE, SEEMP	MARPOL Annex VI, enacted under AMSA Marine Orders Part 97 (Marine Pollution Prevention – Air Pollution)
International Anti-fouling System certificate	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)

While the vessel is located within the survey area, any hydrocarbon spills to sea will be combated in accordance with its SMPEP (or equivalent) and in accordance with the oil spill arrangements outlined in the OPEP (see Chapter 9).

2.5.3. Maritime Safety

The survey vessel and towed array of equipment will operate in accordance with the Convention on the International Regulations for Preventing Collisions at Sea (COLREG) 1972.

The support vessels will actively monitor around the survey vessel to minimise the potential for interactions with third-party vessels. The survey vessel contractor will issue a vessel positioning notification to the Australian Hydrographic Office (AHO), who will in turn publish the survey location in the Notices to Mariners (NTM). A daily AusCoast warning of the survey vessel's location will also be issued to all vessels by AMSA through automatic tracking of the vessel on the Automatic Identification System (AIS). The NTM and AusCoast warnings will provide details of the safe distance (typically 5 nm) to be maintained around the survey vessel and towed equipment.

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

Supplementary to radar detection, the support vessels will have additional transmitting beacons fitted for the duration of the survey. The vessels will use either 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 the support vessels relative to the survey vessel and the towed seismic spread.

All vessels will be capable of communicating and operating both 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).

2.5.3.1. Lighting

The lighting on the survey vessel will comply with COLREG 1972. During survey deployment, recovery and acquisition, the survey vessel will display navigation lights indicating the 'restricted ability to manoeuvre.' In addition to the mandatory navigation lighting, the working deck areas will be lit 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 is lit by warning lights flashing the morse code letter 'U' (two short flashes and one long flash).

The lights are activated by solar switches at night and the floats are a bright yellow or orange colour for identification during the day (see Photo 2.4). The tail buoys will have AIS radar reflectors to assist with tracking and provide target warning on other vessels' radars.

2.5.3.2. Bad Weather Shelter

In cases where extreme weather makes it unsafe for the survey vessel to remain on location, the survey crew will retrieve the in-water equipment (where possible) and the Master will either move the vessel leeward of

King Island or turn into the weather and head into the seas (the latter preferable if it is a short-term weather event).

2.5.4. Support Vessels

At least two support vessels, comprising a ‘supply vessel’ and at least one smaller ‘chase vessel’, will support the survey vessel for the duration of the survey. These vessels will be approximately 20m in length and 6m wide, have a rope hauler and carry about 12 people. They will assist with scouting, fisheries liaison, chase duties and the removal of entanglement hazards as necessary for the safe conduct of the survey.

ConocoPhillips Australia will instruct the support vessel operators that they must be licensed by AFMA to move any unattended fishing gear that may have been lost, drifted or been deployed in the Commonwealth waters portion of the operational area prior to, or during, the survey period. This avoids damaging fishing equipment and lowers risk of entanglement with the towed seismic equipment. The vessels will liaise with any fishermen nearby to minimise interactions between the survey vessel and fishers.

The same principles regarding regulatory jurisdiction, environmental credentials, maritime safety, lighting and bad weather shelter as described for the survey vessel in Section 2.5.3 apply to the support vessels (noting that as the support vessels will be <400 gross tonnes, MARPOL certifications do not apply [e.g., they are not required to carry a SMPEP]). The environmental performance standards listed throughout the EP apply to the support vessels as well as the survey vessel, unless stated otherwise.

2.6. Evolution of Survey Design

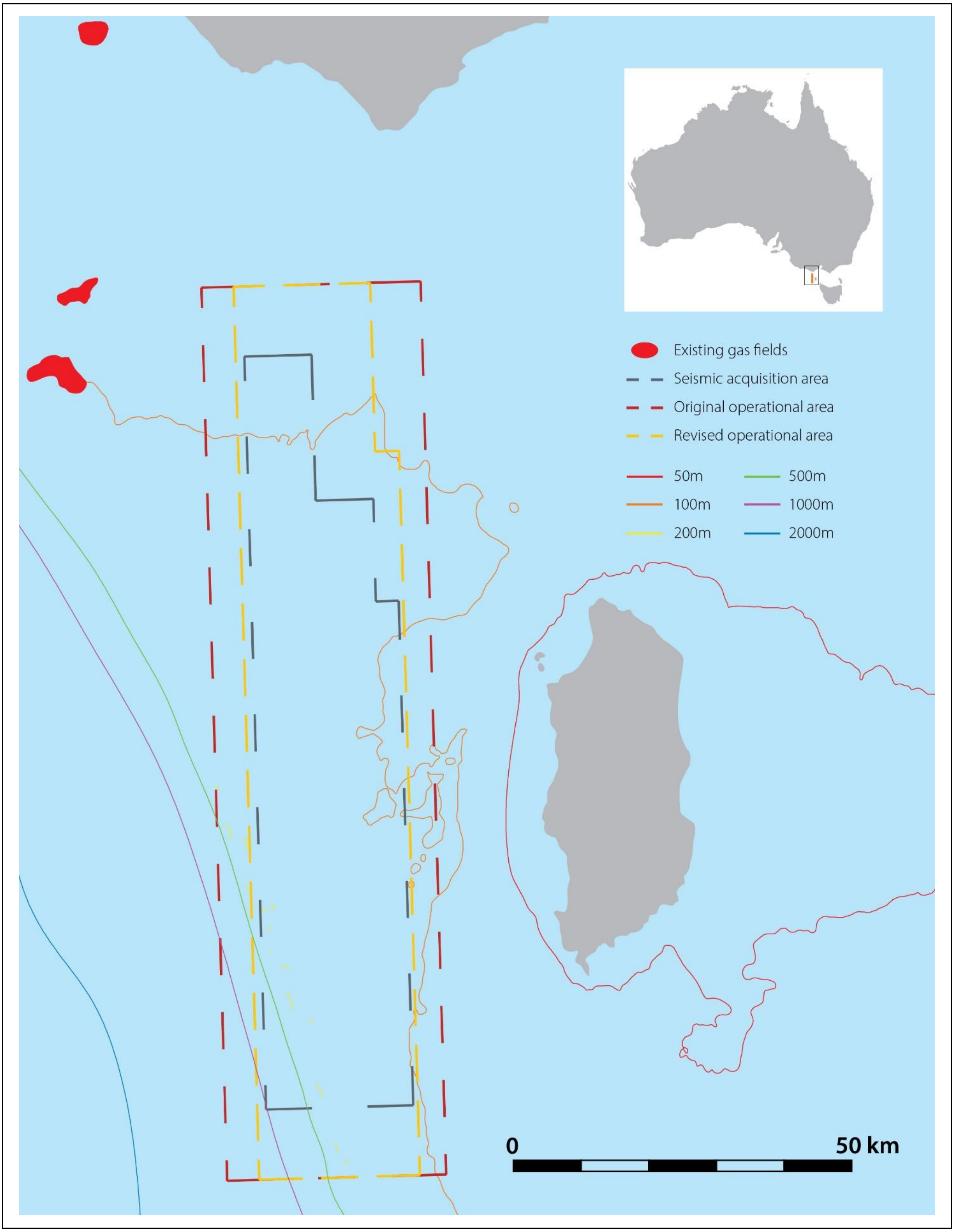
ConocoPhillips Australia’s philosophy to seismic survey design is to meet data acquisition objectives while limiting the impact on environmental and socio-economic receptors. This section discusses the refinement of the Sequoia 3DMSS survey design over time. Refinement to the survey design been based on continued consultation with geophysicists, environmental professionals, fishing associations and other stakeholders.

2.6.1. Survey Area Extent

As illustrated in Figure 2.1, there are several prospects and leads that trend north-south through T/49P. It is ConocoPhillips Australia’s intention to undertake a comprehensive MSS campaign to fully understand the spatial extent and geometry of all prospects and leads. This will result in efficiencies and lower overall impact since only one seismic campaign will be required. To cover all leads and prospects, data needs to be acquired over an area of 2,840 km^2. The initial design had the north-west corner extending outside of the T/49P permit area. The area was refined to stay within the T/49P permit, but to move east approximately 700 m to allow the acquired seismic data tie-in with a legacy well (Whelk-1).

The operational area was initially 6,529 km^2, which allowed an 8 km buffer around the acquisition area. This design intersected the Apollo AMP to the northeast. Through stakeholder and internal consultation in the development of the EP (Q3 2020), the operational area was reduced to 4,089 km^2, reducing the amount of giant crab habitat and fishing grids affected and the complete avoidance of the Apollo AMP (Figure 2.11).

Figure 2.11 Operational Area reduction (Q3 2020)



2.6.2. Exclusion Area

In response to concerns received from the public exhibition of the EP (4 December 2020 to 3 January 2021) with regard to the potential effects of underwater sound on giant crabs and the commercial fishery it supports, ConocoPhillips elected to redesign the acquisition area in order to make the survey is more acceptable to fishing stakeholders. This has involved the following:

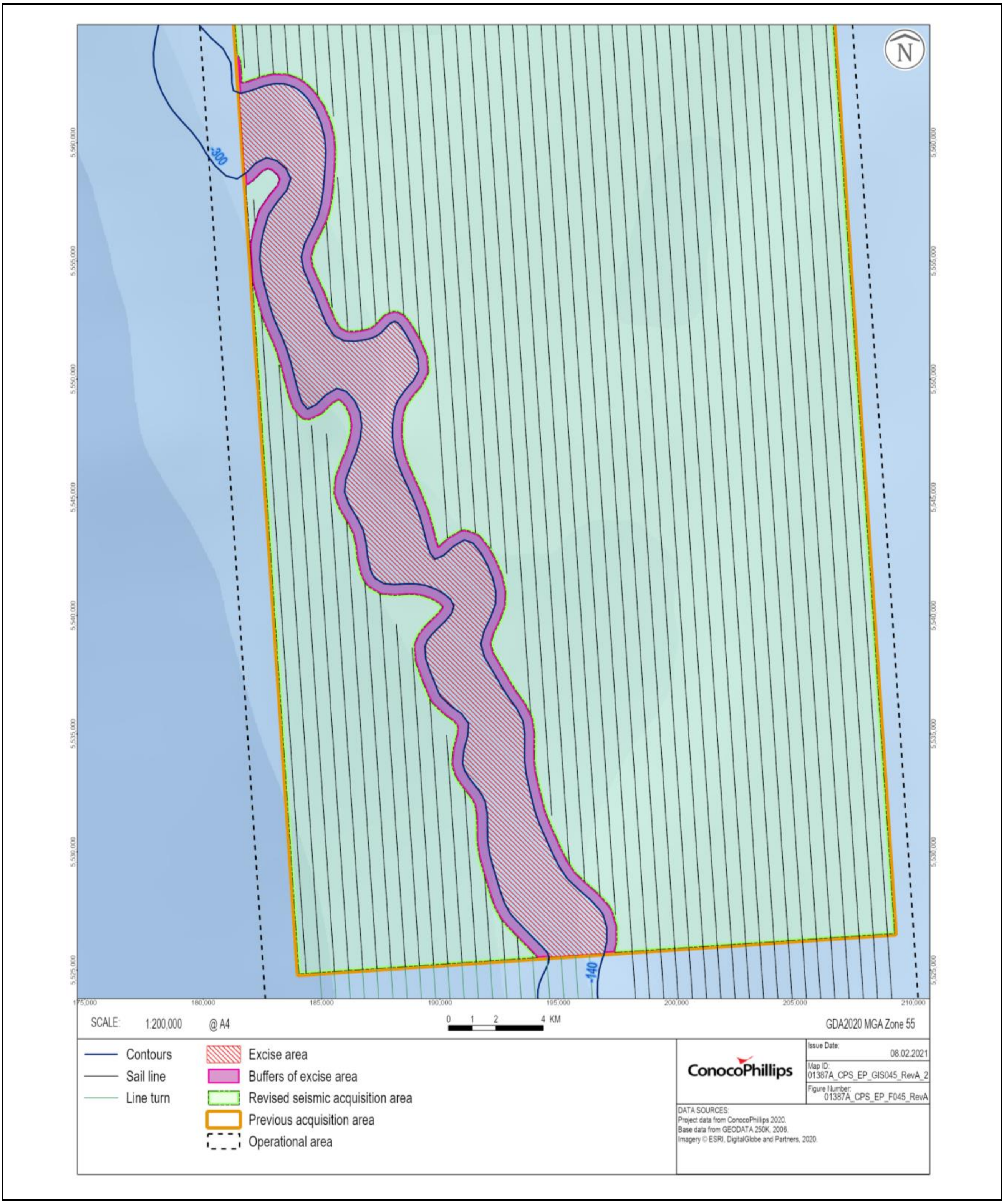
- Confirming the key fishing grounds for giant crabs based on publicly-available literature and stakeholder consultation, which is identified as the area between the 140 m and 300 m depth contours.
- Re-modelling particle motion exposure levels at the seabed for these two depth contours so that an accurate buffer ('no-effects distance') could be applied to ensure that crustaceans within these water depths are not affected by the underwater sound (see also Section 7.1.4 'Impacts to Crustaceans'). The no-effects buffer extends 425 m east of the 140 m depth contour and extends 455 m west of the 300 m depth contour.
- Excising the 140-300 m water depths (and buffers) from the acquisition area resulted in the:
    - Loss of 140 km2 (4.9%) of the acquisition area proposed in the original revision of the EP.
    - Reduction in acquisition line length of 258.9 km.
    - Reduction in the total number of acoustic pulses in the order of 13 to 14 thousand.

Figure 2.12 illustrates this excise area and buffer in detail. All maps in this EP illustrating the excise area include the 'no-effect distance' buffer.

While this re-design compromises the objectives of the survey because the full extent of the southern prospect will no longer be imaged, ConocoPhillips believes the re-design makes the survey more acceptable to commercial giant crab fishery stakeholders.

ConocoPhillips Australia proposes to acquire data in the southwestern corner of the survey area (west of the excise area) to allow extrapolation of the geological structures over the data gap introduced by the exclusion area.

Figure 2.12 Excised area and revised survey design (February 2021)



2.6.3. Sound Source

Initial survey design was based on a sound source of 4,500 cui. Further study was conducted to determine the minimal sound source level that could be used while still meeting the survey objectives. With additional subsurface remodelling and through consultation with seismic vessel companies and underwater sound specialists, the sound source was reduced to a maximum of 3,480 cui in order to minimise impacts to environmental receptors.

2.6.4. Number of Streamers (Base Case)

Since the initial EP was lodged for public comment, ConocoPhillips' base case for the number of streamers has evolved from 14 to 16. The use of 16 streamers results in a wider swath, thus reducing the number of sail lines needed to cover the same area. Even though flexibility needs to remain (12-18) due to unexpected operational issues, using 16 streamers instead of 14 has the benefit in reducing:

Survey Duration – Prime Acquisition Days:	24 days (was 27 days) - estimated
Survey Distance – Sail Line Kilometres:	4,854km (was 5,562km)
– Number of Sail Lines:	42 (was 48)

2.6.5. Timing

Through understanding the key environmental and commercial issues associated with the area and stakeholder consultation, ConocoPhillips Australia has adopted an acquisition window of 1st August - 31st October. ConocoPhillips Australia believes that this, combined with the giant crab fishing area excluded from the acquisition area, is a critical control to limit the impact to environmental receptors and commercial fishing interests.

2.7. Simultaneous Surveys

ConocoPhillips Australia understand that TGS (formerly Spectrum) holds an accepted EP to acquire seismic to the west of the proposed Sequoia MSS. The last remaining window under the EP is 1 October 2021 to end February 2022 which overlaps the Sequoia MSS survey window (1st August – 31st October). ConocoPhillips Australia remain in contact with TGS to keep abreast of their intentions to undertake the activity. This EP assesses the cumulative risks of both seismic surveys being undertaken at the same time.

ConocoPhillips Australia is not aware of other surveys proposed to occur within 100 km of the Sequoia 3DMSS.

2.8. Survey Summary

Table 2.7 summarises the survey parameters. It is important to note that this design may be further refined during the survey's planning phase.

Table 2.7 Summary of the proposed survey parameters

Parameter	Details
Earliest commencement date	1st August 2021
Survey window	1st August – 31st October
Survey duration	Approximately 60 days
Water depths	70 – 1,000 m + (excluding water depths of 140-300 m and associated buffer distances)
Acquisition area	2,840 km^2 (2,703 km^2 with excised area)
Source	
Number of source arrays	Three sub-arrays
Tow depth	6 m
Frequency range	0 to 200 Hz
Total volume	3,480 cui
Operating pressure	2,000 psi
Shot point interval	18.75 m
Streamers	
Number of streamers	Nominally 16 (12 -18 depending on vessel selection/operational constraints)
Length	6,100 m
Depth below sea surface	20-25 m multi-component, or 7-8 m non multi-component
Horizontal separation (average)	75 m
Type	Solid or gel core
Sail lines	
Number of sail lines	42
Sail line distance	4,854 km (4,595 km of active acquisition)
Orientation	North to south
Line separations	Varying from 500 m to 900 m
Survey vessel	
Contractor	To Be Determined
Survey vessel	To Be Determined
Survey vessel speed	4 knots (7.4 km/hr)
Refuelling	At sea
Support vessels	
Vessel types	One support vessel and one chase vessel
Contractors	Unknown at time of EP submission

3. Regulatory and Corporate Framework

In accordance with Regulation 13(4) of the OPGGS(E), this chapter describes the legislative requirements that apply to the activities described in this EP.

3.1. Commonwealth Legislation

Table 3.1 presents a summary of the key Commonwealth legislation and regulations relevant to the environmental management of the activity, with details of the most pertinent legislation and regulations provided below.

3.1.1. Offshore Petroleum and Greenhouse Gas Storage Act 2006

The *Offshore Petroleum and Greenhouse Gas Storage Act* 2006 (OPGGS Act) sets up a system for regulating the exploration for and recovery of petroleum in offshore areas including the construction and operation of infrastructure and pipelines, and provides for the grant of exploration permits, retention leases, production licences, infrastructure and pipeline licences, among other things.

Generally, the administration of the Act in relation to an offshore area of a State is the responsibility of the Joint Authority for the State. In this case, NOPSEMA is responsible for the administration of the occupational health and safety, structural integrity and environmental management provisions.

Offshore areas start 3 nautical miles (nm) from the baseline from which the territorial sea is measured and extend seaward to the outer limits of the continental shelf.

3.1.2. Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

The object of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)) is to ensure that petroleum and GHG storage activities carried out in an offshore area are carried out in a manner that is consistent with the principles of Ecologically Sustainable Development (ESD), where environmental impacts and risks are reduced to ALARP and are of an acceptable level.

The OPGGS(E) requires the preparation of an EP prior to conducting a petroleum activity for acceptance by NOPSEMA. The EP is an activity-specific document that provides a detailed impact and risk assessment and describes how identified risks will be managed. Upon EP acceptance, the activity may commence.

This EP has been prepared in accordance with Part 2 of the OPGGS(E) for NOPSEMA's assessment.

3.1.3. Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) is the key legislation regulating projects that may have an impact on matters of national environmental significance (MNES). The Commonwealth Department of Agriculture, Water and the Environment (DAWE) is the administrator of the EPBC Act. Proposed activities that are likely to have a significant impact on an MNES or the environment in general are required to prepare and submit an EPBC Act Referral to DAWE for determination as a 'not controlled' or 'controlled' action.

In February 2014, NOPSEMA became the sole designated assessor of petroleum and Greenhouse Gas (GHG) storage activities in Commonwealth waters in accordance with the Minister for the Environment's endorsement of NOPSEMA's environmental authorisation process under Part 10, Section 146 of the EPBC Act. Under the streamlined arrangements, impacts on the Commonwealth marine area by petroleum and

GHG storage activities are assessed solely through NOPSEMA and, consequently, an EPBC Act Referral has not been prepared and submitted to DAWE for the Sequoia 3DMSS.

A description of MNES in and around the survey area, and details on potential impacts and risks to MNES associated with the activity, are addressed throughout this EP.

Table 3.1 Summary of Key Commonwealth environmental legislation relevant to the activity

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
EPBC Act 1999 (& Regulations 2000)	Protects MNES, provides for Commonwealth environmental assessment and approval processes and provides an integrated system for biodiversity conservation and management of protected areas. The nine MNES are: 1) World heritage properties; 2) National heritage places; 3) Wetlands of international importance (Ramsar wetlands); 4) Nationally threatened species and ecological communities; 5) Migratory species; 6) Commonwealth marine environment; 7) The Great Barrier Reef Marine Park; 8) Nuclear actions (including uranium mining); and 9) A water resource, in relation to coal seam gas development and large coal mining development. Under the Act project decisions are assessed applying: • The Precautionary Principal; • The Principal of ESD; and • Consideration of key threatening processes. **Relevance to this activity:** This EP includes a description, assessment and mitigation measures associated with the MNES that may be impacted by the activity (principally items 4 and 5 in this list).	• Convention on Biological Diversity and Agenda 21 1992. • Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES). • Agreement between the Government and Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 (JAMBA). • Agreement between the Government and Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA). • Republic of Korea Migratory Birds Agreement 2006 (ROKAMBA). • Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 (RAMSAR). • International Convention for the Regulation of Whaling 1946. • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.	DAWE (NOPSEMA in the case of petroleum activities in an offshore area)

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
OPGGS Act 2006 and OPGGS (Environment) Regulations 2009	The Act addresses all licensing and HSE issues for offshore petroleum and GHG activities extending beyond the 3 nm limit. The Regulations (Part 2) specify that an EP must be prepared for any GHG activity and that activities are undertaken in an ecologically sustainable manner. **Relevance to this activity:** The preparation and acceptance of this EP satisfies the key requirements of this legislation.	Not applicable.	NOPSEMA
Environment Protection (Sea Dumping) Act 1981 (& Regulations 1983)	Aims to prevent the deliberate disposal of wastes (loading, dumping, and incineration) at sea from vessels, aircraft, and platforms. **Relevance to this activity:** There will be no dumping at sea within the meaning of the legislation that would require a sea dumping permit to be obtained.	• Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1972 [London Convention] • Protocol on the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1996 [London Protocol]	DAWE
Australian Maritime Safety Authority Act 1990 (AMSA Act)	Facilitates international cooperation and mutual assistance in preparing and responding to major oil spill incidents and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are implemented through the Australian Maritime Safety Authority (AMSA). AMSA is the lead agency for responding to oil spills in the Commonwealth marine environment and is responsible for implementing the Australian National Plan for Maritime Environmental Emergencies (‘NatPlan)’. **Relevance to this activity:** In the event of a Level 2 or 3 hydrocarbon spill to sea from the vessels, AMSA	• International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 (OPRC). • Protocol on Preparedness, Response and Cooperation to Pollution Incidents by Hazardous and Noxious Substances 2000. • International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969. • United Nations Convention on the Law of the Sea 1982 (UNCLOS) (articles 198 & 221).	AMSA

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
	may take over from ConocoPhillips as the Combat Agency and implement the NatPlan.		
Underwater Cultural Heritage Act 2018	Protects the heritage values of shipwrecks, sunken aircraft and relics (older than 75 years) in Australian Territorial waters below the low water mark to the outer edge of the continental shelf (excluding the State's internal waterways. It is an offence to interfere with a shipwreck covered by this Act. **Relevance to this activity:** Historic shipwrecks are mapped in the EMBA (but not in the operational area). In the event of the discovery of, and damage to previously unrecorded wrecks, this legislation may be triggered.	• Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972.	DAWE
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of ozone depleting substances. **Relevance to this activity:** The survey vessel will have a register of ozone-depleting substances (ODS).	• Montreal Protocol on Substances that Deplete the Ozone Layer 1987. • United Nations Framework Convention on Climate Change (UNFCCC) 1994.	DAWE

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
Navigation Act 2012 (& Regulations 2013)	This Act regulates ship-related activities in Commonwealth waters and invokes certain requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) relating to equipment and construction of ships. Several Marine Orders (MO) are enacted under this Act relating to the environmental and social management of offshore petroleum activities, including: • MO 21 - Safety and emergency arrangements. • MO 30 - Prevention of collisions. • MO 50 - Special purpose vessels. • MO 70 – Seafarer certification. **Relevance to this activity:** The vessels will adhere to the relevant MOs while operating within Commonwealth waters.	• United Nations Convention on the Law of the Sea 1982 (UNCLOS). • International Convention for the Safety of Life at Sea 1974 (SOLAS). • Convention on the International Regulations for Preventing Collisions at Sea 1972 (COLREG). • International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 (MARPOL). • International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) as amended, 1995.	AMSA

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (POSPOPS Act) Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994	Regulates ship-related operational activities and invokes certain requirements of the MARPOL Convention relating to discharge of noxious liquid substances, sewage, garbage, air pollution etc. It requires that ships >400 gross tonnes have pollution emergency plans. Several MO are enacted under this Act relating to offshore petroleum activities, including: • MO 91: Marine Pollution Prevention – Oil • MO 93: Marine Pollution Prevention – Noxious liquid substances • MO 94: Marine Pollution Prevention – Packaged harmful substances • MO 95: Marine Pollution Prevention – Garbage • MO 96: Marine Pollution Prevention – Sewage • MO 97: Marine Pollution Prevention – Air Pollution • MO 98: Marine Pollution Prevention – Anti- fouling Systems. **Relevance to this activity:** The survey vessel (and support vessels if >400 gross tonnes) will adhere to the relevant MOs by having a SMPEP, Oil Record Book and Garbage Management Plan in place and implemented, along with international pollution prevention certificates verifying compliance with oil, air pollution and sewage measures.	Various parts of MARPOL.	AMSA

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
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 10 tonnes, a levy is imposed in respect of the ship for the quarter. **Relevance to this activity:** The survey vessel will adhere to the shipping levy, as required.	Not applicable.	AMSA
Protection of the Sea (Civil Liability for Bunker Oil Pollution Damage) Act 2008	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 >1,000 gross tonnes to carry insurance certificates when leaving/entering Australian ports or leaving/entering an offshore facility within Australian coastal waters. **Relevance to this activity:** The survey vessel will hold the necessary insurance certificates, as required.	• International Convention on Civil Liability for Bunker Oil Pollution Damage 2001.	AMSA
Protection of the Sea (Harmful Antifouling Systems) Act 2006	Creates an offence for a person to engage in negligent conduct that results in a harmful anti- fouling compound being applied to a ship. Also provides that Australian ships must hold 'anti- fouling certificates', provided they meet certain criteria. **Relevance to this activity:** The survey and support vessels will hold valid anti-fouling certificates, as required.	• International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001.	AMSA

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
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 10 tonnes, a levy is imposed in respect of the ship for the quarter. **Relevance to this activity:** The survey and support vessels will adhere to the shipping levy, as required.	Not applicable.	AMSA
National Greenhouse and Energy Reporting Act 2007 (NGER) (& Regulations 2008)	Establishes the legislative framework for the NGER Scheme, which is a national framework for reporting GHG emissions, GHG projects and energy consumption and production by corporations in Australia. **Relevance to this activity:** Under the NGER Act, a controlling corporation assesses its reporting obligations by reference to the facilities that are under its 'operational control.' As the vessel contractor does not come under ConocoPhillips Australia's operational control, it is contractually and legislatively required to collect and submit its own emissions data under the NGER Act.	• UNFCCC 1994.	Clean Energy Regulator

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
Biosecurity Act 2015 (& Regulations 2016)	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal.	• International Convention for the Control and Management of Ships Ballast Water and Sediments 2004. • World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (SPS agreement). • World Organisation for Animal Health and the International Plant Protection Convention.	DAWE

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
	Offshore petroleum installations outside of 12 nm are located outside of Australian territory for the purposes of the Act. While these installations are not subject to biosecurity control, when a vessel or aircraft leaves Australian territory and interacts with an installation or petroleum industry vessel it becomes an 'exposed conveyance' and is subject to biosecurity control when it returns to Australian territory unless exceptions can be met. The person in charge of an exposed conveyance carries the responsibility for pre-arrival reporting under the Act and must arrive at a first point of entry. This Act includes mandatory controls in the use of seawater as ballast in ships and the declaration of sea vessels voyaging into and out of Commonwealth waters. The regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers. **Relevance to this activity:** The survey and support vessels sourced from foreign ports will adhere to the DAWE guidelines regarding quarantine clearance to enter Australian waters.		

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
Marine Safety (Domestic Commercial Vessel) National Law Act 2012 (& Regulations 2013)	This Act provides for a national system for Domestic Commercial Vessels (DCV) between states and territories to ensure their safe operation. This system provides for MO and National Standards to be adopted for DCVs of different classes. Current MO include: 1. MO 501 (Administration – National Law) 2013; 2. MO 502 (Vessel Identifiers – National Law) 2013; 3. MO 503 (Certificates of Survey – National Law) 2013; 4. MO 504 (Certificates of Operation and Operational Requirements – National Law) 2013; 5. MO 505 (Certificates of Competency – National Law) 2013; and 6. MO 507 (Load Line Certificates – National Law) 2013. This law does not over-ride state legislation with respect to marine environmental management, dangerous goods management, speed limits, navigation aids, rules for prevention of collisions, monitoring of marine communications systems, workplace health and safety or emergency management and response. **Relevance to this activity:** Applies to DCV used as support vessels.	Not applicable.	AMSA

Legislation / Regulation	Scope	Related International Conventions	Administering Authority
Fisheries Management Act 1991 (& Regulations 2009)	This Act aims to implement efficient and cost-effective fisheries management on behalf of the Commonwealth, ensure that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ESD, maximise the net economic returns to the Australian community from the management of Australian fisheries, ensure accountability to the fishing industry and to the Australian community in the Australian Fisheries Management Authority's (AFMA's) management of fisheries resources, and achieve government targets in relation to the recovery of the costs of AFMA. **Relevance to this activity:** Provides the regulatory and other mechanisms to support any necessary fisheries management decisions in the event of a hydrocarbon spill in Commonwealth waters.	Not applicable.	AFMA

3.2. Victorian Legislation

No part of the activity is located within Victorian state waters (between the low water mark and the 3 nm limit) and as such, no environmental approvals for the activity are required from the Victorian government. However, Victorian legislation is relevant in the unlikely event of a large hydrocarbon release, as the environment that may be affected (EMBA) intersects Victorian waters (see Chapter 5). The key Victorian legislation relevant to marine pollution in Victorian state waters includes:

- *Pollution of Waters by Oil and Noxious Substances Act* 1986 (‘POWBONS’) – designed to protect State waters from pollution by oil and other substances and to give effect to Annex I of the MARPOL convention. This Act restricts the discharge of treated oily bilge water according to vessel classification, discharge of cargo substances or mixtures, garbage disposal and packaged harmful substances, and sewage. The Act requires mandatory reporting of marine pollution incidents.
- *Emergency Management Act* 2013 – provides for the establishment of governance arrangements for emergency management in Victoria, including the Office of the Emergency Management Commissioner and an Inspector-General for Emergency Management. Provides for integrated and comprehensive prevention, response and recovery planning, involving preparedness, operational coordination and community participation, in relation to all hazards. These arrangements are outlined in the Emergency Management Manual Victoria.
- *Marine (Drug, Alcohol and Pollution) Act* 1988 – defines prohibited discharges (refer to POWBONS), and allocates roles, responsibilities and liabilities to ensure there is a capacity and obligation (i.e., Director – Transport Safety, public statutory body) to respond to marine incidents which have the potential, or do, result in pollution. The Victorian Marine Pollution Contingency Plan (EMV, 2016) is prepared under this Act.
- *Environment Protection Act* 1970 – this is the key Victorian legislation that controls discharges and emissions (air, water) to the Victorian environment (including state and territorial waters). It gives the Environment Protection Authority (EPA) powers to control marine discharges and to undertake prosecutions. It provides for the maintenance and, where necessary, restoration of appropriate environmental quality. Since 2017, the EPA no longer regulates domestic ballast water management in Victoria. This has been taken over by the Commonwealth government. This means vessels visiting a Victorian port no longer need to provide ballast water documentation to EPA Victoria, and that ballast water must be managed in accordance with the Biosecurity Act 2015 (Cth) (see Table 3.1).
- *Flora and Fauna Guarantee Act* 1988 (FFG Act) – this Act protects rare and threatened species and provides for a choice of procedures that can be used for the conservation, management or control of flora and fauna and the management of potentially threatening processes. Where a species has been listed as threatened, an Action Statement is prepared setting out the actions that have been or need to be taken to conserve and manage the species and community.
- *Seafood Safety Act* 2003 – this Act provides a regulatory system under which all sectors in the seafood supply chain are required to manage food safety risks. This could be triggered in the unlikely event that a hydrocarbon spill results in impacts to commercial fisheries or the prevention of sale of seafood caught in waters affected by a spill.
- *National Parks Act* 1975 – activities within Marine National Parks and Marine Sanctuaries require Ministerial consent before activities (such as oil spill response) are carried out. Several marine national parks occur within the MDO spill EMBA (entrained phase only, see Section 5.1).
- *Wildlife Act* 1975 – promotes the protection and conservation of wildlife and prohibit sand regulates persons authorised to engage in activities relating to wildlife (including incidents). The regulations prescribe minimum distances to whales and seals/seal colonies, restrictions on feeding/touching and restriction of noise within a caution zone of a marine mammal (dolphins (150 m), whales (300 m) and seals (50 m)).

3.3. Tasmanian Legislation

No part of the activity is located within Tasmanian state waters and as such, no environmental approvals for the activity are required from the Tasmanian government. Tasmanian legislation is only relevant to this EP in the unlikely event of a large hydrocarbon release, as the EMBA intersects areas of the Tasmanian coastline (the King Island shoreline) and state waters. The key Tasmanian legislation relevant to marine pollution in Tasmanian state waters includes:

- *Pollution of Waters by Oil and Noxious Substances Act* 1987 – designed to protect State waters from pollution by oil and other substances and to give effect to certain parts of the MARPOL convention.
- *Environmental Management and Pollution Control Act* 1994 – provides for the management of the environment and the control of pollution.
- *Emergency Management Act* 2006 – provides for the protection of life, property and the environment in a declared State emergency by outlining prevention, preparedness, response and recovery procedures.
- *Tasmanian Ports Corporation Act* 2005 – sets out administrative arrangements for the Tasmanian Ports Corporation Pty Ltd.
- *Marine and Safety Authority Act* 1997 – sets out powers to ensure the safe operation of vessels in Tasmanian state waters.

3.4. New South Wales Regulation

No part of the activity is located within New South Wales (NSW) state waters and as such, no environmental approvals for the activity are required from the NSW government. NSW legislation is only relevant to this EP in the unlikely event of a large hydrocarbon release, as the EMBA (low threshold for entrained marine diesel oil, MDO) intersects areas of the NSW coastline and state waters. The key NSW legislation relevant to marine pollution in NSW state waters includes:

- *Marine Pollution Act* 2012 (and Marine Pollution Regulations 2014) – designed to protect State waters from pollution by oil and other substances and to provide the Minister with powers of intervention with regard to detaining or directing commercial and trading vessels.;
- *Protection of the Environment Operations Act* 1997 (and Protection of the Environment Operations (General) Regulations 2009) – applies to all navigable waters, with authorised officers have powers to non-pilotage vessels to give clean-up directions and direct a person to take preventative action.;
- *Ports and Maritime Administration Act* 1995 – provides for the relevant port authority (in this case, Port Authority of NSW (Eden)) to exercise port safety functions, which involves providing or arranging for the provision of emergency environment protection services for responding to pollution incidents and carrying out investigations into marine incidents.;
- *State Emergency and Rescue Management Act* 1989 – provides the emergency response framework for state agencies and specifies the requirement for a State Emergency Management Plan to be in place and implemented in the event of an emergency as defined in the plan.

3.5. Environmental Policies, Guidelines and Codes of Practice

This EP has been developed in accordance with the NOPSEMA Guidance Note for *Environment Plan Content Requirements* (N04750-GN1344, Revision 4, April 2019). This document provides guidance to the petroleum industry on NOPSEMA's interpretation of the OPGGS(E) to assist titleholders in preparing EPs.

Other relevant government guidelines that have been incorporated or taken into consideration during the preparation of this EP include:

3.5.1. Environment Plans

- Environment plan assessment (NOPSEMA Policy N-04750-PL1347, Rev 8, March 2020).
- Reducing marine pest biosecurity risks through good practice biofouling management (NOPSEMA Information Paper N-04750-IP1899, Rev 1, March 2020).
- Environment plan decision making (NOPSEMA Guideline GL1721, Rev 6, November 2019).
- Environment plan content requirements (NOPSEMA Guidance Note, N-04750-GN1344, Rev 4, April 2019).
- Oil spill modelling (NOPSEMA Environment Bulletin, April 2019).
- Acoustic impact evaluation and management (NOPSEMA Information Paper, N-04750-IP1765, Rev 2, December 2018).
- Petroleum activities and Australian marine parks (NOPSEMA Guidance Note, N-04750-GN1785, Rev 0, July 2018).

3.5.2. Oil Pollution Emergency Plans

- Oil spill modelling (NOPSEMA Environment Bulletin, April 2019).
- Oil pollution risk management (NOPSEMA Guidance Note GN1488, Rev 2, February 2018).
- Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, January 2015).
- Advisory Note Offshore Petroleum Industry Oil Spill Contingency Planning Consultation (Victorian Department of Transport, Planning and Local Infrastructure, Version 2.0, August 2013).
- Advisory Note for Offshore Petroleum Industry Consultation with Respect of Oil Spill Contingency Plans (AMSA, 2012).

3.5.3. Operational and Scientific Monitoring Programs

- Operational and scientific monitoring programs (NOPSEMA Information Paper, N-04700-IP1349, March 2016).

3.5.4. EPBC Act

- 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, Industry guidelines (DEWHA, 2008).

3.6. Government Management Plans

The environmental performance standards (EPS) provided throughout Chapter 7 of this EP have taken into account various government management plans, generally under the categories of:

- Australian Marine Park (AMP) management plans;
- State coastal park management plans; and
- Recovery Plans, Conservation Plans and Conservation Advice for species threatened at the Commonwealth and/or state levels.

Appendix 1 provides an assessment of the activity against the objectives of marine reserves in the hydrocarbon spill EMBA. Appendix 2 provides an assessment of the activity against the objectives of various Commonwealth-listed threatened species Conservation Advice and Recovery Plans for species that may occur within the hydrocarbon spill EMBA.

3.7. International Codes of Practice and Guidelines

A number of international codes of practice and guidelines are relevant to environmental management of the activity. Those of most relevance are described in this section, listed in chronological order (starting with the most recent). The Commonwealth legislation described in Table 3.1 lists the conventions and agreements that are enacted by, or whose principles are embodied in, that legislation.

While none of the codes of practice or guidelines described in this section have legislative force in Australia (with the exception of MARPOL), they are considered to represent best practice environmental management (BPEM). Aspects of each code or guideline relevant to the impacts and risks presented by the activity are outlined throughout Chapter 7.

3.7.1. International Convention for the Prevention of Pollution from Ships

The key international convention relating to marine environmental matters is the International Convention for the Prevention of Pollution from Ships (MARPOL). This convention was adopted in November 1973 by the International Maritime Organisation (IMO), with ongoing additions and amendments. MARPOL aims to prevent and minimise pollution (routine discharges and accidents) from ships generally larger than 400 gross tonnes. It contains six annexes and is in force in over 170 countries (as of July 2020).

In Australian Commonwealth waters, MARPOL is given effect through the *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 and via Marine Orders made under the *Navigation Act* 2012 and is administered by AMSA. Table 3.2 lists the annexes of the Convention and identifies how they are given effect under Commonwealth legislation (with Victorian, Tasmanian and NSW legislation also included in the event of ingress into State waters being required in an emergency situation).

3.7.2. Environmental Management in the Upstream Oil and Gas Industry (2020)

These guidelines were released in August 2020 by the International Association of Oil & Gas Producers (IOGP) and the International Petroleum Industry Environmental Conservation Association (IPIECA). They supersede the United Nations Environment Programme Industry and Environment (UNEP IE) Environmental Management in Oil and Gas Exploration and Production guidelines released in 1997 prepared by the International Exploration and Production Forum (E&P Forum), the precursor to The International Association of Oil & Gas Producers (IOGP).

These guidelines provide descriptions of upstream oil and gas activities environmental management practices. Chapter 4 of the guidelines lists the environmental impacts and mitigation measures associated with offshore activities and provide a useful benchmark for BPEM for this activity.

3.7.3. Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (2019)

The *Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production* (European Commission, 2019) aims to identify best available techniques (BAT) and best risk management approaches for key environmental issues associated with onshore and offshore oil and gas exploration and production activities. The BATs included are not prescriptive nor exhaustive but included as a point of comparison with documents such as this EP to ensure the desired environmental outcomes commensurate with BAT can be achieved for the European context.

3.7.4. Effective Planning Strategies for Managing Environment Risk associated with Geophysical and other Imaging Surveys (2016)

The Effective Planning Strategies for Managing Environmental Risk associated with Geophysical and other Imaging Surveys: A Resource Guide for Managers (Nowacek and Southall, 2016) is prepared as a practical guide to the responsible and effective planning of offshore geophysical surveys and other forms of environmental imaging by the International Union for the Conservation of Nature (IUCN). The focus of the document is on marine mammals. The four key practices recommended in the document are:

1) Assess and evaluate the environment in the context of the proposed action.
   a) Collect baseline environmental and biological data.
   b) Identify proposed actions and alternatives.
   c) Engage stakeholders.
2) Evaluate risk and develop plans.
   a) Evaluate risks of proposed actions and alternatives.
   b) Identify mitigation actions.
   c) Develop monitoring strategy and methods.
3) Implement mitigation and monitoring of operations.
   a) Implement mitigation measures during survey operations.
   b) Implement real-time mitigation.
   c) Implement monitoring protocol.
4) Evaluate and improve.
   a) Report effectiveness of the mitigation program.
   b) Review effectiveness of the monitoring program.
   c) Promptly analyse and make results available.

Table 3.2 Commonwealth, Victorian and Tasmanian legislation enacting the MARPOL Convention

Annex (entry into force in Australia)	Commonwealth waters (POSPOPS Act 1983 & *Navigation Act* 2012)	Victorian waters (POWBONS Act 1986)	Tasmanian waters (POWBONS Act 1987)	General operating requirements
I Regulations for the Prevention of Pollution by Oil (1988)	AMSA MO 91; Marine Pollution Prevention – Oil.	Part 3, Division 2 – Prevention of pollution from ships Convention (ships carrying or using oil).	Part 2, Division 1 – Prevention of pollution from ships (Pollution by oil).	Addresses measures for preventing pollution by oil from regulated Australian vessels or foreign vessels, and specifies that: • An IOPP certificate is required; • A SMPEP is required; • An oil record book must be carried; • Oil discharge monitoring equipment must be in place; and • Incidents involving oil discharges are reported to AMSA.
II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (1988)	AMSA MO 93; Marine Pollution Prevention – Noxious Liquid Substances.	Part 3, Division 3 – Prevention of pollution from ships Convention (ships carrying noxious liquid substances in bulk).	Part 2, Division 2 – Prevention of pollution from ships (Pollution by noxious substances).	Addresses measures for preventing pollution by 250 noxious liquid substances carried in bulk from regulated Australian vessels or foreign vessels, and specifies that: • An IPP certificate is required; • A SMPEP is required; • A cargo record book must be carried; • Incidents involving noxious liquid substance discharges are reported to AMSA; • The discharge of residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with; and • No discharge of residues containing noxious substances is permitted within 12 nm of the nearest land.

Annex (entry into force in Australia)	**Commonwealth waters (POSPOPS Act 1983 & *Navigation Act* 2012)**	**Victorian waters (POWBONS Act 1986)**	**Tasmanian waters (POWBONS Act 1987)**	**General operating requirements**
III Prevention of Pollution by harmful Substances Carried by Sea in Packaged Form (1995)	AMSA MO 94; Marine Pollution Prevention – Packaged Harmful Substances.	Part 3, Division 4 – Ships carrying harmful substances.	Part 2, Division 2A – Prevention of pollution from ships (Pollution by packaged harmful substances).	Addresses measures for preventing pollution by packaged harmful substances (as defined in the International Marine Dangerous Goods (IMDG) code, which are dangerous goods with properties adverse to the marine environment, in that they are hazardous to marine life, impair the taste of seafood and/or accumulate pollutants in aquatic organisms) from regulated Australian vessels or foreign vessels, and specifies that: • The packing, marking, labelling and stowage of packaged harmful substances complies with Regulations 2 to 5 of MARPOL Annex III; • A copy of the vessel manifest or stowage plan is provided to the port of loading prior to departure; • Substances are only washed overboard if the Vessel Master has considered the physical, chemical and biological properties of the substance; and • Incidents involving discharges of dangerous goods are reported to AMSA.

Annex (entry into force in Australia)	Commonwealth waters (POSPOPS Act 1983 & *Navigation Act* 2012)	Victorian waters (POWBONS Act 1986)	Tasmanian waters (POWBONS Act 1987)	General operating requirements
IV Prevention of Pollution by Sewage from Ships (2004)	AMSA MO 96; Marine Pollution Prevention – Sewage.	Part 3, Division 5 – Sewage pollution prevention certificates.	Part 2, Division 2AB – Prevention of pollution from ships (Pollution by sewage).	Addresses measures for preventing pollution by sewage from regulated Australian vessels or foreign vessels, and specifies that: • An International Sewage Pollution Prevention (ISPP) certificate is required; • The vessel is equipped with a sewage treatment plant (STP), sewage comminuting and disinfecting system and a holding tank approved by AMSA or a recognised organisation; • The discharge of sewage into the sea is prohibited, except when an approved STP is operating or when discharging comminuted and disinfected sewage using an approved
				system at a distance of more than 3 nm from the nearest land; and • Sewage that is not comminuted or disinfected has to be discharged at a distance of more than 12 nm from the nearest land.

Annex (entry into force in Australia)	Commonwealth waters (POSPOPS Act 1983 & *Navigation Act* 2012)	Victorian waters (POWBONS Act 1986)	Tasmanian waters (POWBONS Act 1987)	General operating requirements
V Prevention of Pollution by Garbage from Ships (1990)	AMSA MO 95; Marine Pollution Prevention – Garbage. * Not made under the *Navigation Act* 2012.	Part 2, Division 2A – Prevention of pollution by garbage.	Part 2, Division 2B – Prevention of pollution from ships (Pollution by garbage).	Addresses measures for preventing pollution by garbage from regulated Australian vessels or foreign vessels, and specifies that: • Prescribed substances (as defined in the IMO 2012 Guidelines for the Implementation of MARPOL Annex V) must not be discharged to the sea; • A Garbage Management Plan must be in place; • A Garbage Record Book must be maintained; • Food waste must be comminuted or ground to particle size <25 mm while en route and no closer than 3 nm from the nearest land (or no closer than 12 nm if waste is not comminuted or ground); and • It is prohibited to discharge wastes including plastics, cooking oil, packing materials, glass and metal.
VI Prevention of Air Pollution from Ships (2007)	AMSA MO 97; Marine Pollution Prevention – Air.	Indirectly through the State Environment Protection Policy (Air Quality Management) under the Environment	Environmental Management and Pollution Control Act 1994 Environmental Protection Policy (Air Quality) 2004	Addresses measures for preventing air pollution from regulated Australian vessels or foreign vessels, and specifies that: • An IAPP certificate is in place; • An Engine International Air Pollution Prevention (EIAPP) certificate is in place for each marine diesel engine installed; • An IEE certificate is in place;

Annex (entry into force in Australia)	Commonwealth waters (POSPOPS Act 1983 & *Navigation Act* 2012)	Victorian waters (POWBONS Act 1986)	Tasmanian waters (POWBONS Act 1987)	General operating requirements
		Protection Act 1970: • Clause 33 (Management of Greenhouse Gases). • Clause 35 (Management of ODS). • Clause 36 (Management of other Mobile Sources).		• Specifies that incineration of waste is permitted only through a MARPOL-compliant incinerator, with no incineration of Annex I, II and III cargo residues, polychlorinated biphenyls (PCBs), garbage containing traces of heavy metals, refined petroleum products and polyvinyl chlorides (PVCs); • Marine incidents are reported to AMSA; • Sulphur content of fuel oil is no greater than 3.5% m/m; • A bunker delivery note must be provided to the vessel on completion of bunkering operations, with a fuel oil sample retained; and • Emissions of ODS must not take place and an ODS logbook must be maintained.

3.7.5. World Bank Group EHS Guidelines (2015)

The *Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development* (World Bank Group, 2015) is a technical reference document with general and industry-specific examples of good international industry practice. These guidelines are applied when one or more members of the World Bank Group are involved in a project.

The document contains measures considered to be achievable in new facilities, using existing technology, at reasonable costs. The guidelines are designed to be tailored to the applicable hazards and risks established for a given project.

While the World Bank Group is not involved in financing or assessing this activity, control measures adopted for this activity that adhere to these guidelines can be referenced as examples of BPEM.

3.7.6. Environmental Manual for Worldwide Geophysical Operations (2013)

The *Environmental Manual for Worldwide Geophysical Operations* (IAGC, 2013) produced by the International Association of Geophysical Contractors (IAGC) has been used to benchmark various planning aspects of the project. This manual provides broad guidance on environmental issues associated with seismic surveys (onshore and offshore), with the preparation of a detailed environmental impact assessment (EIA, as contained within this EP) being the key measure in demonstrating that BPEM is applied to a project.

The paper jointly published by the IAGC and IOGP *Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations* (IOGP & IAGC, March 2017) is referenced through this EP as necessary, and broadly recommends the same controls as those in the EPBC Act Policy Statement 2.1.

3.7.7. IOGP Best Practice Guidelines

The IOGP has a membership including companies that produce more than one-third of the world’s oil and gas. The IOGP provides a forum where members identify and share knowledge and good practices to achieve improvements in health, safety, environment, security and social responsibility. The IOGP’s aim is to work on behalf of oil and gas exploration and production companies to promote safe, responsible and sustainable operations. The IOGP’s work is embodied in publications that are made freely available on its website (www.iogp.org).

The IOGP has developed the ‘E&P Sound and Marine Life Programme’ under its Joint Industry Programme (JIP) (https://www.soundandmarinelife.org). The JIP supports research to help increase understanding of the effects of sound from the oil and gas industry on marine life. Research papers supported by the JIP are referenced throughout this EP as relevant.

As of February 2021, IOGP’s members comprise 77 members, comprising oil and gas exploration and production companies, associations and contractors.

ConocoPhillips is both an IOGP and JIP member and the relevant guidelines have been referenced in this EP (and associated OPEP) to support the oil spill response strategies.

The paper *Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations* (IOGP & IAGC, March 2017) is referenced through this EP as necessary, and broadly recommends the same controls as those in the EPBC Act Policy Statement 2.1.

3.7.8. IPIECA Best Practice Guidelines

IPIECA was established in 1974 and as of February 2021, IPIECA has 70 members, comprising oil and gas exploration and production companies, associations and contractors. ConocoPhillips is a corporate member of IPIECA.

IPIECA's vision is for an oil and gas industry whose operations and products meet society's environmental and social performance expectations, with a focus on the key areas of climate and energy, environment, social and reporting. It develops, shares and promotes good practices and knowledge to help the industry improve its environmental and social performance. IPIECA's work is embodied in publications that are made freely available on its website (www.ipieca.org).

Relevant guidelines have been referenced in this EP (and associated OPEP) as relevant, primarily in the areas of atmospheric emissions and oil spill response and preparedness.

ConocoPhillips has applied IPIECA's *Mapping the Oil and Gas Industry to the Sustainable Development Goals: An Atlas* (July 2017) to this activity. Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) is the most relevant to this survey, and has been met by fulfilling the following:

- Incorporating environmental assessments into management plans – this EP satisfies this sub-goal; and
- Accident prevention, preparedness and response – the OPEP and OSMP demonstrate that ConocoPhillips takes prevention, preparedness and response seriously and is well prepared to act in the event of an environmental emergency.

3.7.9. ITOPF Oil Spill Response Technical Information Papers

The International Tanker Owners Pollution Federation Limited (ITOPF) was established in 1968 to promote effective response to marine spills of oil, chemicals and other hazardous substances by providing five core services (spill response, claims analysis and damage assessment, information services, contingency planning and advice and training and education). Membership of ITOPF comprises owners or demise charterers of tankers, defined as any ship (whether or not self-propelled) designed, constructed or adapted for the carriage by water in bulk of crude petroleum, hydrocarbon products or other liquid substances.

Although the ITOPF definition of a tanker excludes seismic survey vessels, its series of Technical Information Papers (relating to marine pollution, including the effects of oil pollution, contingency planning for marine oil spills and responding to oil spills assist the upstream petroleum industry in preparing for and responding to oil spills) have been referenced in this EP (and associated OPEP) to support the oil spill response strategies.

3.8. ITOPF Oil Spill Response Technical Information Papers

There are few Australian industry codes of practice or guidelines regarding environmental management for offshore petroleum exploration. Those that do apply to the Sequoia 3DMSS are briefly discussed here, listed in chronological order (starting with the most recent).

None of these codes of practice or guidelines have legislative force in Australia (other than the EPBC Act Policy Statement 2.1) but are considered to represent BPEM. Aspects of each code or guideline relevant to the impacts and risks presented by the activity are described in the 'demonstration of acceptability' throughout Chapter 7.

3.8.1. National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna (2017)

The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE, 2017) provides a framework for identifying megafauna species (principally whales, dolphins, turtles and whale sharks) most at risk from vessel collision and outlines mitigation measures to reduce this risk.

The measures outlined in this EP are designed to minimise the risk of colliding with megafauna.

3.8.2. Australian Ballast Water Management Requirements (2020)

The Australian Ballast Water Management Requirements (DAWE, 2020, v8) detail the mandatory ballast water management requirements and provide information on ballast water pump tests, reporting and exchange calculations. The measures outlined in this EP are designed to minimise the risk of introducing harmful aquatic organisms into Australian waters.

3.8.3. Australian National Guidelines for Whale and Dolphin Watching (2017)

The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) principally apply to commercial marine tourism operations involves in whale and dolphin watching, outlining measures to comply with the EPBC Act and minimise disturbance to these cetaceans.

In the context of this activity, ConocoPhillips Australia applies these guidelines to the support vessels so that approach distances to cetaceans are adhered to.

3.8.4. National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2009)

The National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (DAFF, 2009) provides a generic approach to a biofouling risk assessment and practical information on managing biofouling on hulls and niche areas.

The measures outlined in this EP are designed to minimise the risk of introducing harmful aquatic organisms into Australian waters.

3.8.5. EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales (2008)

The *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* was published in 2008 by the then Commonwealth Department of the Environment, Water, Heritage and the Arts (2008) (now DAWE).

The statement provides standards to minimise the risk of acoustic injury to whales in the vicinity of MSS operations, provide a framework that minimises the risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important areas (BIAs) or during critical behaviours, and provide guidance to MSS proponents and contractors about their legal responsibilities under the EPBC Act 1999. Key controls applied to MSS in Australian waters are contained within Part A (Standard Management Procedures) and Part B (Additional Management Procedures), as they are for this survey (see Section 7.1).

3.8.6. APPEA: Code of Environmental Practice (2008)

In Australia, the petroleum exploration and production industry operates within an industry code of practice developed by the Australian Petroleum Production and Exploration Association (APPEA); the APPEA Code of Environmental Practice (CoEP) (2008). This code provides guidelines for activities that are not formally regulated and have evolved from the collective knowledge and experience of the oil and gas industry, both nationally and internationally.

The APPEA CoEP covers general environmental objectives for the industry, including planning and design, assessment of environmental risks, emergency response planning, training and inductions, auditing and consultation, and communication. For the offshore sector specifically, it covers issues relating to geophysical surveys, drilling and development and production.

The APPEA CoEP has been used as a reference for the EIA (Section 7 of this EP) to ensure that all necessary environmental issues and controls for petroleum exploration have been incorporated into the management of this activity.

3.8.7. National Strategy for Ecologically Sustainable Development (1992)

The National Strategy for Ecologically Sustainable Development (ESDSC, 1992) defines the goal of

Ecologically Sustainable Development (ESD) as 'development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.' Section 3A of the EPBC Act defines the principles of ESD as:

1) Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
2) 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;
3) 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;
4) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and
5) Improved valuation, pricing and incentive mechanisms should be promoted.

Ensuring that any petroleum activity is undertaken in a manner consistent with the ESD principal is a core aim of the OPGGS(E) and it has been taken into consideration in the demonstrations of acceptability in this EP (see Section 6.5.2).

3.9. ConocoPhillips Corporate Framework

3.9.1. Health, Safety and Environment Policy

In accordance with Regulation 16(a) of the OPGGS(E), ConocoPhillips' Health, Safety and Environment (HSE) Policy is provided in Figure 3.1. The policy provides a public statement of the company's commitment to minimise adverse effects on the environment and to improve environmental performance.

This activity operates under ConocoPhillips' HSE Management System (HSEMS) to minimise and manage the impacts on employees, contractors, the environment and the communities in which the company operates. (described further in Chapter 8).

Figure 3.1 ConocoPhillips Health, Safety and Environment Policy

ConocoPhillips

HEALTH, SAFETY AND ENVIRONMENT POLICY

Our Commitment

ConocoPhillips is committed to protecting the health and safety of everybody who plays a part in our operations, lives in the communities in which we operate or uses our products. Wherever we operate, we will conduct our business with respect and care for both the local and global environment and systematically manage risks to drive sustainable business growth. We will not be satisfied until we succeed in eliminating all injuries, occupational illnesses, unsafe practices and incidents of environmental harm from our activities.

Our Plan

To meet our commitment, ConocoPhillips will:

- Demonstrate visible and active leadership that engages employees and services providers, and manage health, safety and environmental (HSE) performance as a line responsibility with clear authorities and accountabilities.
- Ensure that all employees and contractors understand that working safely is a condition of employment, and that they are each responsible for their own safety and the safety of those around them.
- Maintain "stop work" policies that establish the responsibility and authority for all employees and contractors to stop work they believe to be unsafe.
- Manage all projects, products and processes through their life cycles in a way that protects safety and health and minimizes impacts on the environment.
- Provide employees with the capabilities, knowledge and resources necessary to instill personal ownership and motivation to achieve HSE excellence.
- Provide relevant safety and health information to contractors and require them to provide proper training for the safe, environmentally sound performance of their work.
- Measure, audit and publicly report HSE performance and maintain open dialogue with stakeholder groups and with communities where we operate.
- Comply with applicable regulations and laws.
- Work with both governments and stakeholders where we operate to develop regulations and standards that improve the safety and health of people and the environment.
- Maintain a secure work environment to protect ourselves, our contractors and the Company's assets from risks of injury, property loss or damage resulting from hostile acts.
- Communicate our commitment to this policy to our subsidiaries, affiliates, contractors and governments worldwide and seek their support.

Our Expectations

Through implementation of this policy, ConocoPhillips seeks to earn the public's trust and to be recognized as the leader in HSE performance.

Ryan Lance
Chairman and Chief Executive Officer
ConocoPhillips

3.9.2. ConocoPhillips Sustainable Development Position

ConocoPhillips' approach is to conduct business in a way that promotes economic growth, a healthy environment, and vibrant communities, now and into the future. ConocoPhillips' focus is to develop the following company-wide competencies to successfully promote sustainable development:

- Integration — Clearly and completely integrate economic, social and environmental considerations into strategic planning, decision-making and operating processes.
- Stakeholder Engagement — Engage our stakeholders to understand their diverse and evolving expectations and incorporate that understanding into our strategies.
- Life-Cycle Management — Manage the full life cycle impacts of our operations, assets, and products.
- Knowledge Management — Share our successes and failures to learn from our experiences.
- Innovation — Create a culture that brings new, innovative thinking to the challenges of our evolving business environment.

Further information can be found at: https://www.conocophillips.com/sustainability/integrating-sustainability/sustainable-development-governance/policies-positions/sustainable-development-position/

3.9.3. ConocoPhillips Biodiversity Position

ConocoPhillips has recently released its position regarding biodiversity. ConocoPhillips' biodiversity approach is designed to manage risks and mitigate impacts to biodiversity, with a focus on:

- Applying a science-based approach and considering cumulative effects to develop leading best practices.
- Collecting data and information on local biological diversity through site assessments and baseline studies.
- Developing indicators and metrics to track biodiversity impacts and risk management performance.
- Applying technological innovation and practical, sustainable solutions for biodiversity conservation.
- Implementing stewardship and habitat conservation practices on company owned lands.
- Leveraging our SPIRIT of Conservation Program, migratory bird joint ventures and other partnership programs to support the conservation and restoration of habitats.
- Collaborating with conservation organisations, governments, and policy bodies.
- Engaging with local communities on biodiversity-related impacts associated with our operations, mitigation actions and proactive initiatives to support biodiversity conservation.

ConocoPhillips' commitment is to not operate exploration, development, drilling or production activities in habitats of significant importance to critically endangered species, or other critical habitat, unless we can adequately mitigate impacts through mitigation hierarchy measures in accordance with our sustainable development management system, regulatory requirements and through local engagement.

Further information can be found at: https://www.conocophillips.com/sustainability/integrating-sustainability/sustainable-development-governance/policies-positions/biodiversity-position/

4. Stakeholder Consultation

ConocoPhillips Australia recognises its activities have the potential to impact the environment and the communities where it operates. Impacts of ConocoPhillips Australia's activities are minimised by planning, designing, constructing and operating facilities to the appropriate industry standards and by working collaboratively with stakeholders to identify and mitigate negative impacts.

ConocoPhillips Australia's goal is to respectfully engage with local stakeholders for the Sequoia 3DMSS — those who may impact or may be impacted by the survey — to understand their values and interests and seek to reduce the impact of the Sequoia 3DMSS on such stakeholders.

4.1. Stakeholder Consultation Objectives

ConocoPhillips Australia's objectives of its stakeholder engagement are to:

- Confirm existing stakeholders and identify whether there are additional stakeholders to those identified during 3D Oil's Dorrigo 3DMSS;
- Gather issues from identified stakeholders to inform EP development;
- Initiate and maintain positive, long-term relationships with identified stakeholders that will support ongoing exploration, operations and production of gas from T/49P; and
- Meet regulatory requirements for stakeholder engagement.

Stakeholder engagement is a key element of ConocoPhillips' HSE Policy. Beyond stakeholders in the communities where it operates, ConocoPhillips Australia also engages with government representatives, non-governmental organisations (NGOs), business and community stakeholders, academic institutions and industry associations to gain diverse and valuable perspectives as it continuously works to improve its sustainable development programs and initiatives.

4.2. Guiding Principles for Stakeholder Engagement

ConocoPhillips Australia has a strategic and systematic approach to stakeholder engagement, which aims to foster an environment where two-way communication and ongoing, open dialogue is encouraged to build positive relationships. ConocoPhillips Australia will:

- Proactively identify and consult stakeholders;
- Include stakeholders in the design and implementation of the engagement process;
- Listen to and understand stakeholders' interests, concerns, and culture;
- Communicate openly;
- Seek solutions that create mutually beneficial relationships and build long-term value for both the company and its stakeholders; and
- Follow through on commitments and stand accountable for the results, both internally and externally.

4.3. Regulatory Requirements

Section 280 of the OPGGS Act states that a person carrying out activities in an offshore permit area should not interfere with other users of the offshore area to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.

In relation to the content of an EP, more specific requirements are defined in the OPGGS(E) Regulation 11A. This regulation requires that the titleholder consult with 'relevant persons' in the preparation of an EP. A 'relevant person' is defined in Regulation 11A as:

- Each Department or agency of the Commonwealth to which the activities to be carried out under the EP, or the revision of the EP, may be relevant;
- Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP, or the revision of the EP, may be relevant;
- The Department of the responsible State Minister, or the responsible Northern Territory Minister;
- A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP, or the revision of the EP; and
- Any other person or organisation that the titleholder considers relevant.

Further guidance regarding the definition of functions, interests or activities is provided in NOPSEMA's Assessment of Environment Plans: Deciding on Consultation Requirements Guidelines (N-04750-GL1629, Rev 0, April 2016), as follows:

- Functions – a person or organisation's power, duty, authority or responsibilities;
- Activities – a thing or things that a person or group does or has done; and
- Interests – a person or organisation's rights, advantages, duties and liabilities; or a group or organisation having a common concern.

Regulation 14(9) of the OPGGS(E) also defines a requirement for ongoing consultation to be incorporated into the Implementation Strategy in the EP (see Chapter 8). In addition, Regulation 16(b) of the OPGGS(E) requires that the EP contain a summary (see Section 4.8) of consultation with relevant persons and all correspondence with relevant persons (provided in Appendix 3).

Amendments to the OPGGS(E) that took effect on the 25th of April 2019 also specify (in Regulation 9AB) that the complete EP will be published on the NOPSEMA website. For MSS EPs, Regulation 11B states that NOPSEMA must invite comments from the public on the EP and that those comments must be submitted to NOPSEMA within 30 days of the invitation and that the comments will be provided to the titleholder. In response to the comments, the titleholder may then modify the EP prior to formal submission for NOPSEMA assessment, with the EP re-published on the NOPSEMA website (refer to Section 4.5.6).

4.4. Stakeholder Identification

For the purpose of stakeholder consultation to support this EP, ConocoPhillips Australia has identified and consulted with relevant persons whose functions, interests or activities may be affected by the activity, as well as those who ConocoPhillips Australia deems necessary to keep up to date with the activities in the T/49P permit. Table 4.1 identifies these relevant persons, using the five classifications listed in Section 4.3.

ConocoPhillips Australia leveraged the stakeholder identification efforts undertaken by 3D Oil as part of the Dorrigo 3D MSS to identify and inform relevant stakeholders. ConocoPhillips Australia has made best efforts to engage with all relevant stakeholders that have been identified through the preparation of the EP; however, it is noted that a number of stakeholders did not respond, despite multiple attempts.

Table 4.1 Stakeholders consulted for the Sequoia MSS

Stakeholder organisation or individual	Function, Activity, Interest
Commonwealth Department or Agency Department or agency of the Commonwealth to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant.	
Australian Fisheries Management Authority (AFMA)	Manager of fisheries in Commonwealth waters.
Australian Maritime Safety Authority (AMSA)	AMSA is a statutory authority established under the *Australian Maritime Safety Authority Act* 1990, with one its key functions being to promote maritime safety and protect the ocean.

Stakeholder organisation or individual	Function, Activity, Interest
Director of National Parks (DNP)	Manages the AMP network in Commonwealth waters
Australian Hydrographic Office (AHO)	Responsible for the publication and distribution of nautical charts and other information required for safe shipping navigation in Australian waters.
Department of Agriculture, Water and the Environment (DAWE)	Commonwealth department responsible for administration of the EPBC Act, Australian Marine Parks (AMPs) and MNES.
Department of Defence (DoD) - Defence Support Group	Manage all Australian defence activities.
Department of Infrastructure and Regional Development (DIRD)	Commonwealthinfrastructure and development department.
Civil Aviation Safety Authority (CASA) - Aviation Group	Aviation regulator
Maritime Border Control	Biosecurity requirements for vessels entering Australian waters and ports.

Stakeholder organisation or individual	Function, Activity, Interest
State or Territory Department or Agency Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP, or the revision of the EP, may be relevant.	
Tasmania	
Department of Primary Industries, Parks, Water and Environment (DPIPWE)	Tasmania's leading natural resources agency, responsible for the sustainable management of natural and cultural heritage.
Tasmania Parks and Wildlife Service (PWS) – King Island Office	Government agency responsible for managing protected areas on Tasmanian public land.
Environment Protection Authority (EPA)Tasmania	Tasmanian environmental regulator.

Mineral Resources Tasmania (MRT)	Tasmanian mineral resources regulator.
Victoria	
Victorian Fishing Authority (VFA)	Manager of commercial fisheries in Victorian waters.
Department of Environment, Land, Water and Planning (DELWP)	Responsible for management of coastal and marine parks.
Department of Jobs Precincts and Regions (DJPR): Marine Pollution	Control agency for marine pollution emergencies in Victorian waters.
New South Wales	
Port Authority of NSW	Acts as harbourmaster NSW's six commercial seaports, managing shipping movements, safety, security and emergency response (only relevant in the event of an MDO spill entering state waters).
Transport for NSW	Leading transport and roads agency in NSW (only relevant in the event of an MDO spill entering state waters).

Stakeholder organisation or individual	Function, Activity, Interest
Organisation, Function or Individual A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP, or the revision of the EP	
Fishing Associations	
Commonwealth	
Commonwealth Fisheries Association	Peak body representing the collective rights, responsibilities and interests of a range of Commonwealth fisheries.
Tuna Australia – Eastern Tuna and Billfish Fisheries Industry Association	Peak body representing the Eastern Tuna and Billfish Fishery.
Australian Southern Bluefin Tuna Industry Alliance (ASBTIA)	Peak body representing the Southern Bluefin Tuna Fishery.
South East Trawl Fishing Industry Association (SETFIA)	Peak representative body for trawl fishing in south-east Australia.
Sustainable Shark Fishing Inc	Peak industry body representing shark gillnetters.
Southern Shark Industry Alliance	Supports its members who rely on the sustainable harvesting of the Southern Shark Fishery
Bass Strait Scallop Industry Association	Peak representative body for the Bass Strait Central Zone Scallop Fishery.
Tasmanian	
Tasmanian Seafood Industry Council (TSIC)	Peak body representing the interests of wild capture fishers, marine farmers and seafood processors in Tasmania.
ConocoPhillips Australia has identified the following Tasmanian fishing associations as relevant under Regulation 11A(a). ConocoPhillips Australia's commitment to TSCI to consult in accordance with the SIV/TSIC policy (Policy in Relation to Mining, Gas and Petroleum Sector Consultation with the Professional Seafood Industry), resulted in engagement with sub-associations facilitated via the peak industry association.	
Tasmanian Association for Recreational Fishing (TARFish)	Peak body representing recreational fishers in Tasmania.

Tasmanian Abalone Council Limited	Voice of the fishery representing divers, non-diving quota holders, processors and exporters.
Tasmanian Rock Lobster Fisherman's Association	Association of Tasmanian rock lobster fishermen.
Tasmanian Scallop Fisherman's Association	Association of Tasmanian scallop fishermen.
Victorian	
Seafood Industry Victoria (SIV)	Peak industry body for Victorian Fisheries.
ConocoPhillips Australia has identified the following Victorian fishing associations as relevant under Regulation 11A(a). ConocoPhillips Australia's commitment to SIV to consult in accordance with the SIV/TSIC policy (Policy in Relation to Mining, Gas and Petroleum Sector Consultation with the Professional Seafood Industry), resulted in engagement with sub-associations facilitated via the peak industry association.	
Victorian Rock Lobster Fishing Association (VRLA)	Peak fishing body for southern rock lobster in Victoria.
Warrnambool Professional Fishermen's Association	Peak body representing professional fishermen in Warrnambool.

Stakeholder organisation or individual	Function, Activity, Interest
Port Campbell Professional Fisherman's Association	Peak body representing professional fishermen in Port Campbell.
Apollo Bay Fishing Cooperative	Association for Apollo Bay fishermen.
VRFish	Peak body representing recreational fishers in Victoria.
Individual Fishers	
Commonwealth Fishing Licensee	
[redacted]	Commonwealth Trawl Sector (CTS) fisher.
[redacted]	CTS fisher.
[redacted]	CTS fisher
[redacted]	CTS fisher.
[redacted]	CTS fisher.
[redacted]	CTS fisher.
[redacted]	CTS fisher.
[redacted]	CTS fisher.
[redacted]	CTS and Bass Strait Central Zone Scallop Fishery fisher.
[redacted]	Gillnet, Hook and Trap (GHaT) and Scalefish Hook Sector (SHS) fisher
[redacted]	GHaT and SHS fisher
[redacted]	GHaT and Victorian rock lobster fisherman.
Possible Fishing Licensee (in the central Bass Strait)	
Mures Fishing Pty Ltd	Possible Fishing Licensee in the central Bass Strait.
Muollo Fishing Pty Ltd	Possible Fishing Licensee in the central Bass Strait.
Gazak Holdings Pty Ltd	Possible Fishing Licensee in the central Bass Strait.
Corporate Alliance Enterprises Pty Ltd	Possible Fishing Licensee in the central Bass Strait.
ANZT Fishing Company Pty Ltd	Possible Fishing Licensee in the central Bass Strait.

Southern Squid Fisher	Possible Fishing Licensee in the central Bass Strait.
Tasmanian Fishing Licensee	
ConocoPhillips Australia's commitment to TSIC to consult in accordance with the SIV/TSIC policy (Policy in Relation to Mining, Gas and Petroleum Sector Consultation with the Professional Seafood Industry), resulted in engagement with fishing licensees facilitated via the peak industry association.	
Victorian Fishing Licensee	
ConocoPhillips Australia's commitment to SIV to consult in accordance with the SIV/TSIC policy (Policy in Relation to Mining, Gas and Petroleum Sector Consultation with the Professional Seafood Industry), resulted in engagement with fishing licensees facilitated via the peak industry association.	
Stakeholder organisation or individual	**Function, Activity, Interest**
Relevant Others Any other person or organisation that the title holder considers relevant.	
Titleholders	
Beach Energy	Titleholder of several exploration permits, production licences and retention leases to the east and northwest.
TGS (formerly Spectrum)	Seismic survey service provider with an approved EP in nearby waters.
Local Government	
Colac Otway Shire	Victorian local government authority (LGA) council adjacent to the MSS.
Corangamite Shire Council	Victorian shire council near the survey area.
King Island Shire Council	Tasmanian shire council in closest proximity to the survey area.
Circular Head Council	Tasmanian shire council near the survey area.
Conservation	
Blue Whale Study	Organisation concerned with conservation and research outcomes for blue whales.
Deakin University – School of Life and Environmental Sciences	Marine conservation research.
Recreation	
Ocean Racing Club of Victoria (ORCV)	Conducts ocean/offshore and bay yacht races and events in Victoria.
Traditional Owner Groups	
Bunurong Land Council Aboriginal Corporation	Incorporated association representing the Bunurong community
Eastern Maar Aboriginal Corporation	Incorporated association representing the Eastern Maar community.
Wadawurrung Traditional Owners Aboriginal Corporation	Incorporated association representing the Wadawurrung community.
Other	
University of Tasmania (UTAS) - Institute for Marine and Antarctic Studies (IMAS)	Cooperative teaching and research institute between various marine and Antarctic agencies
Indigo Communications Cable (SULO)	Operator of the 'superloop' subsea telecommunications cable.

Aquasure	Operators of the Victorian Desalination Plant.
King Island Chamber of Commerce (KICC)	Association supporting business on King Island.
Colac and District Chamber of Commerce	Association supporting businesses in Colac and surrounds.
Tourism Industry Council of Tasmania	Peak body representing Tasmania's tourism industry.

Note that consultation with contractors to ConocoPhillips Australia who will assist with undertaking the MSS is not addressed in this section of the EP. This includes organisations that ConocoPhillips Australia has a contract or agreement with for:

- EP and specialist studies development;
- Seismic acquisition design and execution (i.e., seismic contractors); and
- Assistance in the event of an MDO spill response or operational and scientific monitoring.

Discussions with these organisations that are not directly linked to undertaking the MSS, and vendors involved in the design and tender process are not included in the summary of stakeholder consultation in Section 4.8.

Where discussions with these organisations have assisted in the development or refinement of vessel-based MDO spill response strategies described in the Oil Pollution Emergency Plan (OPEP) (see Chapter 9), then these have been incorporated. The 'functions, interests or activities' of these organisations are only triggered in an emergency response. Consultation with these contractors and organisations is undertaken in accordance with Regulation 14(5) of the OPGGS(E), which requires measures to ensure that each employee or contractor working on, or in connection with the activity, is aware of his or her responsibilities in relation to this EP and has the appropriate competencies and training. This is detailed in Section 8.10 of the EP.

ConocoPhillips Australia recognises that the relevance of stakeholders identified in this EP may change in the event of a non-routine event or emergency. Every effort has been made to identify stakeholders that may be impacted by a non-routine event or emergency, the largest of which is considered a Level 2 or 3 MDO spill from the survey vessel or from one of its support vessels (see Section 7.13).

ConocoPhillips Australia acknowledges that other stakeholders not identified in this EP may be affected, and that these may only become known to ConocoPhillips Australia in the event of an MDO.

4.5. Engagement Methodology

After the initial stakeholder identification process was complete, the stakeholder engagement process commenced to determine area use, marine habitats and areas of most concern within the marine environment in relation to the Sequoia 3DMSS. Stakeholders were then identified based on this list.

To support ongoing engagement and enable stakeholder feedback, ConocoPhillips Australia created a Sequoia 3DMSS-specific:

- Email address: sequoia@conocophillips.com
- Telephone number: 07 3182 7122
- Resource page on website: https://www.conocophillips.com.au/what-we-do/otway-basin/

ConocoPhillips Australia acknowledges the technical nature of information relating to the modelling can mean it can be difficult to understand. While the technical reports are summarised within the EP and available for stakeholders as appendices to the EP, ConocoPhillips Australia summarised the key impacts, risks and controls of the key reports in a concise and accessible way. This approach was taken for the vessel MDO spill modelling fact sheet and the underwater sound modelling fact sheet.

The global COVID-19 pandemic and associated travel restrictions have impacted ConocoPhillips Australia's ability to undertake face-to-face consultation during the planning of this activity. While travelling to undertake face-to-face consultation has not been possible, ConocoPhillips Australia has undertaken engagement via post, phone, email and online meetings. Face-to-face consultation methods will be used once travel restrictions ease.

ConocoPhillips Australia maintains all records of stakeholder engagement in a database called Mendix™.

The information provided in this section highlights that ConocoPhillips Australia has provided sufficient information to relevant persons (in accordance with OPGGS(E) Regulation 11A(2)) and that a reasonable period of time (in accordance with OPGGS(E) Regulation 11A(3)) has been allowed for in the engagement process.

4.5.1. Fact Sheets

The following fact sheets (see Appendix 4) were issued to relevant persons and made available for stakeholders.

- Project Summary fact sheet (ABU2-000-EX-R01-D-00001) and personalised letter of introduction – issued to all relevant persons between 7 and 17 August 2020. This fact sheet provided a high-level overview of ConocoPhillips Australia's intention to undertake the Sequoia 3DMSS and outlined the proposed survey design, location and timing. It also included some question and answers (Q&As) and contact details that stakeholder could use to provide feedback. This fact sheet was also posted on the ConocoPhillips Australia website
- Proposed Survey Area Summary fact sheet (ABU2-000-EX-R01-D-00002) – issued to peak fishing industry associations and identified Commonwealth fishers on 17 September 2020. This fact sheet provided geographic coordinates of the proposed Sequoia 3DMSS operational area and seismic acquisition area. A simplified version of this fact sheet was posted on the ConocoPhillips Australia website.
- How we will undertake a 3D seismic survey fact sheet (ABU2-000-EX-R01-D-00003) – issued to peak fishing industry associations and identified Commonwealth fishers between 15 and 17 September 2020. This fact sheet provided information on MSS and ConocoPhillips Australia's proprietary CSI technology. This fact sheet was also posted on the ConocoPhillips Australia website.
- Vessel MDO spill modelling and controls fact sheet (ABU2-000-EX-R01-D-00004) – issued to various stakeholders between 23 and 27 October 2020. This fact sheet presented the results of the vessel MDO modelling undertaken and identified controls to support the survey. This fact sheet was also posted on the ConocoPhillips Australia website.
- Underwater sound modelling and controls fact sheet (ABU2-000-EX-R01-D-00005) – issued to various stakeholders on 27 October 2020. This fact sheet presented the results of the underwater sound modelling undertaken and identified controls to support the survey. This fact sheet was also posted on the ConocoPhillips Australia website.
- Project Update fact sheet (ABU2-000-EX-R01-D-00008) – issued to all relevant persons on 9 February 2021. This fact sheet provided a high level update on what had occurred since the last communication and outlined the new control to excise the giant crab habitat in the south west region of the survey area from the seismic acquisition area. It also included some frequently asked questions (FAQ's) and contact details that stakeholder could use to provide feedback. This fact sheet was also posted on the ConocoPhillips Australia website.

4.5.2. Project Briefings

Project briefings were provided to any relevant person that expressed concerns or identified issues with the Sequoia 3DMSS. Briefings were facilitated/attended by the project team, technical experts and senior management. The purpose of these briefings was for ConocoPhillips Australia to provide activity information and updates, listen to issues and concerns, gain feedback on the project and to identify further opportunities for engagement. Information was tailored to accommodate the different levels of stakeholder understanding.

Appendix 3 contains all individual responses provided to stakeholders as part of this process, including records of formal project briefings undertaken.

4.5.3. Fishing Activity Survey

ConocoPhillips Australia worked with SIV and TSIC to distribute a survey to relevant fishers of their membership base in order to determine relative fishing intensity in the survey area and associated concerns. Both associations received the agreed information for issue to members on 15 September 2020.

TSIC issued the survey (Appendix 5) to all members with an email address (345 members) on 18 September and 6 October 2020. This represents 72% of the TSIC wild catch membership base. Notice of the survey and an invitation to contribute also appeared on the TSIC website accompanied by the survey. In a separate email campaign, 268 SRL and giant crab entitlement holders (being members of the TRLFA) were contacted in two email campaigns on 16 and 28 September 2020.

A total of 41 responses (representing 54 people) were received from TSIC members by phone and email as part of this process (Appendix 8). TSIC followed up with phone calls to 78 SRL and giant crab fishers who live on King Island or in northwest Tasmania.

Identified SIV members were emailed the same survey on 16 September 2020. SIV identified the following stakeholders were consulted as part of this process:

- 24 giant crab stakeholders (licence holders and operators);
- 185 rock lobster stakeholders (licence holders and operators);
- 152 Ocean Access Fishery licence holders;
- 36 Ocean Scallop licence holders;
- 47 In-shore Trawl licence holders; and
- 17 member associations.

4.5.4. Individual Responses

ConocoPhillips Australia provided written responses to all written enquires received from stakeholders to address their specific concerns throughout the duration of EP development.

Appendix 3 contains all individual responses provided to stakeholders as part of this process.

4.5.5. Media Engagement

ConocoPhillips Australia has responded to several media enquiries as part of EP development. For the purposes of this EP ConocoPhillips Australia has distributed information to media outlets where media outlets have made the request to be included as part of project information distribution.

4.5.6. Public Exhibition of EP

In line with the requirements of OPGGS(E) Regulation 11B, the EP was publicly exhibited on the NOPSEMA website from 4 December 2020 to 3 January 2021. This exhibition period resulted in 340 submissions on the EP, broadly categorised as:

- 302 (89%) generally opposed to continued petroleum exploration and production, with no specific concerns raised about the content of the EP;
- 27 (8%) blank submissions (name and/or email provided, but no associated comments); and
- 11 (3%) submissions that provided specific comments on EP content, 5 of which were responded to with a letter by ConocoPhillips between 15 and 27 January 2021. (Note: 3 additional letters were sent to stakeholders ConocoPhillips Australia had been liaising with but did not make a submission)

The titleholder report on public comment that accompanies the formal submission of this EP identifies the following themes that emerged from the public comments:

- The seismic survey will result in injury or death to whales and dolphins. Recent strandings of pilot whales in Tasmania may have been related to a seismic survey.
- Seismic surveys should not be allowed to proceed until the Senate Inquiry regarding the Impact of seismic testing on fisheries and the marine environment is complete and the report is released.
- The timing of public exhibition over the Christmas and new year period was a tactic designed to give stakeholders less time to provide comments.
- Exploration for oil and gas should cease in preference for creating more renewable energy sources.
- The risk of an oil spill during the survey is too high and that oil would pollute large sections of Bass Strait and be detrimental to marine life.
- The seismic survey will result in unacceptable losses of southern rock lobster larvae.
- The seismic survey will result in unacceptable losses of larvae for fish species of commercial fishing importance.
- The seismic survey will damage Tasmania's and King Island's 'clean and green' image.

In response to the comments, ConocoPhillips Australia has modified the design of the acquisition area (see Section 2.6.1.2), and consequently modified this EP for formal submission for NOPSEMA assessment.

4.6. Engagement with the Commercial Fishing Industry

The commercial fishing industry is the key stakeholder group with a commercial interest in the marine environment within and surrounding the Sequoia 3DMSS operational area.

ConocoPhillips Australia leveraged the stakeholder identification efforts undertaken by 3D Oil as part of the Dorrigo 3DMSS to identify and inform relevant industry associations and commercial fishers in the region. The proposed activity will occur in Commonwealth waters, however, Commonwealth, Tasmanian and Victorian fisheries and licence holders were identified as relevant as part of stakeholder identification.

Through early engagement with peak commercial fishing associations (SETFIA, SIV, TSIC), key industry concerns were identified and preferences sought on ideal consultation approach with sub-associations and individual fishers moving forward. These discussions are summarised in this section.

To understand the potential impact of the activity to commercial fishing activity, ConocoPhillips Australia commissioned SETFIA to revise the *Review of Commercial Fishing Operations* Report commissioned by 3D Oil for the Dorrigo 3DMSS. As per the original report, the revision was undertaken by Fishwell Consulting.

ConocoPhillips Australia wishes to recognise the professional, transparent and ongoing relationship that was built with SETFIA, TSIC and SIV.

4.6.1. South East Trawl Fishing Industry Association (SETFIA) Engagement

Early engagement with SETFIA focused on two objectives; understanding how SETFIA would like ConocoPhillips Australia to engage with them and its members; and engaging with SETFIA to update the Review of Commercial Fishing Operations Report developed for the Dorrigo 3DMSS.

Through discussions with SETFIA, it was agreed that ConocoPhillips Australia would engage with individual fishers as SETFIA membership is voluntary and may not represent all Commonwealth fishers in the area. SETFIA would assist in contacting fishers that ConocoPhillips Australia had no contact details for or did not hear from.

As outlined above, ConocoPhillips Australia engaged SETFIA to produce a report on State and Commonwealth commercial fisheries catch data and fishing intensity effort to understand fishing history in and around the survey area. The report also overlays seasonality to the fishing intensity effort. A copy of this report is provided in Appendix 6. This report identified each of the different Commonwealth and State fisheries that operate in and around the proposed Sequoia 3D MSS operational area.

4.6.2. Seafood Industry Victoria (SIV) Engagement

Early engagement with SIV highlighted their preference for ConocoPhillips Australia to engage according to the SIV/TSIC Mining, Gas and Petroleum Consultation Policy (Appendix 9). This meant that SIV would manage engagement with their membership (associations and fishers) on ConocoPhillips Australia's behalf in a fee-for-service arrangement. This arrangement did not preclude ConocoPhillips Australia from engaging with SIV members should they contact ConocoPhillips Australia directly. This approach also assisted to reduce stakeholder fatigue and placing additional engagement burden on the industry.

The initial focus of the engagement was to understand fishing intensity in the proposed operational area and identifying member concerns about the proposed activity. To achieve this, ConocoPhillips Australia worked with SIV to issue a survey to relevant fishers of their membership base as outlined in Section 4.5.3.

A copy of the draft SIV consultation report is provided in Appendix 7.

4.6.3. Tasmanian Seafood Industry Council (TSIC) Engagement

Early engagement with TSIC highlighted their preference for ConocoPhillips Australia to engage according to the SIV/TSIC Mining, Gas and Petroleum Consultation Policy (Appendix 9). This meant that TSIC would manage engagement with their membership (associations and fishers) on ConocoPhillips Australia's behalf in a fee-for-service arrangement. This arrangement did not preclude ConocoPhillips Australia from engaging with SIV members should they contact ConocoPhillips Australia directly. This approach also assisted to reduce stakeholder fatigue and placing additional engagement burden on the industry.

The initial focus of the engagement was to understand fishing intensity in the proposed operational area and identifying member concerns about the proposed activity. To achieve this ConocoPhillips Australia worked with TSIC to issue a survey to relevant fishers of their membership base as outlined in Section 4.5.3.

4.7. Adjustment Protocol

ConocoPhillips Australia will have in place an adjustment protocol so that fishers who believe they have been impacted by the survey can submit a claim. An important part of ConocoPhillips Australia's planning is to undertake the seismic acquisition in the months that will have the least impact commercially on fishers.

ConocoPhillips Australia understands there is not a standard approach to fishing adjustment in Australia. For the purposes of the Sequoia 3DMSS, ConocoPhillips Australia will develop an adjustment protocol and will engage with fishing associations and members on principles to compensate impacted fishers in appropriate circumstances.

4.8. Summary of Stakeholder Consultation

The development of this Sequoia 3DMSS EP has involved extensive consultation with a broad range of relevant persons, as listed in Table 4.1.

Table 4.2 outlines key engagement themes from stakeholder engagement undertaken for the EP.

Table 4.3 presents all the consultation undertaken with relevant persons in the process of developing this EP.

Table 4.2 Key Engagement Themes/Summary of Issues

Theme	Identified Issues	Stakeholders Involved	Referenced in EP
Impact to marine life	Impact to rock lobster, giant crab and their larvae as a result of seismic array used in seismic survey	ASBTIA TRLFA SIV TSIC Blue Whale Study	A description of rock lobster, giant crab and their larvae is provided in Section 5.5.1. Impacts to these species resulting from the seismic array are addressed in Section 7.1.
	Impact to whales during key migration periods		A description of cetaceans is provided in Section 5.5.6. Impacts to cetaceans resulting from the seismic array are addressed in Section 7.1.
	Impact to other marine life due to timing and size of survey and seismic array used in seismic survey		A description of marine life is provided throughout Section 5.5. Impacts to marine life resulting from the seismic array are addressed in Section 7.1.
	Impact to lobster and crab stock rebuilding programs currently underway in Tasmania		A description of rock lobster and giant crab is provided in Section 5.5.1. A description of fisheries that target rock lobster and giant is provided in Section 5.7.5. Impacts to these species resulting from the seismic array are addressed in Section 7.1.
Survey Design	Size, duration, and timing of proposed activity.	SETFIA ASBTIA TRLFA SIV TSIC	The size, duration and timing of the survey is described in Chapter 2.
Scientific research of seismic acquisition	Limited baseline information on stock levels in the permit area	TRLFA SIV TSIC	Relevant commercial fisheries catch and associated value is described in Section 5.7.5. Conducting stock assessments of relevant commercial fisheries is outside the scope of this EP.
	Limited and/ or conflicting research of impact of seismic array on marine life, focusing on rock lobster and giant crab		A description of rock lobster and giant crab is provided in Section 5.5.1. Impacts to these species resulting from the seismic array and presentation of scientific literature is presented in Section 7.1.

Seismic Practices	The use of seismic surveys as part of the exploration process	TRLFA SIV TSIC Colac Otway Shire Council King Island Chamber of Commerce	A description of the survey and its use in the exploration process is provided throughout Chapter 2.
	Re-surveying areas and/or not using existing information		The objectives of the survey are presented in Section 2.1.
	Acquiring 3D seismic data is more impactful than acquiring 2D seismic data		The objectives of the survey are presented in Section 2.1.
Compensation	ConocoPhillips Australia's compensation approach	SIV TSIC TRLFA King Island Council Colac Otway Shire Council	ConocoPhillips Australia's approach to compensation regarding the potential loss of catch or displacement from fishing grounds is presented in Section 4.7.
	Displacement and loss of catch		
	Long-term loss of catch		
	Displacement of fishers from operational area displacing other fishers		
Social	Power disparity between fishers and exploration companies, including: Ongoing seismic acquisition despite opposition to the practice Consultation approach taken by oil and gas companies	TRLFA SIV TSIC Colac Otway Shire Council King Island Council	ConocoPhillips Australia's consultation with stakeholders, including objectives, methodology, guiding principles and outcomes, is presented throughout Chapter 4.
	Flow-on impacts of a fishing decline to other business in value chain		A description of relevant commercial fisheries is provided in Section 5.7.5. Impacts to these fisheries from the seismic array are addressed in Section 7.1.
	Long-term viability of the fishing industry		
	Presence of UXO in the operational area	Colac Otway Shire Council	A description of UXO is provided in Section 5.7.7. An assessment of the survey regarding UXO is provided in Section 7.1.

4.9. Ongoing Consultation

ConocoPhillips Australia considers engagement with stakeholders for the Sequoia 3DMSS an ongoing process (in accordance with OPGGS(E) Regulation 14(9)).

ConocoPhillips Australia has developed an ongoing consultation strategy for the Sequoia 3DMSS to achieve the following:

- Identification of additional relevant persons that may be affected by the MSS;
- Provision of sufficient information to all relevant persons;
- Adjustment protocol principles to compensate impacted fishers in appropriate circumstances; and
- Ongoing identification and resolution of issues identified by relevant stakeholders.

ConocoPhillips Australia's stakeholder engagement for the Sequoia 3DMSS commenced in July 2020. Following the submission of this EP for public exhibition and assessment by NOPSEMA, ConocoPhillips Australia will continue consulting with relevant persons. Key milestones that will trigger further consultation include:

- Notification to all relevant stakeholders in relation to project timing and location;
- Notification to fishers one month prior to survey commencement (for fishing activity in the survey area);
- Commencement of the survey (five days prior to equipment deployment and at commencement);
- Daily SMS to fishers (who subscribed to the service) of vessel location;
- Survey completion;
- Any significant incidents (e.g., large MDO spill); and
- If there is a material change to the MSS activity scope that would affect the functions, interests or activities of relevant persons.

With regard to engaging with commercial fishers and industry associations, ConocoPhillips Australia will:

- Provide all relevant fishers with the survey schedule once it is confirmed a minimum of four weeks prior to commencement of the activity.
- Seek permission to include relevant fishers on an SMS notification list. Once the activity commences, ConocoPhillips Australia will provide SMS notification each day to detail the survey vessel's location so that fishers can plan their fishing activities with the least disruption.
- Provide fishers with its privacy policy and obligations to provide assurances that any sensitive fishing information shared with ConocoPhillips will not be made publicly available.
- Communicating the MSS exclusion zone and cautionary zone to fishers via a Notice to Mariners (NTM) and SMS notifications. Fishers are able to contact the survey vessel and its support vessels via VHF channel 16 at any time.

4.9.1. Ongoing stakeholder Feedback

Any feedback raised by stakeholders after submission of the EP will be assessed for merit and a response will be provided in line with engagement undertaken for EP submission. If a change to the activity or controls adopted during the MSS occurs as a result of stakeholder consultation, the change will be managed in line with ConocoPhillips Australia's Management of Change Process, described in Section 8.13.1.

If the feedback relates to a new or significant increase in existing impact or risk, a revised EP will be submitted to NOPSEMA for assessment in accordance with the OPGGS(E) Regulation 17(6). ConocoPhillips Australia will determine at the time of the risk assessment whether an impact or risk is significant based on available information (e.g., reviewed scientific information, stakeholder claims or concerns). Notification to existing and new stakeholder of any significant new or increased risks will occur prior to the submission of the revised EP as part of the consultation activity for the EP revision. This process for assessing, evaluating and implementing ongoing stakeholder feedback throughout the life of this EP is outlined in the ConocoPhillips Australia Stakeholder Enquiry, Complaint, Dispute, and Grievance Procedure.

4.10. Management of Feedback

ConocoPhillips Australia's Stakeholder Enquiry, Complaint, Dispute and Grievance Procedure sets a minimum standard for responses to stakeholders as part of the EP development.

As outlined in Section 4.9.1, if an objection or claim triggers a revision of the EP, this will be managed as outlined in Section 8.13.1. This will also be communicated to the relevant stakeholder.

Table 4.3 Summary of stakeholder consultation undertaken

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Category 1. Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant				
AFMA	Manager of fisheries in Commonwealth waters.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	The extent of Commonwealth fisheries that overlap the survey area are well understood (see Section 5.7.5 of the EP). As such, additional attempts to contact this stakeholder are not required.
		26/08/2020	ConocoPhillips Australia called as follow up to project information sheet. No answer.	
		27/10/2020	ConocoPhillips Australia emailed the project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
AMSA	AMSA is a statutory authority established under the *Australian Maritime Safety Authority Act* 1990, with one its key functions being to promote maritime	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	ConocoPhillips Australia will continue to consult with AMSA and make the necessary notifications for safe maritime operations. Notification requirements are included in Section 8.11 of the EP.
		27/08/2020	ConocoPhillips Australia called to follow up. No answer.	
		27/08/2020	Email response from AMSA. Email explained their expectations regarding pre-survey notifications and on future communications.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
	safety and protect the ocean.	27/08/2020	AMSA returned phone call and explained appropriate and timely promulgation of information for safe operations.	
		27/10/2020	ConocoPhillips Australia emailed project update information and MDO and underwater sound modelling fact sheets.	
		30/10/2020	ConocoPhillips Australia received acknowledgement email and reminders on appropriate and timely promulgation of information for safe operations. No stakeholder concerns raised.	
		14/12/2020	Email response received from AMSA confirming they have received the update on the public comment period. AMSA has no further comments.	
		9/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		23/12/2020	Email received from AMSA re-stating their expectations regarding pre-survey notifications and on appropriate lights and shapes for natural operations.	
		9/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
AHO	Responsible for the publication and distribution of nautical charts and other information required for safe shipping navigation in Australian waters.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	ConocoPhillips Australia will continue to consult with the AHO and make the necessary notifications throughout the survey. Notification requirements are included in Section 8.11 of the EP.
		18/08/2020	AHO emailed acknowledgement of project information.	
		26/08/2020	ConocoPhillips Australia called AHO as follow up to initial email. AHO acknowledged initial email had been received and had no initial feedback.	
		27/10/2020	ConocoPhillips Australia emailed project update.	
		28/10/2020	Email acknowledgement of project information. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		9/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		9/02/2021	ConocoPhillips Australia emailed project update.	
DAWE	Commonwealth department responsible for administration of the EPBC Act, Australian Marine Parks (AMPs) and MNES.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	ConocoPhillips Australia will continue to consult with DAWE regarding the necessary biosecurity reporting requirements.
		18/08/2020	Email response received from DAWE with updated contact details.	
		27/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment to the new contact.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		28/08/2020	Response to initial project information from DAWE acknowledging receipt of information.	Vessel biosecurity controls are provided in Section 7.11 of the EP.
		14/09/2020	DAWE Biosecurity & Compliance Group acknowledged receipt of initial email and advised on reporting requirements for the survey vessel.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	
		27/10/2020	DAWE emailed acknowledgement of project update. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		9/02/2021	ConocoPhillips Australia emailed project update.	
DNP	Manages the AMP network in Commonwealth waters	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Section 5.1.1 of the EP describes the values of the AMPs. ConocoPhillips Australia has assessed the routine and non-routine activities associated with the survey against the
		15/09/2020	Email response received from DNP acknowledging receipt of information sheet and provided information on the specific values of Zeehan and Apollo AMPs. DNP outlined expectations for future notifications and emergency response requirements.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	conservation values of relevant AMPs in the South East Marine Network. (see Appendix 1). Notification requirements are included in Section 8.11 of the EP.
		6/11/2020	Email response received from DNP acknowledging receipt of update and changes to the survey area. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
DoD – Defence Support Group	Manage all Australian defence activities.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Routine and non-routine activities will not impact on the functions, interests or activities of this stakeholder. The risks of the survey to and from UXO are assessed in Section 7.1 of the EP. Notification requirements are included in Section 8.11 of the EP.
		27/08/2020	ConocoPhillips Australia called to follow up. Left message requesting call back.	
		04/09/2020	Email response received from DoD requesting the AHO be notified three weeks before activities.	
		09/09/2020	ConocoPhillips Australia emailed DoD to organise a meeting to discuss the survey.	
		11/09/2020	Meeting between DoD and ConocoPhillips Australia took place to understand the potential risks associated with unexploded ordnance (UXO) known to occur in and around the MSS area. DoD advised that the survey poses a low risk to UXO and chemical dumping sites.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		27/10/2020	ConocoPhillips Australia emailed project update. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
DIRD	Commonwealth infrastructure and development department.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Routine and non-routine activities will not impact on the functions, interests or activities of this stakeholder. Impacts of the survey on the Indigo telecommunications cable are assessed in Section 7.1 of the EP.
		15/09/2020	ConocoPhillips Australia called to follow up and DIRD stated that they did not need to be further consulted unless the survey impacted on subsea pipelines or cables.	
		27/10/2020	ConocoPhillips Australia emailed project update. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Department of Industry, Science, Energy and Resources	Commonwealth department for economic growth and job creation.	07/09/2020	Meeting between ConocoPhillips Australia and DISER Head of Division, Resources; Manager - Environment, Safety and Security, Offshore Resources Branch; and, General Manager	Routine and non-routine activities will not impact on the functions, interests or activities

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
(DISER)			Offshore Resources Branch.	of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed project update. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		04/02/2021	Meeting between ConocoPhillips Australia and General Manager Offshore Resources Branch. ConocoPhillips provided an update on its EP, overview of feedback received from stakeholders and public comment period and path forward.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
CASA	Aviation regulator.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Routine and non-routine activities will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		27/08/2020	ConocoPhillips Australia called to follow up. Left message requesting a return call.	
		27/10/2020	ConocoPhillips Australia emailed project update. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Maritime Border Control	Biosecurity requirements for vessels entering Australian waters and ports.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	ConocoPhillips Australia will continue to consult with Maritime Border Control in accordance with biosecurity requirements. Notification requirements are included in Section 8.11 of the EP.
		19/10/2020	ConocoPhillips Australia called for correct contact information as initial email bounced back.	
		19/10/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment to the new contact.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Category 2. Each Department or agency of a State to which the activities to be carried out under the EP may be relevant				
Tasmania				
DPIPWE	Tasmania's leading natural resources agency, responsible for the sustainable management of natural and cultural heritage.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Commercial fisheries are described in Section 5.7.5 of the EP, the impacts of the MSS are described throughout Chapter 7, and a fisheries adjustment protocol is described in Section 4.7. Based on the small overlap with the southern rock lobster and giant crab fisheries and the predicted negligible effect of the survey on these fisheries (see Section 7.1), ConocoPhillips has determined there is no need for a baseline survey. Additional contact with this stakeholder is only necessary in the event of an MDO spill. Contact details for DPIPWE
		18/08/2020	Received DPIPWE response email acknowledging project information and requested meeting with ConocoPhillips Australia.	
		28/08/2020	Meeting held between DPIPWE and ConocoPhillips Australia. Discussed relevant commercial fisheries, seismic survey impacts, compensation and baseline surveys. ConocoPhillips Australia agreed to provide updates as EP progressed.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		20/11/2020	DPIPWE Fisheries Management Officer returned email and asked if they would be notified when the EP is available for comment.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
				are provided in Section 8.11.2 of the EP.
		23/11/2020	ConocoPhillips Australia confirmed that they would be notified when the EP is available for comment.	
		24/11/2020	ConocoPhillips Australia emailed the DPIPWE Manager (Wild Fisheries Management Branch) regarding activities conducted near the Waterwitch Reef Research Area.	
		2/12/2020	Email received from DPIPWE confirming they do not intend to conduct research in the Waterwitch Reef Area during the proposed survey period.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		04/01/2021	Department provided submission to public consultation period requesting exclusion of giant crab habitat from acquisition area to support stock rebuilding.	
		18/01/2021	ConocoPhillips Australia emailed Senior Fisheries Management Officer regarding submission to NOPSEMA during the public comment period. ConocoPhillips Australia requested a phone call to discuss.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		18/01/2021	ConocoPhillips Australia emailed Principal Fisheries Management Officer requesting more information in relation to public comment submission. ConocoPhillips Australia also included a contact number for further discussion.	
		25/01/2021	ConocoPhillips issued a letter responding to DPIPWE's concerns raised during the EP public exhibition period. These concerns were focused on the impacts of the survey on southern rock lobsters and giant crabs.	hillips' letter detailed the known science around the effects of MSS on southern rock lobster and giant crabs, with input from the specialist underwater sound consultancy, Jasco Applied Science.
		9/02/2021	ConocoPhillips Australia emailed project update.	
PWS – King Island Office	Government agency responsible for managing protected areas on Tasmanian public land.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Routine and non-routine activities will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
EPA Tasmania	Tasmanian environmental regulator.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Routine and non-routine activities will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
MRT	Tasmanian mineral resources regulator.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Routine and non-routine activities will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed project update and modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Victoria				
VFA	Manager of commercial fisheries in Victorian	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional follow up is not required, as consultation has

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
	waters.	27/08/2020	ConocoPhillips Australia called to follow up on initial information. VFA confirmed receipt of the project information.	been undertaken with peak body representatives of the fishing industry and the extent of Victorian fisheries in relation to the survey area is well understood (see Section 5.7.5 of the EP). There is a very small overlap with the Victorian southern rock lobster and giant crab fisheries and the predicted effect of the survey on these fisheries is negligible (see Section 7.1).
		14/09/2020	VFA Fisheries Manager called to update primary contact information.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	
		29/10/2020	VFA Fisheries Manager emailed response and raised concerns regarding potential impacts of survey on southern rock lobster and giant crab commercial fisheries.	
		12/11/20202	ConocoPhillips Australia responded to stakeholder concerns by email, noting that the timing of the survey avoids spatial conflicts with the southern rock lobster and giant crab fisheries, but that avoiding their spawning times is not possible given that it coincides with the migration period of the threatened pygmy blue whale in the region.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		15/12/2020	Email received from VFA asking for a copy of the EP open for public comment. ConocoPhillips Australia emailed VFA the link to the EP on the NOPSEMA page. VFA acknowledge receipt of link.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		09/02/2021	ConocoPhillips Australia emailed project update.	
DELWP	Responsible for management of coastal and marine parks.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional contact with this stakeholder is only necessary in the event of an MDO spill. Contact details for DELWP are provided in Section 8.11.2 of the EP.
		27/08/2020	ConocoPhillips Australia called to follow up on initial information. Left message, no response.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
DJPR – EMB	Control agency for marine pollution emergencies in Victorian waters.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. Email bounced.	Additional contact with this stakeholder is only necessary in the event of an MDO spill. Contact details for EMB are provided in Section 8.11.2 of the EP.
		27/10/2020	Re-issued the project information sheet and MDO and underwater sound modelling fact sheets and invited return comment to updated contact information. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
New South Wales				
Transport for NSW	Leading transport and roads agency in NSW.	23/10/2020	ConocoPhillips Australia emailed letter of introduction and MDO spill modelling fact sheet to the Marine Pollution and Emergency Response Manager and invited return comment.	Additional contact with this stakeholder is only necessary in the event of an MDO spill. Contact details for EMB are provided in Section 8.11.2 of the EP.
Port Authority NSW	Acts as Harbour Master for NSW's six commercial seaports, managing shipping movements, safety, security and emergency response.	23/10/2020	ConocoPhillips Australia emailed letter of introduction and MDO spill modelling fact sheet to the Eden Harbour Master.	Additional contact with this stakeholder is only necessary in the event of an MDO spill. Contact details for EMB are provided in Section 8.11.2 of the EP.

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Category 3 – The Department of the responsible State Minister				
Members of Parliament (MPs)				
Gavin Pearce MP	Federal Member for Braddon (northwest Tasmania, including King Island).	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The activity will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		31/08/2020	ConocoPhillips Australia called to follow up on initial information and arrange meeting.	
		14/09/2020	Electorate Officer emailed to request a briefing.	
		21/09/2020	Meeting held between ConocoPhillips Australia and the Federal Member for Braddon.	
		27/10/2020	ConocoPhillips Australia emailed updated project information sheet. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		04/02/2021	Meeting held between ConocoPhillips Australia and the Federal Member for Braddon to discuss changes to survey design and electorate views.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Senator the Hon. Keith Pitt	Minister for Resources, Water and Northern	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The activity will not impact on the functions, interests or

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
	Australia.	09/09/2020	Meeting between ConocoPhillips Australia, Minister's Chief of Staff and Manager - Gas Market Analysis and Development at Department of Industry to provide briefing on the survey. Slide deck was provided to members of the meeting,	activities of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed updated project information sheet. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		4/02/2021	Meeting between ConocoPhillips Australia and Minister's staff to provide briefing on the survey, EP approvals process and its ongoing stakeholder consultation. Outlined COP's next steps in progressing the EP and undertook to continue to keep the office informed.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Senator the Hon. Richard Colbeck	Senator for Tasmania. Assistant Minister for Agriculture and Water Resources.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The activity will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed updated project information sheet. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Senator the Hon. Jonathon Duniam	Assistant Minister for Forestry and Fisheries and Assistant Minister for Regional Tourism.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The activity will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		19/08/2020	Email from Diary Manager acknowledging receipt of initial information.	
		23/09/2020	Meeting between ConocoPhillips Australia, Minister for Forestry and Fisheries and Assistant Minister for Regional Tourism to provide briefing on the survey.	
		27/10/2020	ConocoPhillips Australia emailed updated project information sheet. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Senator the Hon. Anne Urquhart	Senator for Tasmania.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The activity will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed updated project information sheet. No stakeholder response.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
The Hon. Joel Fitzgibbon MP	Federal Member for Hunter (central NSW, near Newcastle).	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The activity will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
		27/10/2020	ConocoPhillips Australia emailed updated project information sheet. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Category 4 – A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP.				
Commonwealth Fisheries Associations				
CFA	Peak body representing the collective rights, responsibilities and interests of a range of Commonwealth fisheries.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required, as consultation has been undertaken with peak fishing industry associations.
		26/08/2020	ConocoPhillips Australia called to follow up on initial information. CFA Executive Officer acknowledged receipt of project information.	
		4/09/2020	ConocoPhillips Australia called to follow up, no answer.	
		4/09/2020	ConocoPhillips Australia emailed offering a meeting to discuss the project.	
		7/09/2020	CFA Executive Officer emailed in response and deferred discussion to relevant sector bodies. Requested updates with progression and developments.	
		17/09/2020	ConocoPhillips Australia emailed project update information.	
		27/10/2020	ConocoPhillips Australia emailed updated project information sheet and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
ETBF Industry Association (ETBFIA)	Peak body representing the Eastern Tuna and Billfish Fishery.	7/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section 5.7.5 of the EP). Concerns expressed by the stakeholder were addressed in a telephone call and potential impacts to commercial fisheries are assed in Section 7.1 of the EP.
		26/08/2020	ConocoPhillips Australia called to follow up on initial information. No answer, left a voice message.	
		04/09/2020	ConocoPhillips Australia called to follow up again. ETBFIA Executive Officer confirmed they had received the initial project information. ETBFIA Executive Officer expressed general concerns on the impacts of a seismic survey on commercial fisheries and marine ecology. ConocoPhillips Australia provided a letter of response to the concerns raised by ETBFIA.	
		17/09/2020	ConocoPhillips Australia emailed project update.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
ASBTIA	Peak body representing the Southern Bluefin Tuna Fishery.	07/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section
		04/09/2020	ConocoPhillips Australia called to follow up on initial information. Stakeholder stated preference for written updates.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		04/09/2020	ConocoPhillips Australia sent follow up email offering a meeting.	5.7.5 of the EP). The stakeholder is satisfied that the survey will not impact on their fishing operations.
		17/09/2020	ConocoPhillips Australia emailed project update.	
		18/09/2020	ConocoPhillips Australia received a submission from ASBTIA's Research Scientist and Chief Executive Officer (CEO) that raised concerns regarding impacts to the Bonney Upwelling, CSI Technology and the size, timing and duration of the survey.	
		12/10/2020	ConocoPhillips Australia provided a letter of response to the concerns raised by ASBTIA.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	
		29/10/2020	ASBTIA emailed acknowledgment of response letter and most recent project update. Stakeholder identified the August to October operating window as satisfactory to their fishery operations.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
SETFIA	Peak representative body for trawl fishing in south-east Australia.	28/07/2020	ConocoPhillips Australia emailed SETFIA CEO about engaging them to prepare a fishing activity report for the survey area.	Additional consultation is not required.
		07/08/2020	ConocoPhillips Australia provided project information to SETFIA CEO to assist with consultation and the fisheries report.	Information in the report prepared by SETFIA is

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		07/08/2020	SETFIA received factsheet and GIS shape files of operational and acquisition area to their members.	included in Section 5.7.5 of the EP so that the catch from the fisheries intersected by the survey area can be quantified. An adjustment protocol is in development (see Section 4.7 of the EP).
		12/08/2020	SETFIA CEO advised ConocoPhillips that the intersection with fishing grid cells could be limited by reducing the operational area.	
		18/08/2020	ConocoPhillips Australia advised SETFIA CEO that they have reduced the operational area.	
		18/08/2020	ConocoPhillips Australia revise scope of SETFIA fisheries report to request data from new operational area.	
		21/08/2020	SETFIA CEO advises that the delivery of the fisheries report will be delayed.	
		15/09/2020	ConocoPhillips Australia requested an update on the delivery of the fisheries report. SETFIA CEO advised on issues in acquiring all the necessary fisheries data.	
		21/09/2020	Conversation with SETFIA CEO regarding response by Commonwealth fishing associations and fishers to initial mail out. Follow up email sent outlining sub associations and individuals that requested SETFIA represent them in engagement process.	
		30/09/2020	SETFIA CEO advised on issues in acquiring all the necessary fisheries data and delay of fisheries report.	
		07/10/2020	SETFIA CEO advised of ongoing issues in acquiring the necessary data to complete the fisheries report.	
		13/10/2020	ConocoPhillips Australia called SETFIA CEO to discuss potential compensation arrangements for affected fishers.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		16/10/2020	SETFIA CEO advised that the fisheries report would be delayed due to concerns about the data received from government agencies.	
		20/10/2020	SETFIA CEO provided the draft fisheries report to ConocoPhillips Australia (see Appendix 6 and results included in Section 5.7.5 of the EP).	
		21/10/2020	Meeting held between ConocoPhillips Australia and SETFIA CEO to discuss draft fisheries report.	
		23/10/2020	Meeting held between ConocoPhillips Australia and SETFIA CEO to discuss oil and gas industry approaches to compensation/ adjustment protocols.	
		29/10/2020	SETFIA CEO provided the final fisheries report to ConocoPhillips Australia.	
		03/11/2020	ConocoPhillips Australia called. No answer.	
		05/11/2020	ConocoPhillips Australia called. SETFIA CEO was unavailable.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		25/01/2021	ConocoPhillips Australia emailed a letter as an update after the public consultation period. ConocoPhillips Australia informed SETFIA of the intentional timing of the seismic survey for least impact and the reduction of operational area size.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		10/02/2021	Call to SETFIA CEO to advise of pending submission. No Answer, left message.	
Sustainable Shark Fishing Inc	Peak industry body representing shark gillnetters.	7/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section 5.7.5 of the EP) and the stakeholder has not expressed any concerns.
		26/08/2020	ConocoPhillips Australia called to follow up on initial information. No answer, left a voice message.	
		9/09/2020	ConocoPhillips Australia called to follow up on initial information. Requested further information on source array as soon as it is available.	
		10/11/2020	ConocoPhillips Australia emailed project update and modelling fact sheets. No stakeholder concerns raised.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Southern Shark Industry Alliance	Supports its members who rely on the sustainable harvesting of the Southern Shark Fishery	7/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section 5.7.5 of the EP) and the stakeholder has not expressed any concerns.
		26/08/2020	ConocoPhillips Australia called to follow up on initial information. No answer, left a voice message.	
		17/09/2020	ConocoPhillips Australia emailed project update. No response.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
			No response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
Bass Strait Scallop Industry Association (BSCIA)	Peak representative body for the Bass Strait Central Zone Scallop Fishery.	7/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section 5.7.5 of the EP) and the stakeholder has not expressed any concerns.
		4/09/2020	ConocoPhillips Australia called to follow up on initial information. No answer. Follow up with email offering meeting for project briefing.	
		7/09/2020	BSCIA Executive Officer returned email and deferred discussion to relevant sector bodies. Requested updates with progression and development.	
		17/09/2020	ConocoPhillips Australia emailed project update. No response.	
		27/10/2020	ConocoPhillips Australia emailed project update and modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Southern Rock Lobster Limited	National peak body working to further the interests of the Australian southern rock lobster	07/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required as the extent of southern rock lobster fisheries in relation to the
		26/08/2020	ConocoPhillips Australia called to follow up on initial information. No answer, left a message requesting a call	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
	industry.		back.	survey area is well understood (see Section 5.7.5 of the EP). An adjustment protocol is in development (see Section 4.7 of the EP).
		08/09/2020	Southern Rock Lobster Limited Executive Officer called and spoke with ConocoPhillips Australia and raised concerns regarding the timing of the survey and of the practice of resurveying already surveyed areas. ConocoPhillips Australia outlined rationale for timing and reiterated that on a small section of the proposed acquisition area would be resurveyed.	
		17/09/2020	ConocoPhillips Australia emailed project update.	
		27/10/2020	ConocoPhillips Australia emailed project update and modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Tasmania Fisheries Associations				
TSIC	Peak body representing the interests of wild capture fishers, marine farmers and seafood processors in Tasmania.	21/07/2020	Initial meeting between ConocoPhillips Australia, TSIC Chief Executive and SIV Executive Director to discuss expectations and concerns with the seismic survey and stakeholder consultation process. Both fishing associations stated they had difficult experiences with past permit holder in their application for an EP. Both associations and ConocoPhillips representatives agreed to disagree on items relating to the science of seismic and instead focus on a partnership approach and genuine two-way conversations in this process. SIV and TSIC outlined their membership base and member concerns with seismic. High level conversation around the proposed timing of the survey and how they may work with their member activities. Discussed role and service that SIV and TSIC could provide, with reference to their Engagement Policy of 2018. Next steps, ConocoPhillips to send information on project, and SIV/TSIC to respond with quote to undertake survey with their members	Information gathered from TSIC and its members has been incorporated into Section 5.7.5 and Section 7.1 of the EP. An adjustment protocol is in development (see Section 4.7). Consultation with TSIC will be ongoing.

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		07/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. ConocoPhillips Australia called TSIC to discuss the survey overview and agreed that correspondence with relevant fishing associations would be formally channelled through TSIC.	
		28/08/2020	Meeting held between ConocoPhillips Australia TSIC and SIV to discuss fisheries stakeholder engagement and EP process. Discussion held on initial mailout to stakeholders. Organisations outlined expected work requirements for facilitating engagement and provided suggestions on approach for engaging members.	
		15/09/2020	ConocoPhillips Australia provide project information and questionnaire to TSIC for distribution to relevant fisheries stakeholders.	
		16/09/2020	TSIC undertook a mail out of project information to its 270 members on behalf of ConocoPhillips Australia.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		08/10/2020	ConocoPhillips Australia received responses from TSIC members. Responses raised include concerns regarding impacts to marine animals, resurveying an area, acquiring 3D seismic data, using seismic surveys as part of the exploration process, compensation concerns, power disparity between small fishers and oil and gas companies and potential flow-on impacts and catch decrease following the survey.	
		2/11/2020	ConocoPhillips Australia provided a response letter to stakeholder concerns and outlined controls in place to reduce impacts from the survey including acquiring seismic in months that have the least commercial and environmental impact, reducing the operational area, using CSI technology to reduce survey duration, using the lowest sound pressure to achieve the survey objectives and implementing EPBC Act requirements.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	
		18/11/2020	ConocoPhillips Australia inquired about TSIC's availability to meet about adjustment protocol. TSIC informed ConocoPhillips Australia they were unable to respond and postponed discussion a week.	
		18/11/2020	ConocoPhillips Australia emailed TSIC advising that the EP would be submitted in a few weeks and comments would be welcomed.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		08/01/2021	ConocoPhillips Australia emailed TSIC and acknowledged submission during the public comment period and their concerns about timing of consultation.	
		14/01/2020	ConocoPhillips Australia called Project Officer at TSIC asking to set up a meeting with Chief Executive. Advised unable to do so.	
		25/01/2021	ConocoPhillips Australia emailed a letter in response to TSIC submission received during the EP public comment period.	
		27/01/2021	ConocoPhillips Australia resent the appendices relating to operational area as there were issues viewing versions originally sent.	
		29/01/2021	Called to request meeting to discuss changes to proposed acquisition. Chief Executive requested SIV Chief Executive also be included in the meeting. Meeting set.	
		04/02/2021	Meeting between ConocoPhillips Australia, TSIC and SIV to discuss changes to the Sequoia 3D MSS.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		08/02/2021	Email to TSIC Chief Executive to follow up meeting from 4 February and enquire if they required a meeting prior to EP submission.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
		10/02/2021	Call to TSIC Chief Executive unable to talk due to deadline. Sent follow up email requesting potential meeting dates for early March and advised of pending EP submission.	
TARFish	Peak body representing recreational fishers in Tasmania.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	Consultation with Tasmanian fisheries has been directed through TSIC following a meeting between TSIC and ConocoPhillips Australia on 21/07/2020. No further consultation required.
Tasmanian Abalone Council	Voice of the fishery representing divers, non-diving quota holders, processors and exporters.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	As above
TRLFA	Association of Tasmanian rock lobster fishermen.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The extent of the Tasmanian southern rock lobster fishery in relation to the survey area is well understood (see Section 5.7.5 of the EP).
		18/09/2020	Email response from TRLFA Executive Officer raising concerns regarding impacts of the survey on marine	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
			life, proximity to King Island key fishing grounds, possible effect on southern rock lobster and giant crab larvae, stock rebuilding strategies, dismissal and misrepresentation of IMAS data and poor consultation process.	An adjustment protocol is in development (see Section 4.7 of the EP). Consultation with the TRLFA will be ongoing as required in line with agreement between TSIC.
		15/10/2020	ConocoPhillips Australia emailed a detailed response to TRLFA concerns. No response received.	
		29/10/2020	Re-issued initial appendix from detailed response as figures were omitted.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
Tasmanian Scallop Fisherman's Association	Association of Tasmanian scallop fishermen.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	Consultation with Tasmanian fisheries has been directed through TSIC following a meeting between TSIC and ConocoPhillips Australia on 21/07/2020. No further consultation required.
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Victorian Fisheries Association				
SIV	Peak industry body for Victorian Fisheries.	21/07/2020	Initial meeting between ConocoPhillips Australia, TSIC Chief Executive and SIV Executive Director to discuss expectations and concerns with the seismic survey and stakeholder consultation process. Both fishing associations stated they had difficult experiences with past permit holder in their application for an EP. Both associations and ConocoPhillips representatives agreed to disagree on items relating to the science of seismic and instead focus on a partnership approach and genuine two-way conversations in this process. SIV and TSIC outlined their membership base and member concerns with seismic. High level conversation around the proposed timing of the survey and how they may work with their member activities. Discussed role and service that SIV and TSIC could provide, with reference to their Engagement Policy of 2018. Next steps, ConocoPhillips to send information on project, and SIV/TSIC to respond with quote to undertake survey with their members	The extent of Victorian fisheries in relation to the survey area is well understood (see Section 5.7.5 of the EP). An adjustment protocol is in development (see Section 4.7 of the EP). Consultation with SIV will be ongoing.

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		07/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. ConocoPhillips Australia called SIV to discuss the survey overview and agreed that correspondence with relevant fishing associations would be formally channelled through SIV.	
		28/08/2020	Meeting held between ConocoPhillips Australia, SIV and TSIC to discuss fisheries stakeholder engagement and EP process. Discussion held on initial mailout to stakeholders. Organisations outlined expected work requirements for facilitating engagement and provided suggestions on approach for engaging members.	
		15/09/2020	ConocoPhillips Australia called SIV to discuss fishing member distribution of project information, survey questionnaire and timeframes.	
		16/09/2020	SIV emailed ConocoPhillips Australia to confirm that project information and survey questionnaire had been distributed to SIV members.	
		16/10/2020	SIV provided draft report on the survey questionnaire completed by its members. Concerns raised include impacts to marine life, removal of rock lobster and giant crab habitat from survey, a request to undertake pre- and post-survey monitoring of fisheries stocks, cumulative impacts, compensation and engagement process.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	
		05/11/2020	ConocoPhillips Australia issued response to draft report of SIV members concerns. Also attached spill and noise modelling fact sheets.	
		18/11/2020	ConocoPhillips Australia inquired about SIV's availability to meet about adjustment protocol. No response to date.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		16/12/2020	SIV emailed ConocoPhillips Australia expressing his concerns of not being properly informed of timeframes and the concerns of the SIV members.	
		17/12/2020	ConocoPhillips Australia responded to SIV explaining when timeframes were discussed and asked to arrange a meeting. Email response received from SIV around availability to meet.	
		11/01/2021	Email received from SIV requesting invoicing details for the consultation work SIV has assisted with. ConocoPhillips Australia emailed invoice details for consultation assistance payment.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		15/01/2021	Meeting with ConocoPhillips Australia and SIV to discuss adjustment protocol approach.	
		18/01/2021	ConocoPhillips Australia emailed the link of the Sequoia EP on the NOPSEMA website.	
		25/01/2021	ConocoPhillips Australia emailed a letter to advise of changes to the EP as a result of the public consultation period.	
		27/01/2021	ConocoPhillips Australia received email requesting a new attachment of the revised operational area as the previous one was corrupt.	
		29/01/2021	ConocoPhillips Australia called and left a message to request a meeting.	
		29/01/2021	ConocoPhillips Australia emailed requesting availability to discuss proposed changes to the Sequoia 3D MSS. ConocoPhillips Australia received an email with availability for meeting to discuss proposed changes to the Sequoia 3D MSS. Meeting invitation sent	
		04/02/2021	Meeting between ConocoPhillips Australia, TSIC and SIV to discuss changes to the Sequoia 3D MSS.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		10/02/2021	Call to SIV Chief Executive. No answer, left message. Sent follow up email requesting potential meeting dates for early March and advised of pending EP submission.	
Victoria Rock Lobster Fishing Association (VRLFA)	Peak industry body for rock lobster fisheries.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	Consultation with Victorian fisheries has been directed through SIV following a meeting between SIV and ConocoPhillips Australia on 21/07/2020. No further consultation required.
Warrnambool Professional Fishermen's Association (WPFA)	Peak body representing professional fishermen in Warrnambool.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	As above.
Port Campbell Professional Fisherman's Association (PCFA)	Peak body representing professional fishermen in Port Campbell.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	As above.
Apollo Bay Fishing Co-op (ABFC)	Association for Apollo Bay fishermen.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	As above.
VR Fish	Peak body representing recreational fishers in Victoria.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. No stakeholder response.	As above.
Individual Fishers				

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Commonwealth Trawl Sector (CTS) Fisherman	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section 5.7.5 of the EP).
		15/09/2020	ConocoPhillips Australia called to follow up. Stakeholder requested that the initial information be sent again.	
		15/09/2020	ConocoPhillips Australia re-sent project information sheet.	
		17/09/2020	ConocoPhillips Australia email updated project information.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
CTS Fisherman	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/2020	ConocoPhillips Australia email updated project information.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
CTS Fisherman	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/2020	ConocoPhillips Australia email updated project information.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
CTS Fisherman	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/2020	ConocoPhillips Australia email updated project information.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
CTS Fisherman	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/2020	ConocoPhillips Australia email updated project information.	
		17/09/2020	ConocoPhillips Australia called to follow up on initial information. No answer.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		09/02/2021	ConocoPhillips Australia emailed project update.	
CTS Fisherman	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/2020	ConocoPhillips Australia email updated project information.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Gillnet, Hook and Trap (GHaT) Fisherman, Scalefish Hook Sector (SHS)	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/2020	ConocoPhillips Australia email updated project information.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
GHaT Fisherman, SHS	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/2020	ConocoPhillips Australia email updated project information.	
		17/09/2020	ConocoPhillips Australia called to follow up on sent information. No answer, left voice message.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Muollo Fishing Pty Ltd	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Corporate Alliance Enterprises Pty Ltd	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	
		15/09/2020	ConocoPhillips Australia called to follow up on sent information. Stakeholder confirmed they had received the initial information.	
		17/09/2020	ConocoPhillips Australia email updated project information. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
ANZT Fishing Company Pty Ltd	Fishery licence holder.	18/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		17/09/2020	ConocoPhillips Australia email updated project information.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Southern Squid Jig Fishery fisherman	Fishery licence holder.	18/08/220	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
		17/09/220	ConocoPhillips Australia called to follow up on sent information. Stakeholder raised concerns regarding timing of survey and impacts to deep water species and the flow on effects to decreasing catches.	
		17/09/2020	ConocoPhillips Australia email updated project information and information on use of CSI technology.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Category 5 – Any other person or organisation that the titleholder considers relevant				
Local Government				
Colac Otway Shire	Victorian shire council near the survey area.	17/8/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	ConocoPhillips Australia has addressed the stakeholder's concerns and attempted follow ups to ascertain whether these concerns have been allayed. The adjustment protocol is discussed in Section 4.7 of the EP and impacts to UXO is addressed in Section 7.1 of the EP. Lobsters will not be translocated to facilitate the Sequoia 3DMSS. ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning.
		21/08/2020	Colac Otway Shire Executive Assistant requested meeting with ConocoPhillips Australia to discuss the survey.	
		09/09/2020	Meeting held between Colac Otway Shire and ConocoPhillips Australia. Stakeholder raised concerns regarding resurveying areas already surveyed, potential UXO in the survey area, compensation approach and translocation of lobsters. Meeting minutes were emailed to Colac Otway Shire after the meeting.	
		17/09/2020	ConocoPhillips Australia called stakeholder to follow up. No answer and left a voice message.	
		17/09/2020	ConocoPhillips Australia emailed follow up information addressing concerns of Colac Otway Shire.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		24/12/2020	ConocoPhillips received a copy of submission made to NOPSEMA during public comment period from Colac Otway Shire	
		25/01/2021	ConocoPhillips issued a letter responding to the Colac Otway Shire's concerns raised during the EP public exhibition period. These concerns were focused on the the obligations tied to exploration permits, impacts of the survey on southern rock lobsters, indirect and cumulative effects to marine fauna, and processes for compensation to affected fishers.	ConocoPhillips' letter referred to sections of the EP that answered the Shire's questions and briefly outlined the legislative process regarding the issue of exploration permits and compensation.
		09/02/2021	ConocoPhillips Australia emailed project update.	
Corangamite Shire Council	Victorian shire council near the survey area.	17/8/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. The Mayor accepted the offer of a briefing.	ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning.
		09/09/2020	Meeting between ConocoPhillips Australia and Corangamite Shire Council to share survey details.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
King Island Shire Council	Tasmanian shire council in closest proximity to the survey area.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	ConocoPhillips Australia has addressed the stakeholder's concerns. The potential impacts to the giant crab and southern rock lobster fisheries are addressed in Section 7.1 of the EP. ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning.
		27/08/2020	ConocoPhillips Australia called stakeholder to follow up. King Island Shire Council confirmed they had received the project information and would contact ConocoPhillips Australia regarding further information if required.	
		21/10/2020	King Island Shire Council raised concerns regarding impacts to giant crab and rock lobster, potential economic benefit to King Island and statutory approvals.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	
		29/10/2020	ConocoPhillips Australia emailed response to stakeholder concerns.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		28/01/2021	ConocoPhillips Australia emailed letters and relative appendices to King Island Shire Council and King Island Brand Management responding to submission received during public comment period.	
		01/02/2021	ConocoPhillips Australia resent letter and requested meeting with Mayor. No response received.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Circular Head Council	Tasmanian shire council near the survey area.	17/8/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	No further active consultation is required based on the fact that the stakeholder has advised they have no concerns about the survey.
		15/9/2020	ConocoPhillips Australia called to follow up on sent information. No answer.	
		18/9/2020	Circular Head Shire representative called ConocoPhillips Australia and advised they did not believe they were a relevant stakeholder and as such had no concerns regarding the survey.	
Conservation				
Blue Whale Study (BWS)	Organisation concerned with conservation and research outcomes for blue whales.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment. BWS Senior Research Scientist accepted invitation for phone meeting.	The potential impacts to blue whales are addressed in Section 7.1 of the EP. Impacts are avoided because the survey is timed to avoid their seasonal migration through the survey area. ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning.
		28/08/2020	Meeting between BWS and ConocoPhillips Australia. Topics discussed included: - Familiarity with the T49P area. - Proposed timing of survey is one of the better times for blue whales. - Blue whales use the Bonney Upwelling continental shelf. - Lots of uncertainty. - Climate change is also an issue. - Hard to get funding for aerial surveys. - No surveys have been undertaken for 6-years. - Interested in a speedy process to minimise disruption to marine life.	
		27/10/2020	ConocoPhillips Australia emailed project update and MDO and underwater sound modelling fact sheets.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
			ConocoPhillips Australia expressed desire for further discussion on underwater sound modelling, whale interaction and proposed research.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Deakin University – School of Life and Environmental Sciences	Marine conservation research.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The survey will not impact on the functions, interests or activities of this stakeholder. The stakeholder has not expressed an interest in the survey. As such, no further consultation is required.
		27/10/2020	ConocoPhillips Australia email updated project information. No response to date.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Recreation				
Ocean Racing Club of Victoria	Conducts ocean/offshore and bay yacht races and events in Victoria.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The stakeholder has not expressed an interest in the survey. As such, no further consultation is required.
		27/10/2020	ConocoPhillips Australia email updated project information. No response to date.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Media				
King Island Courier (KIC)	Local newspaper headquartered on King Island.	09/09/2020	KIC Editor emailed ConocoPhillips Australia and requested to be kept informed of survey information.	ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning so that the King Island community is kept informed.
		09/09/2020	ConocoPhillips Australia called KIC Editor in response to information request. Called and left message. No response.	
		27/10/2020	ConocoPhillips Australia emailed project update. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
Titleholders and Service Providers				
Beach Energy	Titleholder of several exploration permits, production licences and retention leases to the east and northwest.	28/02/2020	Meeting between ConocoPhillips Australia and Beach Energy to discuss Otway Basin and Bass Basin seismic survey. Agreed to keep each other informed of activities.	The activities of the nearby titleholder are well understood (see Section 5.7.2 of the EP). ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning
		29/07/2020	Meeting between ConocoPhillips Australia and Beach Energy to provide updates on Otway Basin and Bass Basin seismic survey.	
		8/10/2020	Meeting between ConocoPhillips Australia and Beach Energy to provide updates on Otway Basin and Bass Basin seismic survey.	
		10/12/2020	Email received from Beach Energy providing an update on the Prion Marine Seismic Survey.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
TGS	Seismic survey service provider with an approved EP in nearby waters.	26/10/2020	Meeting between ConocoPhillips Australia and TGS to discuss upcoming seismic surveys. Agreed to keep each other informed of activities.	The potential activities of the stakeholder are well understood (see Section 7.1 of the EP). ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning.
		09/02/2021	ConocoPhillips Australia emailed project update.	
Other				
University of Tasmania (UTAS) - Institute for Marine and Antarctic Studies (IMAS)	Cooperative teaching and research institute between various marine and Antarctic agencies	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The survey will not impact on the functions, interests or activities of this stakeholder. The stakeholder has not expressed an interest in the survey. As such, no further consultation is required.
		19/08/2020	UTAS Associate Professor expressed desire for ConocoPhillips Australia to share multibeam sonar data with UTAS and Parks Australia.	
		24/08/2020	A phone meeting was arranged between UTAS and ConocoPhillips Australia Exploration Manager.	
		27/08/2020	Meeting between UTAS and ConocoPhillips Australia. ConocoPhillips Australia explained that multibeam sonar was not part of the survey scope.	
		27/10/2020	ConocoPhillips Australia email updated project information. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		23/11/2020	Email received from UTAS to confirming interest in the possibility of acquiring the seismic survey multibeam	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
			sonar data..	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open.	
		04/01/2021	ConocoPhillips Australia emailed UTAS asking if more findings could be shared from a Rock Lobster study as referenced in DPIPWE's submission.	
		04/01/2021	Email response received from UTAS explaining the results are not yet publicly released. UTAS will forward results when available to the public.	
		05/01/2021	ConocoPhillips Australia emailed UTAS requesting further information on methodology and equipment used in the study to compare these with predictions of the Sequoia survey. UTAS responded explaining the methodology will be shared shortly but further details requested by ConocoPhillips Australia will not be included in the study report. UTAS confirmed the further details requested will be shared with ConocoPhillips Australia when it is published.	
		07/01/2021	ConocoPhillips Australia requested to be put on the distribution list for research and publication updates.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Indigo Communications Cable (SULO)	Operator of the 'superloop' subsea telecommunications cable.	07/10/2020	ConocoPhillips Australia called SULO Customer Service inquiring about the location of the Indigo Central subsea cable in the survey area. SULO asked that the request be emailed.	The location of the SULO in the survey area is well understood (see Section 5.7.3 of the EP) and an assessment of the potential impacts to the cable is provided in Section 7.1 of the EP. Although the stakeholder has not expressed an interest in the survey, ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning given that the survey will pass over its infrastructure.
		09/10/2020	ConocoPhillips Australia emailed SULO with information regarding the Sequoia MSS and requested the location of the subsea cable in the survey area.	
		21/10/2020	ConocoPhillips Australia called to follow up on information request. ConocoPhillips Australia was advised that the request was still being processed.	
		03/11/2020	ConocoPhillips Australia called to follow up again. SULO provided an alternative email addressed to send request to again. ConocoPhillips Australia forwarded the request to the updated contact information.	
		18/11/2020	ConocoPhillips Australia called to follow up again on previous emails. SULO advised that the request would be followed up on as soon as possible.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Aquasure	Operators of the Victorian Desalination Plant.	24/11/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional contact with this stakeholder is only necessary in the event of an MDO spill.
King Island Chamber of Commerce (KICC)	Association supporting business on King Island.	08/07/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	ConocoPhillips Australia has addressed the stakeholder's concerns. ConocoPhillips Australia will continue to keep the stakeholder informed about survey planning.
		17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	
		09/09/2020	ConocoPhillips Australia and KICC arranged a briefing regarding the survey.	
		17/09/2020	Meeting held between ConocoPhillips Australia and KICC. ConocoPhillips Australia briefed KICC members on the survey. ConocoPhillips Australia provided slide deck and fact sheets to KICC following the presentation.	
		27/10/2020	ConocoPhillips Australia email updated project information. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Colac and District Chamber of	Association supporting businesses in Colac and	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The survey will not impact on the functions, interests or

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Commerce	surrounds.	27/10/2020	ConocoPhillips Australia email updated project information. No stakeholder response.	activities of this stakeholder. The stakeholder has not expressed an interest in the survey. As such, no further consultation is required.
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the public comment period for the EP is now open. CDCC responded requesting a meeting.	
		10/12/2020	Telephone call between ConocoPhillips Australia and CDCC to discuss and set briefing to the Chamber of Commerce.	
		17/12/2020	ConocoPhillips Australia meeting with the Colac District Chamber of Commerce for a briefing.	
		09/02/2021	ConocoPhillips Australia emailed project update.	
Tourism Industry Council of Tasmania	Peak body representing Tasmania's tourism industry.	17/08/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	The survey will not impact on the functions, interests or activities of this stakeholder. The stakeholder has not expressed an interest in the survey. As such, no further consultation is required.
		27/10/2020	ConocoPhillips Australia email updated project information. No stakeholder response.	
		20/11/2020	ConocoPhillips Australia emailed notification of pending EP submission.	
		09/12/2020	ConocoPhillips Australia emailed informing that the	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
			public comment period for the EP is now open.	
		09/02/2021	ConocoPhillips Australia emailed project update.	

Stakeholder	Function, interests and/or activities	Date	Consultation conducted and stakeholder concerns	Assessment of merit
Cultural Heritage Interests				
Bunurong Land Council Aboriginal Corporation	Incorporated association representing the Bunurong community.	18/11/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	Additional contact with this stakeholder is only necessary in the event an MDO spill contacts shorelines of their lands.
Eastern Maar Aboriginal Corporation	Incorporated association representing the Eastern Maar community.	18/11/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.
Wadawurrung Traditional Owners Aboriginal Corporation	Incorporated association representing the Wadawurrung community.	18/11/2020	ConocoPhillips Australia emailed the project information sheet and invited return comment.	As above.

5. Existing Environment

In accordance with OPGGS(E) Regulation 13(2), the 'environment that may be affected' (EMBA) by the activity is described in this section, together with its values and sensitivities. Each hazard associated with the survey has its own unique EMBA. The largest one, which encompasses all others, has been chosen (the 'hydrocarbon spill EMBA') for this chapter so as to describe all possible values and sensitivities, which is a marine diesel oil (MDO) spill originating within the survey area.

The MDO spill EMBA ('spill EMBA') (Figure 5.1 The Sequoia 3DMSS EMBA

) is defined as:

The combined extent of low-level hydrocarbon exposure to the sea surface (1 g/m2), entrained in the water column (10 ppb), dissolved in the water column (10 ppb) and contact to shorelines (10 g/m2) resulting from the loss of 373 m3 of MDO (over 6 hours) from the survey vessel using annualised metocean conditions.

The spill EMBA is generated from stochastic modelling (see Section 7.12) and therefore does not represent the possible outcome from a single spill scenario, but rather represents the compilation of possible outcomes and area predicted to be affected from 100 simulations of the scenario under annualised weather conditions. The resultant EMBA is conservative, covering vast areas that are unlikely to be affected by any single spill event (Figure 5.2).

The maps presented in this chapter illustrate the following phases of MDO fate under the different scenarios:

- Sea surface – floating hydrocarbons at the sea surface;
- Entrained – hydrocarbon droplets suspended in the water column;
- Dissolved – hydrocarbons dissolved in the water column; and
- Shoreline – hydrocarbons accumulated on the shoreline.

Where appropriate, descriptions of the Bass Strait environment (beyond the spill EMBA) are provided for context. The 'environment' is defined in the OPGGS(E) regulations as:

Ecosystems and their constituent parts, including people and communities;

- Natural and physical resources;
- The qualities and characteristics of locations, places and areas;
- The heritage value of places; and
- The social, economic and cultural features of these matters.

The key sources of information used in developing this chapter include the:

- EPBC Act Protected Matters Search Tool (PMST) database (DAWE, 2020a), conducted for the survey area and EMBA on the 5th of October 2020 (Appendix 10);
- Species Profile and Threats (SPRAT) Database (DAWE, 2020b);
- South-east Marine Region Profile (DoE, 2015a);
- Marine Natural Areas Values Study Vol 2: Marine Protected Areas of the Flinders and Twofold Shelf Bioregions (Barton et al., 2012);
- National Conservation Values Atlas (NCVA) (DAWE, 2020c);
- Victorian Oil Spill Response Atlas (OSRA) (DEDJTR, 2017) (Appendix 11);
- Tasmanian 'Listmap' database; and
- Australian Ocean Data Network (AODN) portal.

While the PMST database gathers data from a wide range of national, state and museum databases, this EP also includes information from the following databases for completeness because they list all species recorded in an area, not just threatened and migratory species like the PMST does. This provides a more complete picture of the species known to occur in the survey area.

- The Atlas of Living Australia (ALA) database (Appendix 12);
- Victorian Biodiversity Atlas (VBA) (DELWP, 2020)(Appendix 13); and
- Shorebirds 2020 database (Appendix 14).

The relevant values and sensitivities considered in this chapter are inclusive of but not limited to the matters protected under Part 3 of the EPBC Act.

Table 5.1 summarises the presence or absence of receptors and sensitivities within the proposed survey area and the EMBA.

Figure 5.1 The Sequoia 3DMSS EMBA

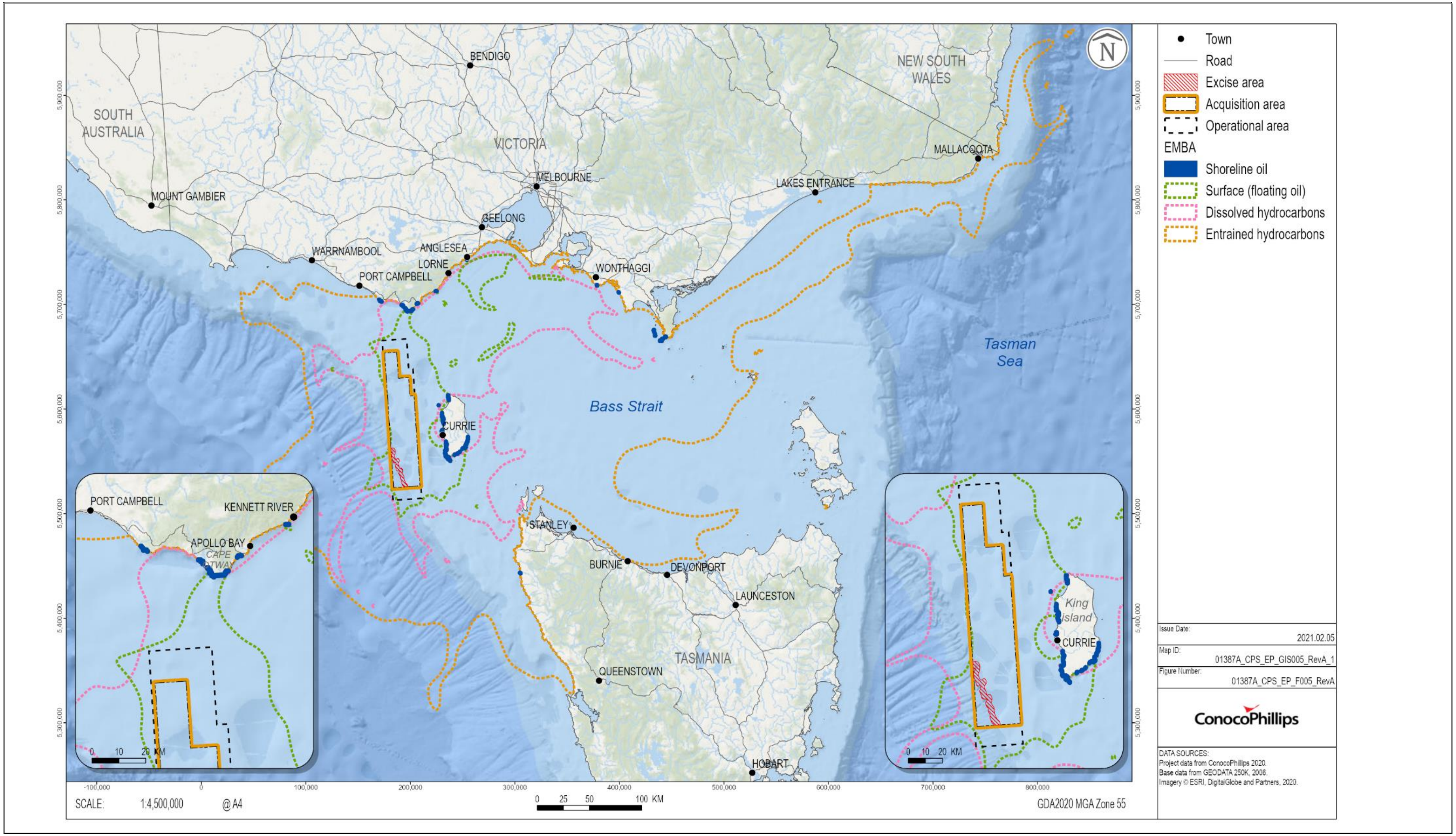
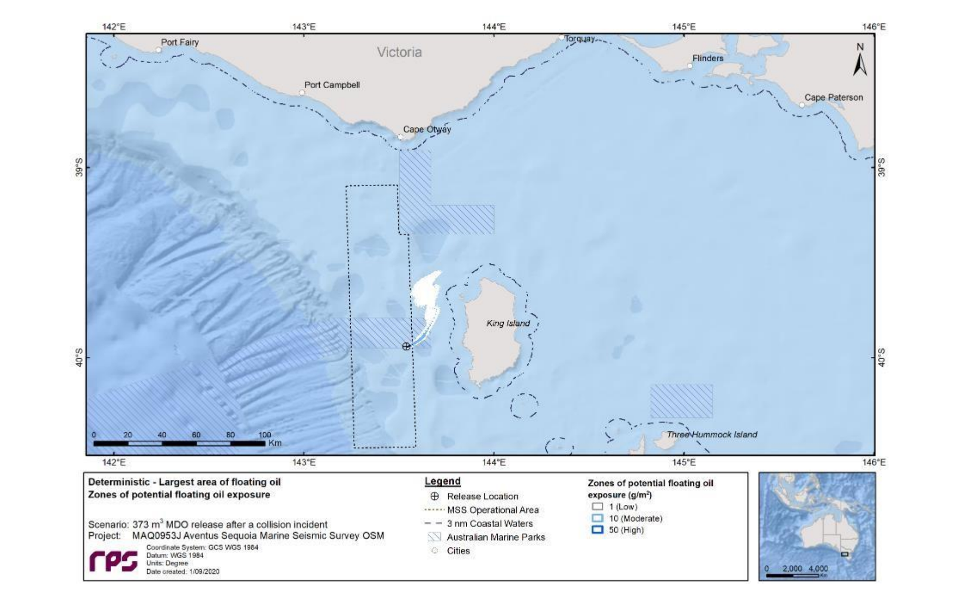
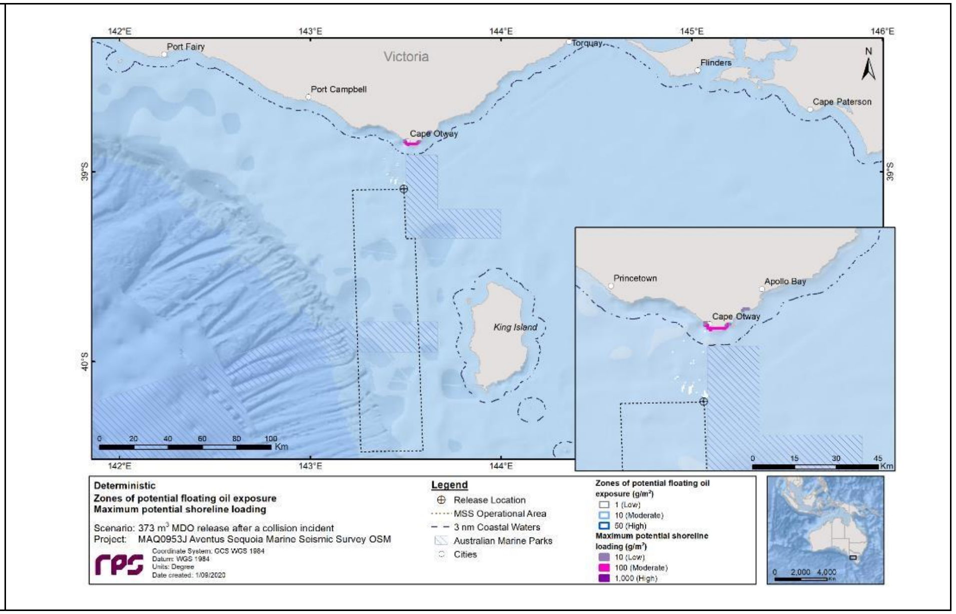


Figure 5.2 Largest extent of hydrocarbon from a single spill



Maximum potential floating hydrocarbon exposure



Maximum potential shoreline loading

Table 5.1 Presence or absence of receptors and sensitives within the survey area and the spill EMBA

Receptor	Survey area	Spill EMBA
Habitats		
Soft sediment seabed	Yes	Yes
Sandy shores	No	Yes
Rocky reef	Yes	Yes
Rocky shores	No	Yes
Sponge gardens	Yes	Yes
Seagrass communities	No	Yes
Benthic species		
Abalone	No	Yes
Scallops	No	Yes
Rock lobsters	Yes	Yes
Pelagic species		
BIA, Great white shark	Yes	Yes
BIA, Pygmy blue whale	Yes	Yes
BIA, Southern right whale	Yes	Yes
BIA, Humpback whale	No	Yes
Pinnipeds, breeding colonies and haul-out sites	No	Yes
Turtles	Yes	Yes
Turtle nesting sites	No	No
Seabirds	Yes	Yes
Shorebirds	No	Yes
Conservation Values & Sensitivities		
Australian Marine Parks (AMPs)	Yes	Yes
World Heritage-listed properties	No	No
National Heritage-listed properties	No	Yes
Wetlands of International Importance (Ramsar)	No	Yes
Commonwealth Heritage-listed places	No	No
Threatened Ecological Communities	No	Yes
Key Ecological Features	Yes	Yes
Nationally Important Wetlands	No	Yes
Victorian marine protected areas	No	Yes
Tasmanian marine protected areas	No	Yes
State coastal / shoreline protected areas	No	Yes
Cultural heritage values		
Shipwrecks	No	Yes
Native title	No	Yes
Indigenous heritage	No	Yes
Socio-economic environment		

Receptor	Survey area	Spill EMBA
Tourism	No	Yes
Commercial fishing	Yes	Yes
Recreational fishing	Yes	Yes
Commercial shipping	Yes	Yes

Green cells = presence of receptor, red cells = absence of receptor.

5.1. Conservation Values and Sensitivities

The conservation values and sensitivities in and around the survey area and within the spill EMBA are described in this section, with Table 5.2 providing an outline of the conservation categories assessed.

Table 5.2 Conservation values assessed in relation to the EMBA

Category	Conservation classification	EP Section
MNES	Australian Marine Parks (Commonwealth)	5.1.1
	World Heritage-listed properties	5.1.2
	National Heritage-listed places	5.1.3
	Wetlands of International Importance (Ramsar)	5.1.4
	Nationally threatened species and threatened ecological communities	Throughout Section 5.5 and Section 5.1.6
	Migratory species	Throughout Section 5.5
	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
Other areas of national importance	Commonwealth heritage-listed places	5.1.5
	Key Ecological Features (KEFs)	5.1.7
	Nationally important wetlands (NIWs)	5.1.8
Victorian protected areas	Marine National Parks (MNPs), coastal reserves and marine sanctuaries	5.1.9
Tasmanian protected areas	MNPs, coastal reserves and marine sanctuaries	5.1.10
New South Wales protected areas	Coastal reserves	5.1.11

5.1.1. Australian Marine Parks

The South-east Commonwealth Marine Reserves Network was designed to include examples of each of the provincial bioregions and the different seafloor features in the region (DNP, 2013). Provincial bioregions are large areas of the ocean where the fish species and ocean conditions are broadly similar. There are five Australian Marine Parks (AMPs) relevant to this activity in the South-east Commonwealth Marine Reserves Network. The spill EMBA intersects the following AMPs (as shown in Figure 5.3), which are described in this section:

- Apollo;
- Zeehan;
- Franklin;
- Boags; and
- Beagle.

Following proclamation of the South-east Commonwealth Marine Reserve Network, approval was given under Section 359B of the EPBC Act for the carrying on of oil and gas seismic surveys in Special Purpose zones (IUCN VI) and Multiple Use zones (IUCN VI), and the transit of vessels in connection with these (DNP, 2013). Appendix 2 demonstrates how the proposed survey activities (and information in the EP) are not inconsistent with the strategic objectives of the South-east Commonwealth Marine Reserves Network Management Plan 2013-2023 (DNP, 2013).

Apollo AMP

The survey acquisition area lies approximately 8 km south of the Apollo AMP at its closest point while the operational area skirts approximately 200 m west of Apollo AMP at its closest point. This AMP has a water depth of less than 50 m near Cape Otway and extends to 100 m along the Otway Depression - a deep undersea valley joining the Bass Basin to the open ocean. The waters of the reserve are exposed to large swell waves generated from the southwest and strong tidal flows. The sea floor has many rocky reef patches interspersed with areas of sediment and, in places, has rich, benthic fauna dominated by sponges. Seabirds, dolphins, seals and white shark forage in the reserve, and Pygmy Blue Whale (Balaenoptera musculus brevicauda) (PBW) migrate through Bass Strait (DNP, 2013). The major conservation values for the AMP are (DNP, 2013):

- Ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province and associated with the sea-floor features: deep/hole/valley and shelf;
- An important migration area for blue, fin, sei and humpback whales;
- An important foraging area for black-browed and shy albatross, Australasian gannet, short-tailed shearwater and crested tern;
- A cultural and heritage site wreck of the MV City of Rayville.

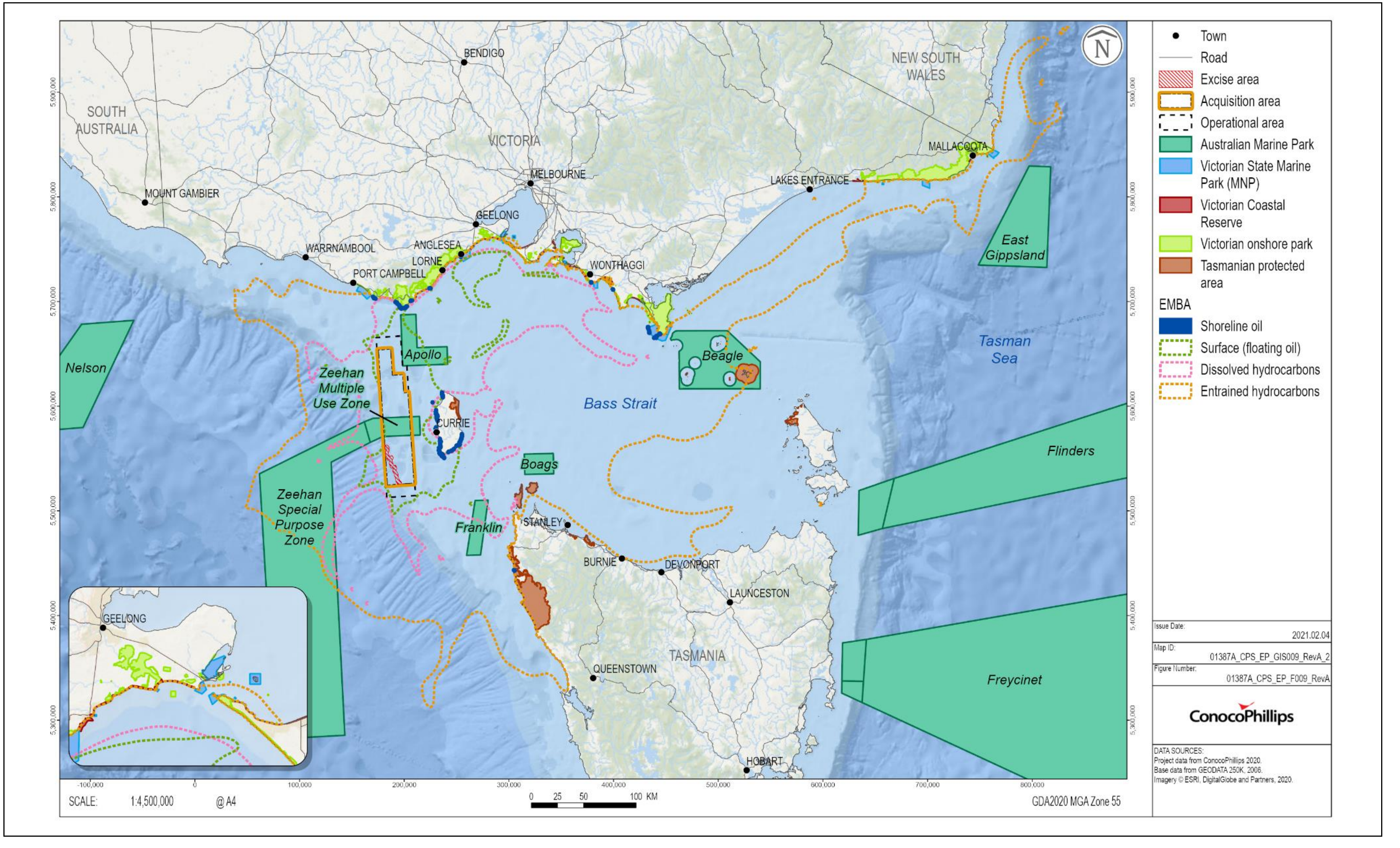
Zeehan AMP

The survey area spatially overlaps the Multiple Use Zone (IUCN VI) of the Zeehan AMP. The management approach for IUCN VI areas provides for general sustainable use by allowing activities that do not significantly impact on benthic habitats. Activities are allowed or may be authorised provided they are consistent with the IUCN management principles and will not have an unacceptable impact on the values of the area (DNP, 2013).

The Zeehan AMP covers a depth range from 50 m (coastal shelf) to 3,000 m (abyssal plain). A significant feature of this reserve is a series of four submarine canyons that incise the continental slope, extending from the shelf edge to the abyssal plain. When the Zeehan Current (extending from the west) meets these canyons, water swirls upwards, taking nutrients towards the surface and contributing to diverse marine life. The AMP includes a variety of seabed habitats, including exposed limestone, that support animal communities of large sponges and other, permanently fixed, invertebrates on the continental shelf. There are also extensive 'thickets' of invertebrate animals, such as lace corals and sponges, on the continental slope. The rocky limestone provides important habitats for a variety of commercial fish species, including the giant crab and SRL. The major conservation values for the Zeehan AMP are (DNP, 2013):

- Examples of ecosystems, habitats and communities associated with the Tasmania Province, the West Tasmania Transition and the Western Bass Strait Shelf Transition and associated with the sea-floor features: abyssal plain/deep ocean floor, canyon, deep/hole/valley, knoll/abyssal hill, shelf and slope;
- An important migration area for blue and humpback whales; and
- An important foraging area for black-browed, wandering and shy albatrosses, and great-winged and cape petrels.

Figure 5.3 Protected areas intersected by the EMBA



Franklin AMP

The Franklin AMP is located 61 km southeast of the acquisition area and 25 km off the northwest coast of Tasmania in waters ranging from 40 m to 150 m deep over a total area of 671 km2. The reserve represents an area of shallow continental shelf ecosystems and incorporates the major bioregions of western Bass Strait and the Tasmanian shelf (DNP, 2013). The ocean reserve provides feeding grounds for seabirds including species of albatross, petrel, shearwater and cormorant that have breeding colonies on the nearby Hunter Island Group. Great white sharks are also known to forage in the park (DNP, 2013).

Boags AMP

The Boags AMP is located 106 km east of the acquisition area of the northwest coast of Tasmania and covers 537 km2. The AMP represents an area of shallow ecosystems that has a depth range of mostly between 40 m and 80 m. It encompasses the fauna of Bass Strait, which is expected to be especially rich based on studies of several seafloor-dwelling animal groups (DNP, 2013).

The Boags AMP contains a rich array of life, particularly benthic animals and animals living in the seafloor sediments and muds including crustaceans, polychaete worms and molluscs, as is common for the Bass Strait seabed. The sandy seabed of the AMP is also likely to host benthic fish such as flathead, skates, rays and latchets but not extensive sponge gardens. The reserve is adjacent to the important seabird colonies of Tasmania's northwest, particularly the Hunter Island Group including three Hummock Island, Hunter Island, Steep Island, Bird Island, Stack Island and Penguin Islet). Bird species present in the Hunter group include shy albatross, fairy prions, black-faced cormorants, common diving petrels, little penguins and Cape Barren geese. It is likely that the rich abundance of benthic fauna facilitates the presence of pelagic fish species within the AMP. The proximity of these two features means that the AMP is an important foraging area for the variety of seabirds that inhabit the Hunter group (DNP, 2013). The AMP overlaps the identified BIAs of several seabird species including the black-browed albatross, Buller's albatross, Campbell albatross, Indian yellow-nosed albatross, shy albatross, wandering albatross, white-faced storm petrel, common diving petrel and short-tailed shearwater as well as the southern right and PBW BIAs. The marine park is also on the migration route for the critically endangered orange-bellied parrots as they across Bass Strait each spring and autumn on their migration to and from Tasmania to the Australian mainland (Parks Australia, 2020).

Beagle AMP

The Beagle AMP is located 261 km east of the acquisition area in shallow water (50-70 m deep) and covers an area of 2,928 km2 that surrounds the Hogan and Kent Group of islands. The deep rocky reefs support a rich array of sea life, including sponge gardens and Port Jackson sharks. The area provides homes and feeding grounds for seabirds, little penguins and Australian fur seals (DNP, 2013). The reserve is located near the Furneaux group of islands which contains island important to breeding seabirds and shorebirds such as the fairy prion, shy albatross, silver gull, short tailed shearwater, black faced cormorant, Australasian gannet, common diving petrel and little penguins.

5.1.2. World Heritage-listed properties

World Heritage Listed properties are examples of sites that represent the best examples of the world's cultural and heritage values, of which Australia has 19 properties (DAWE, 2020d). In Australia, these properties are protected under Chapter 5, Part 15 of the EPBC Act.

There are no World Heritage Properties within the survey area or spill EMBA (DAWE, 2020d). The closest are located onshore in Melbourne (Royal Exhibition Building and Carlton Gardens) and the Tasmanian Wilderness area.

5.1.3. National Heritage-listed properties

The National Heritage List is Australia's list of natural, historic and Indigenous places of outstanding significance to the nation (DAWE, 2020e). These places are protected under Chapter 5, Part 15 of the EPBC Act. No National Heritage-listed properties occur in the survey area.

The Western Tasmania Aboriginal Cultural Landscape is intersected by the spill EMBA (at its shoreline) and described below.

The PMST report lists the Point Nepean Defence Sites and Quarantine Station Area National Heritage-listed property as intersected by the spill EMBA. However, this site is located onshore above the high-water mark and will therefore not be intersected by the spill EMBA.

The Western Tasmania Aboriginal Cultural Landscape

During the late Holocene Aboriginal people on the west coast of Tasmania developed a specialised and more sedentary culture based on a dependence on seals, shellfish and land mammals. This way of life is

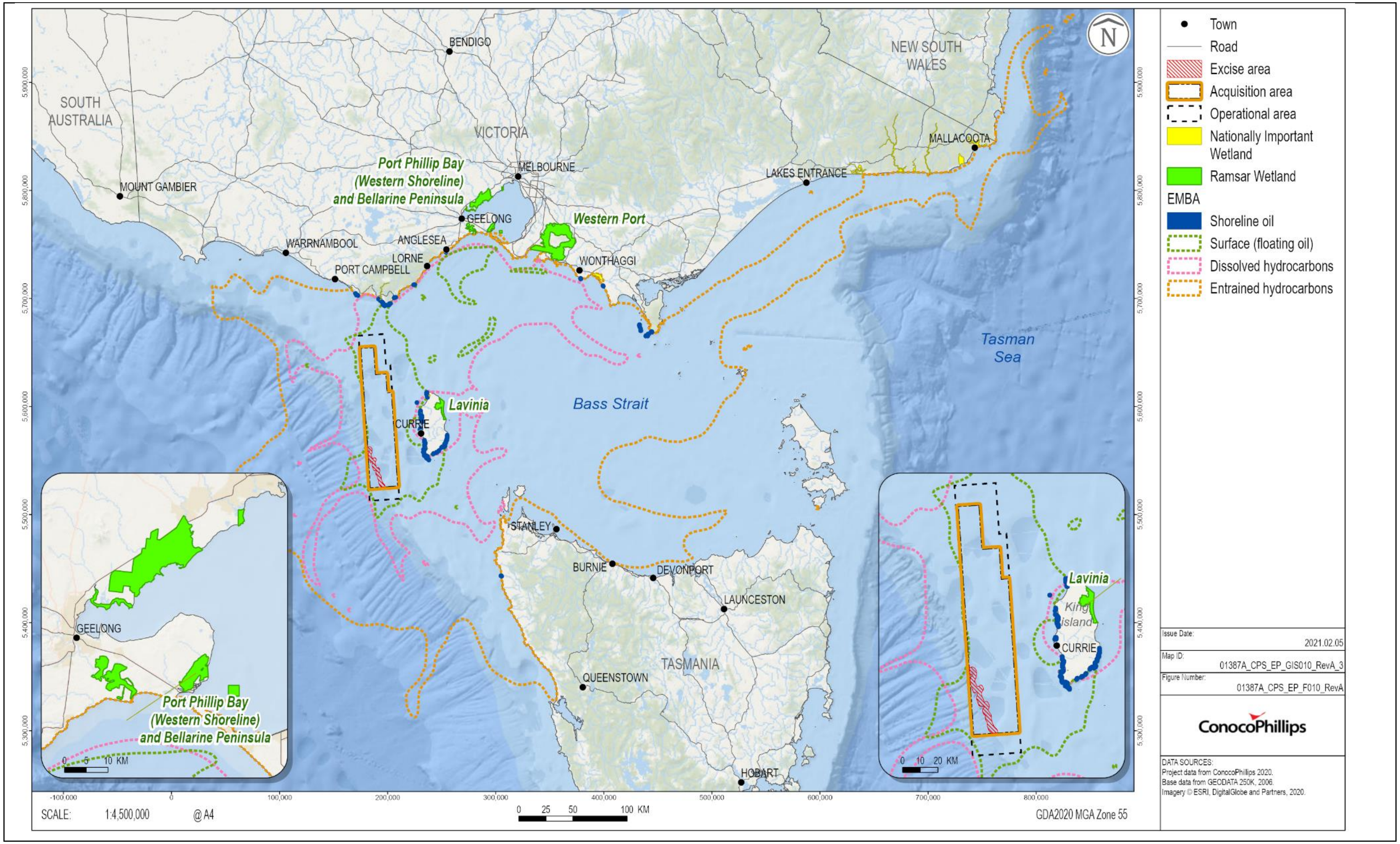
represented by shell middens that lack the remains of bony fish, but contain 'hut depressions' which sometimes formed semi-sedentary villages (DAWE, 2020e). Nearby some of these villages are circular pits in cobble beaches which the Aboriginal community believes are seal hunting hides. The remains of the shell middens in the Western Tasmania Aboriginal Cultural Landscape and its accompanying hut depressions provide evidence of an unusual, specialized and more sedentary Aboriginal community that began almost 2,000 years ago and continued until the 1830s. Archaeological studies of the area found evidence of early villages built near an elephant seal colony. Based on the large number of seal bones in the middens, it is believed the elephant seals where a major source of Aboriginal people's diet in the area (DAWE, 2020e). The Western Tasmania Aboriginal Cultural Landscape also contains other stone artefact scatters, stone arrangements, rock engravings and shelters and human burials that provide further insight into this unique way of life.

5.1.4. Wetlands of International Importance (Ramsar Wetlands)

Australia has 66 wetlands of international importance ('Ramsar wetlands') that cover more than 8.3 million hectares (as of February 2021) (DAWE, 2020c). Ramsar wetlands are those that are representative, rare or unique wetlands, or are important for conserving biological diversity, and are included on the List of Wetlands of International Importance developed under the Ramsar Convention. These wetlands are protected under Chapter 5, Part 15 of the EPBC Act.

There are no Ramsar wetlands in the survey area. The 'Lavinia', 'Western Port', and 'Port Phillip Bay (Western Shoreline) and Bellarine Peninsula' Ramsar sites are intersected by the spill EMBA (entrained hydrocarbons) and are described here (Figure 5.4).

Figure 5.4 International and nationally important wetlands intersected by the survey area and EMBA



Lavinia

The Lavinia Ramsar site is intersected by the entrained phase of the spill EMBA (Figure 5.4) and is located on the northeast coast of King Island, Tasmania, approximately 47 km east of the survey area. The boundary of the site forms the Lavinia State Reserve, with major wetlands in the reserve including the Sea Elephant River estuary area, Lake Martha Lavinia, Penny's Lagoon, and the Nook Swamps.

The shifting sands of the Sea Elephant River's mouth have caused a large back-up of brackish water in the Ramsar site, creating the saltmarsh which extends up to 5 km inland. The present landscape is the result of several distinct periods of dune formation. The extensive Nook Swamps, which run roughly parallel to the coast, occupy a flat depression between the newer parallel dunes to the east of the site and the older dunes further inland. Water flows into the wetlands from the catchment through surface channels and groundwater and leaves mainly from the bar at the mouth of the Sea Elephant River and seepage through the young dune systems emerging as beach springs (PWS, 2000).

The Lavinia State Reserve is an unaltered area of native vegetation on King Island. The vegetation communities include succulent saline herbland, coastal grass and herbfield, coastal scrub and king island eucalyptus globulus woodland. The freshwater areas of the Nook Swamps are dominated by swamp forest. Nook Swamps and the surrounding wetlands contain extensive peatlands (PWS, 2000).

The site is an important refuge for a collection of regional and nationally threatened species, including the nationally endangered orange-bellied parrot. This parrot is heavily dependent upon the samphire plant, which occurs in the saltmarsh, for food during migration. They also roost at night in the trees and scrub surrounding the Sea Elephant River estuary.

Several species of birds that use the reserve are rarely observed on the Tasmanian mainland, including the dusky moorhen, nankeen kestrel, rufous night heron and the golden-headed cisticola.

The site is currently used for conservation and recreation, including boating, fishing, camping and off-road driving. There are artefacts of Indigenous Australian occupation on King Island that date back to the last ice age when the island was connected to Tasmania and mainland Australia via the Bassian Plain.

There are ten critical components and processes identified in the Ramsar site, being (Newall and Llyod, 2012):

- Wetland vegetation communities;
- Regional and national rare plant species;
- Regionally rare bird species;
- Kind Island scrubtit;
- Orange-bellied parrot;
- Water and sea birds;
- Migratory birds;
- Striped marsh frog; and
- Green and gold frog.

Western Port

The Western Port Ramsar site is intersected by the entrained phase of the spill EMBA (Figure 5.4) and is located approximately 60 km southeast of Melbourne and 185 km northeast of the acquisition area. In 1982 a large portion of Western Port Bay was specified of international importance especially as waterfowl habitat. The area consists of large shallow intertidal areas divided by deeper channels with adjacent narrow strips of coastal land (DELWP, 2017).

Westernport Bay is valued for its terrestrial and marine flora and fauna, cultural heritage, recreational opportunities and scientific value. The area has substantial intertidal areas supported by mangroves, saltmarsh, seagrass communities and unvegetated mudflats, which are significant as shorebird habitat.

Additionally, the saltmarsh and mangroves filter pollutants, trap and process nutrients, stabilise sediments and protect the shoreline from erosion (DELWP, 2017). The intertidal mudflats provide a significant food source for migratory waders, making it one for the most significant areas in south-east Australia for these birds. The interaction between critical processes and components provide habitat for many waterbirds. The mangrove and saltmarsh vegetation are of regional, national and international significance because of the role in stabilising the coastal system, nutrient cycling in the bay and providing wildlife habitat (Ross, 2000). There are three state marine parks within the Ramsar site (Yaringa, French Island and Churchill Island MNPs). There are numerous community and government projects that help monitor, protect, raise awareness and educate the community about the Ramsar site wetland (Brown and Root, 2010).

Western Port is protected under the Western Port Ramsar Site Management Plan (DELWP, 2017), which describes the values as:

- Supports a diversity and abundance of fish and recreational fishing;
- The soft sediment and reef habitats support a diversity and abundance of marine invertebrates;
- Supports bird species, including 115 waterbird species, of which 12 are migratory waders of international significance;
- Provides important breeding habitat for waterbirds, including listed threatened species;
- Provides habitat to six species of bird and one fish species that are listed as threatened under the EPBC Act;
- Rocky reefs comprise a small area within the Ramsar site, but includes the intertidal and subtidal reefs at San Remo, which support a high diversity, threatened community and Crawfish Rock, which supports 600 species (Shapiro, 1975);
- The Western Port Ramsar Site has three MNPs, one National Park and has been designated as a
- Biosphere Reserve under the UNESCO’s Man and the Biosphere program;
- The Ramsar site is within the traditional lands of the Boonwurrung, who maintain strong connections to the land and waters; and
- The site contains the commercial Port of Hastings that services around 75 ships per year and contributes around $67 million annually to the region’s economy.

Port Phillips Bay (Western Shoreline) and Bellarine Peninsula

The Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site is intersected by the entrained phase of the spill EMBA (Figure 5.4) and is located in the western portion of Port Phillip Bay, near the city of Geelong in Victoria. The description below provides the values and baseline ecological character of the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site.

The site provides important connective habitat for migratory bird species, habitat for fauna staging and foraging, is home to indigenous cultural sites, provides use of resources, and a site for commercial and recreational activities and education initiatives. The ecological character of the Ramsar site is reliant on the management of human activities and health of environment and water ways.

The Port Phillip Bay Ramsar site consists of a number of component areas that include: parts of the shoreline, intertidal zone and adjacent wetlands of western Port Phillip Bay, extending from Altona south to Limeburners Bay; and parts of the shoreline, intertidal zone and adjacent wetlands of the Bellarine Peninsula, extending from Edwards Point to Barwon Heads and including the lower Barwon River. It is protected under the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site Management Plan (DELWP, 2018), which defines the key values as;

- Representativeness – it includes all eight wetlands types.
- Natural function – the interactions of physical, biological and chemical components of wetlands that enable them to perform certain natural functions and making them a vital element of the landscape.
- Flora and fauna – contains the genetic and ecological diversity of the flora and fauna of the region, with at least 332 floral species (22 state threatened species) and 304 species of fauna (29 threatened species).
- Waterbirds – provides habitat for migratory shorebirds, including some of international and national importance.
- Cultural heritage – many aboriginal sites, particularly shell middens and artefact scatters have been found at the site.
- Scenic – provide vistas of open water and marshland in a comparatively pristine condition.
- Economic – use of natural resources in agriculture, fisheries, recreation and tourism.
- Education and interpretation – offers a wide range of opportunities for education and interpretation of wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation.
- Recreation and tourism – provides activities such as recreational fishing, birdwatching, hunting, boating, swimming, sea kayaking and camping and activities by commercial operators.
- Scientific – site for long-term monitoring of waterbirds and waders.

5.1.5. Commonwealth Heritage-listed places

Commonwealth Heritage-listed places are natural, indigenous and historic heritage places owned or controlled by the Commonwealth. In Australia, these properties are protected under Chapter 5, Part 15 of the EPBC Act.

No properties on the Commonwealth Heritage List occur within the survey area or spill EMBA.

5.1.6. Threatened Ecological Communities

Threatened Ecological Communities (TECs) are protected as MNES under Part 13, Section 181 of the EPBC Act and provide wildlife corridors and/or habitat refuges for many plant and animal species. Listing a TEC provides a form of landscape or systems-level conservation (including threatened species). There are no TECs in the survey area, and the following TECs occur in the spill EMBA (entrained hydrocarbons) (Figure 5.5):

- Giant Kelp Marine Forests of South East Australia (Endangered); and
- Subtropical and Temperate Coastal Saltmarsh (Vulnerable).

Giant Kelp Marine Forests of South East Australia

Giant kelp (Macrocystis pyrifera) is large brown algae that grows on rocky reefs from the sea floor 8 m below sea level and deeper. Its fronds grow vertically toward the water surface, in cold temperate waters off southeast Australia. It is the foundation species of this TEC in shallow coastal marine ecological communities. The kelp species itself is not protected, rather, it is communities of closed or semi-closed giant kelp canopy at or below the sea surface that are protected (DSEWPC, 2012d).

Giant kelp is the largest and fastest growing marine plant. Its presence on a rocky reef adds vertical structure to the marine environment that creates significant habitat for marine fauna, increasing local marine biodiversity. Species known to shelter within the kelp forests include weedy sea dragons (Phyllopteryx taeniolatus), six-spined leather jacket (Mesuchenia freycineti), brittle star (Ophiuroid spp), urchins, sponges, blacklip abalone (Tosia spp) and southern rock lobster (Jasus edwardsii). The large biomass and productivity of the giant kelp plants also provide a range of ecosystem services to the coastal environment. Giant kelp is a cold-water species and as sea surface temperatures have risen on the east coast of Australia over the last 40 years, it has been progressively lost from its historical range (DSEWPC, 2012d).

Giant kelp requires clear, shallow water no deeper than approximately 35 metres (DSEWPC, 2012b). They are photo-autotrophic organisms that depend on photosynthetic capacity to supply the necessary organic materials and energy for growth. O'Hara (in Andrew, 1999) reported that giant kelp communities in Tasmanian coastal waters occur at depths of 5 to 25 m. The largest extent of the ecological community is in Tasmanian coastal waters from Eddystone Point in the north-east of Tasmania along the eastern coastline to Port Davey. It is also known to develop intermittently on the northern and western coasts of Tasmania (DSEWPC, 2012d). The listing advice for the TEC identifies that in Tasmania, patches of the TEC are predominantly found in sheltered embayments associated with rocky reefs on the south and east coasts. Patches are rare on the west and northern coasts but do occur in sheltered areas where substrata and water conditions are favourable for growth (DSEWPC, 2012d) (refer Figure 5.5).

Subtropical and Temperate Coastal Saltmarsh

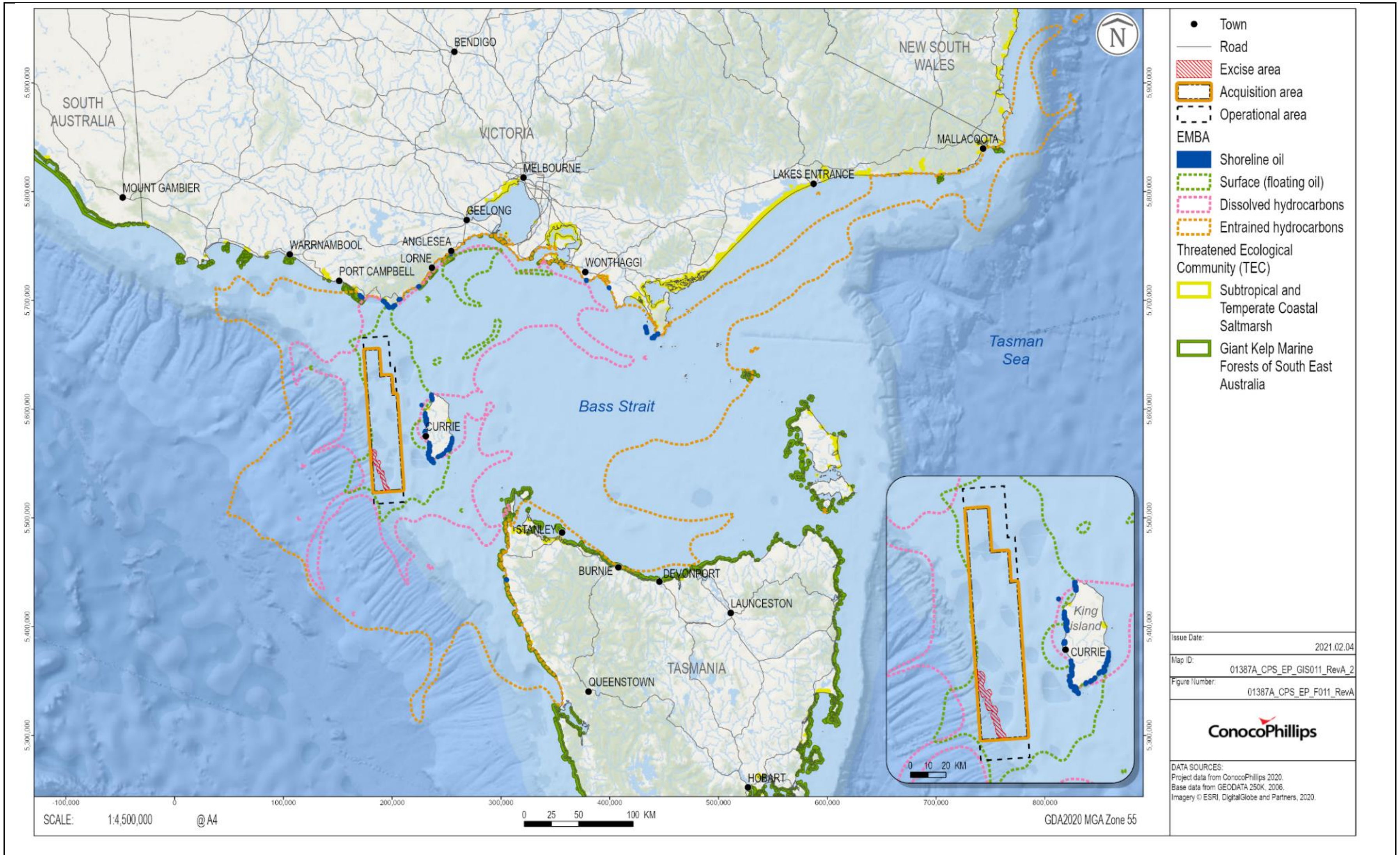
According to the Conservation Advice for Subtropical and Temperate Coastal Saltmarsh, this TEC occurs in a relatively narrow strip along the Australian coast, within the boundary along 23°37' latitude along the east coast and south from Shark Bay on the west coast of WA (TSSC, 2013). The community is found in coastal areas which have an intermittent or regular tidal influence.

The coastal saltmarsh community consists mainly of salt-tolerant vegetation including grasses, herbs, sedges, rushes and shrubs. Succulent herbs, shrubs and grasses generally dominate and vegetation is generally less than 0.5 m in height (Adam, 1990). In Australia, the vascular saltmarsh flora may include many species, but is dominated by relatively few families, with a high level of endism at the species level.

The saltmarsh community is inhabited by a wide range of infaunal and epifaunal invertebrates and low and high tide visitors such as fish, birds and prawns (Adam, 1990). It is often important nursery habitat for fish and prawn species. Insects are also abundance and an important food source for other fauna. The dominant marine residents are benthic invertebrates, including molluscs and crabs (Ross et al., 2009).

The coastal saltmarsh community provides extensive ecosystem services such as the filtering of surface water, coastal productivity and the provision of food and nutrients for a wide range of adjacent marine and estuarine communities and stabilising the coastline and providing a buffer from waves and storms. Most importantly, the saltmarshes are one of the most efficient ecosystems globally in sequestering carbon, due to the biogeochemical conditions in the tidal wetlands being conducive to long-term carbon retention. A concern with the loss of saltmarsh habitat is that it could release the huge pool of stored carbon to the atmosphere.

Figure 5.5 Threatened Ecological Communities intersected by the EMBA



5.1.7. Key Ecological Features

Key Ecological Features (KEFs) are elements of the Commonwealth marine environment that based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity. KEFs have no legal status in decision-making under the EPBC Act but may be considered as part of the Commonwealth marine area.

The spill EMBA intersects five KEFs (Figure 5.6), these being (from west to east):

- The Bonney Upwelling (128 km northwest of the acquisition area);
- West Tasmanian Canyons (intersected by the acquisition area);
- The Upwelling East of Eden (425 km northeast of the acquisition area);
- Big Horseshoe Canyon (525 km northeast of the acquisition area); and
- Canyons on the Eastern Continental Slope (700 km northeast of the acquisition area). Each KEF is described below.

5.1.7.1. Bonney Upwelling

The Bonney Upwelling is intersected by the entrained phase of the spill EMBA, is an area of high productivity and aggregations of marine life. It is a predictable, seasonal upwelling which brings of cold, nutrient rich water to the sea surface 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. Nonetheless the upwelling can extend to at least as far as Beach’s Thylacine gas platform (Levings & Gill 2010),

This phenomenon generally starts in the eastern part of the Great Australian Bight 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 upwelling occurs via Ekman dynamics, where the ocean surface experiences a steady wind stress which results in a net transport of water at right angles to the left of the wind direction.

The upwelling season begins slowly in November and December, peaks from January to March, and then declines from April (Nieblas et al., 2009). Similar to other seasonal upwelling systems, Nieblas et al (2009) found that intra-seasonal variability follows four distinct phases, these being:

- ‘Onset’ - commences in November/December;
- ‘Sustained’ - commences in January/February;
- ‘Quiescent’ - commences in March; and
- ‘Downwelling’ - commences in April (DAWE, 2020b).

Ecological importance

The primary ecological importance of the Bonney Upwelling is as a feeding area for the PBW. The upwelled nutrient-rich re-heated Antarctic intermediate water promotes blooms of coastal krill (Nyctiphanes australis) which in turn attracts PBW to the region to feed. The Bonney Upwelling is one of only two identified seasonal feeding areas for PBW in Australian coastal waters and is one of 12 known blue whale feeding aggregation areas globally. Sightings of other species – namely the sei whale (Gill et al., 2015), and the fin whale (Morrice et al., 2004), indicate this is potentially be an important feeding ground for other species.

The Bonney Upwelling promotes planktonic diversity, which increases productivity of the area as a fishery and foraging ground for many higher predator species including little penguins and fur-seals feeding on baitfish.

Variability

While the general characteristics of the Bonney Upwelling are broadly understood virtually nothing is known of the longer-term variability of the phenomenon. 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, that not all favourable upwelling winds lead to an upwelling event. The El Niño – Southern Oscillation (ENSO) has been identified by some authors as a potential driver of upwelling strength along the south Australian coast. The ENSO is the dominant global mode of inter-annual climate variability, is a major contributor to Australia's climate and influences Australia's marine waters to varying degrees around the coast. The two phases of ENSO, El Niño and La Niña, produce distinct and different changes to the climate.

Middleton et al (2007) examined meteorological and oceanographic data and output from a global ocean model. The authors concluded that El Niño events lead to enhanced upwelling along Australia's southern shelves. However, it has been found that relationships between ENSO events and upwelling and production indices off southern Australia are weak due to the high interannual and inter-seasonal variability in these indices.

Linkages between climate, upwelling strength and PBW abundance

The complex interaction between climatic conditions, upwelling strength and seasonal PBW distribution and abundance within the Bonney Upwelling is currently poorly understood other than at a general level. Factors to be resolved to enable a more detailed understanding include observations that not all strong upwelling-favourable winds necessarily lead to strong upwelling events (Griffin et al., 1997) and that increased upwelling does not necessarily equate to increased productivity as conditions may be less optimal for plankton growth. Further an increase in plankton biomass does not necessarily coincide with the presence of PBW.

Review of PBW aerial observation data from Gill et al (2011) from the 2001-02 to 2006-07 seasons, and additional surveys in the Otway Basin commissioned by Origin during February 2011 and November - December 2012 did not find a significant positive correlation between El Niño conditions and PBW abundance. Such a positive correlation could be expected if El Niño conditions caused stronger upwelling, stronger upwelling led to increased planktonic productivity and PBW were more likely to be present when productivity is higher.

Two of the six seasons subject to aerial surveys in the eastern section of the Otway Basin (Gill et al., 2011) were determined by the Bureau of Meteorology to demonstrate weak to moderate El Niño conditions. The remainder of the years were assessed to be neutral. The two El Niño seasons (2002-03 and 2006-07) corresponded with the lowest observation frequencies (sightings/1,000 km) for PBW of all the yearly surveys.

Aerial surveys commissioned by Origin undertaken during February 2011 and November-December 2012 were undertaken during La Niña events classified by the BOM as very strong and strong respectively.

Although observation frequencies are not available, the absolute numbers of PBW observed was substantially higher than during the 2001-01 to 2006-07 surveys. Also, of note is that PBW observed during February 2011 were congregated along the seaward edge of a plume of terrestrial runoff, potentially suggesting use of this plume as a feeding resource, which has no relationship to upwelling.

5.1.7.2. West Tasmania Canyons

The West Tasmania Canyons are intersected by the survey area and spill EMBA. This KEF is located on the relatively narrow and steep continental slope west of Tasmania. This location has the greatest density of canyons within Australian waters where 72 submarine canyons have incised a 500 km-long section of slope

(Heap & Harris, 2009). The canyons in the Zeehan AMP are relatively small on a regional basis, each less than 2.5 km wide and with an average area of 34 km^2 shallower than 1,500 m. The Zeehan canyons are typically gently sloping and mud-filled with less exposed rocky bottoms compared with other canyons in the south-east marine region (e.g., Big Horseshoe Canyon).

Submarine canyons modify local circulation patterns by interrupting, accelerating, or redirecting current flows that are generally parallel with depth contours. Their size, complexity and configuration of features determine the degree to which the currents are modified and therefore their influences on local nutrients, prey, dispersal of eggs, larvae and juveniles and benthic diversity with subsequent effects which extend up the food chain (DAWE, 2020b).

Eight submarine canyons surveyed in Tasmania displayed depth-related patterns with regard to benthic fauna, in which the percentage occurrence of faunal coverage visible in underwater video peaked at 200-300 m water depth, with averages of over 40% faunal coverage. Coverage was reduced to less than 10% below 400 m depth. Species present consisted of low-relief bryozoan thicket and diverse sponge communities containing rare but small species in water depths of 150 m to 300 m.

Sponges are concentrated near the canyon heads, with the greatest diversity between 200 m and 350 m water depths. Sponges are associated with abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts (DAWE, 2020b). Based upon this enhanced productivity, the West Tasmanian canyon system includes fish nurseries (blue warehou (*Seriolella brama*) and ocean perch), foraging seabirds (albatross and petrels), white shark and foraging blue and humpback whales.

5.1.7.3. Big Horseshoe Canyon

The Big Horseshoe Canyon lies south of the coast of eastern Victoria and is the easternmost arm of the Bass Canyon system. The steep, rocky slopes provide hard substrate habitat for attached large megafauna.

Canyons have a marked influence on diversity and abundance of species through their combined effects of topography, geology and localised currents, all of which act to funnel nutrients and sediments into the canyon. Sponges and other habitat forming species provide structural refuges for benthic fish, including the commercially important pink ling (*Genypterus blacodes*) It is the only known temperate location of the stalked crinoid (*Metacrinus cyaneu*), which occurs in water depths between 200 m and 300 m (DoE, 2015a).

5.1.7.4. Upwelling East of Eden

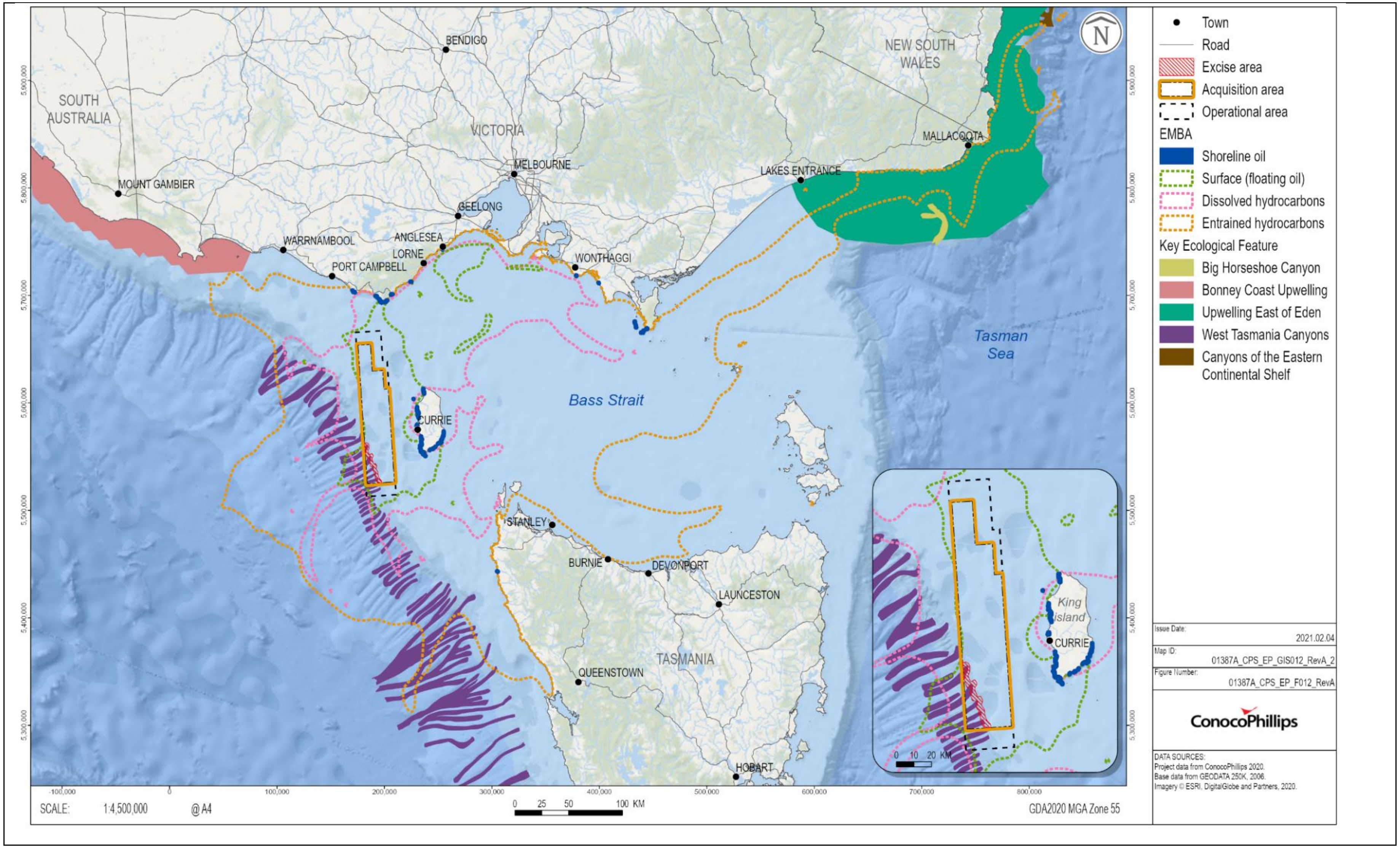
Dynamic eddies of the East Australian Current cause episodic productivity events when they interact with the continental shelf and headlands. The episodic mixing and nutrient enrichment events drive phytoplankton blooms that are the basis of productive food chains including zooplankton, copepods, krill and small pelagic fish (DoE, 2015a). The key value of the KEF is its high productivity and aggregations of marine life. The upwelling of this region on the eastern Victorian coast and southern NSW coast occurs more or less continuously from austral spring to autumn (Huang and Wang, 2019). However, there is strong temporal (i.e., month to month, seasonal and inter-annual) variability of the upwelling characteristics and area of influence (Huang and Wang, 2019).

The upwelling supports regionally high primary productivity that supports fisheries and biodiversity, including top order predators, marine mammals and seabirds. This area is one of two feeding areas for blue whales and humpback whales, known to arrive when significant krill aggregations form. The area is also important for other cetaceans, seals, sharks and seabirds (DoE, 2015a).

5.1.7.5. Canyons of the Eastern Continental Slope

The canyons of the eastern continental slope are defined as a KEF as they provide a unique seafloor feature with enhanced ecological functioning, integrity and biodiversity, which apply to both its benthic and pelagic habitats. These canyons affect the water column by interrupting the flow of water across the seafloor and creating turbulent conditions in the water column. This turbulence transports bottom waters to the surface, creating localised upwellings of cold, nutrient-rich waters, which result in regions of enhanced biological productivity relative to the surrounding waters (DAWE, 2020b).

Figure 5.6 KEFs intersected by the EMBA



5.1.8. Nationally Important Wetlands

Nationally important wetlands (NIWs) help maintain ecological and hydrological roles in wetland systems, provide important habitat for animals at a vulnerable stage in their life cycle, support 1% or more of the national population of a native plant or animal taxa or protect outstanding historical or cultural significance (DAWE, 2020g).

There are no NIWs in the survey area. Twelve NIWs have been identified along the coast that is intersected by the spill EMBA (Figure 5.4). Many of these NIW would only be intersected by the spill EMBA if they are open to the sea at the time of a spill. These NIWs are described below based on DAWE (2020g):

- Lavinia Nature Reserve (TAS075) – Lavinia is also a wetland of international significance and is described in Section 5.1.4. The site is a refuge for regional and nationally threatened species (including the orange-bellied parrot) and provides recreational experiences including boating, fishing, camping and off-road driving.
- Western Port (VIC083) (permanently open) – Western Port NIW is of high value for its avifauna and flora. The bay's seagrass flats are nursery grounds for King George whiting (*Sillaginoides punctatus*) and other fish species with many bird species dependent on the area. Many sites in Western Port are important breeding, roosting and feeding sites for migratory and wading bird species. Western Port contains over 50% of Victoria's mangroves and extensive areas of seagrass and mudflats, which are relatively undisturbed and particularly productive for bird, fish and invertebrate fauna. Western Port is also a Ramsar Wetland site and is described in Section 5.1.4.
- Powlett River Mouth (VIC078) (permanently open) - The Powlett River Mouth supports saltmarsh vegetation which in turn provides valuable habitat for the endangered orange-bellied parrot.
- Anderson Inlet (VIC062) (permanently open) – Anderson Inlet is one of the largest estuaries on the Victorian coast (2,230 ha) and is significant for the 23 waterbird species recorded here, including many threatened species such as the hooded plover, fairy tern, eastern curlew and orange-bellied parrot. The site is popular for recreational line-fishing, sailing, powerboating, bait collection and duck hunting.
- Mud Islands (VIC077) - Mud Islands are a group of low, sandy islands located in the southern part of Port Phillip Bay. On the southern, western and northern shores, extensive intertidal mudflats and sea-grass meadows are present. The islands have very high value for fauna since they support large numbers of migratory wading birds and breeding seabirds. Mud Islands has a high value for its ecological, recreational, scientific, educational and aesthetic features. It has a very high diversity of birds (114 species) and is an important feeding and roosting site for many migratory birds.
- Lake Connewarre State Wildlife Reserve (VIC070) (intermittently open) - The Lake Connewarre State Wildlife Reserve consists of an extensive estuarine and saltmarsh system drained by the Barwon River. It includes a large permanent freshwater lake, a deep freshwater marsh, several semi-permanent saline wetlands and an estuary. Lake Connewarre State Game Reserve is the largest area of native vegetation remaining on the Bellarine Peninsula. The Lake Connewarre State Game Reserve consists of a wide variety of wetland habitats which support a large and diverse waterbird population and contain a significant area of natural vegetation in this part of the south east coastal plain.
- Lower Aire River Wetlands (VIC091) (intermittently open) - These Victorian wetlands consist of three shallow freshwater lakes, brackish to saline marshes and an estuary on the Aire River floodplain. This floodplain occurs at the confluence of the Ford and Calder Rivers with the Aire River. It is surrounded by the Otway Ranges and dune-capped barrier along the ocean shoreline. The Lower Aire River Wetlands have extensive beds of Common Reed and groves of Woolly Tea-tree which can support large numbers of waterbirds. These wetlands act as a drought refuge for wildlife.
- Tamboon Inlet (VIC135) (intermittently open) – This wetland is located in east Gippsland and hosts a variety of wetland types that are affected by fresh and saline water, which supports a diversity of flora and fauna in estuarine habitat. Ninety-six (96) plant taxa (including 38 introduced) have been recorded in

the Tamboon Inlet area. The inlet is fringed by multiple vegetation classes including riparian scrub complex and coastal saltmarsh. The south of the inlet is separated from Bass Strait behind a dune and barrier system that forms part of Ninety Mile Beach. The inlet may flow to Bass Strait during times of high flow, though generally remains closed.

- Thurra River (VIC155) (intermittently open) – The reach corridor of Thurra River has an area of 2,920 ha and flows through State forest and Croajingolong National Park. There are 29 threatened flora species and 37 threatened fauna species within the wetland. Ninety Mile Beach and the associated dunes create a barrier to Bass Strait, which may be open during times of high flow, though generally remains closed.
- Sydenham Inlet Wetlands (VIC134) (intermittently open) – The Sydenham Inlet Wetlands include a variety of wetland types affected by fresh to saline water and provides a large area of estuarine habitat and supports a high diversity of flora and fauna. Approximately 260 plant taxa have been recorded at the site as well as 10 bird species listed under the JAMBA and CAMBA agreements.
- Mallacoota Inlet Wetlands (VIC133) (permanently open)– This wetland was formed by the submergence of two river valleys and partial closure of the marine embayment by a sandy barrier and accumulation of dunes. Eighty-nine (89) waterbird species have been recorded at Mallacoota Inlet. The wetland is fringed by lowland forest and coastal saltmarsh.
- Nadgee Lake and tributary wetlands (NSW187) (intermittently open) – Nadgee Lake is an intermittently open/closed coastal lake that is fed by large swamps and ephemeral creeks flowing from the Nadgee Range. The wetland is an important drought refuge for waterbirds. Estuarine aquatic vegetation includes seagrass beds of Ruppia sp. That occurs in shallower water near the southern and western foreshores.

5.1.9. Victorian Protected Areas

Victoria has a large network of onshore and offshore protected areas that are established, protected and managed under the National Parks Act 1982 (Vic) by Parks Victoria. There are 24 Victorian marine national parks and sanctuaries.

The 17 marine protected areas and 13 onshore protected areas (i.e., reserves that extend to the low-water mark) intersected by the EMBA are shown in Figure 5.3 and described in Table 5.3, moving west to east along the spill EMBA.

The survey area does not intersect any Victorian protected areas.

5.1.10. Tasmanian Protected Areas

Tasmania has a large network of onshore and offshore protected areas that are established, protected and managed under the *National Parks and Reserves Management Act* 2002 (Tas) and *Nature Conservation Act* 2002 (Tas) by DPIPWE. There are seven marine reserves and 14 marine conservation areas (with the latter restricted to waters around Hobart in southern Tasmania).

The one marine protected area and 37 onshore protected areas intersected by the EMBA are shown in Figure 5.3 and described in Table 5.4, moving anti-clockwise through the spill EMBA beginning at King Island.

The survey area does not intersect any Tasmanian protected areas.

Where official management plans are not available for Tasmanian protected areas, information has been obtained from the Protected Planet (2020) database.

5.1.11. New South Wales Protected Areas

Under the *National Parks and Wildlife Act* 1974 (NSW), land may be reserved as part of a national park, historical site, conservation area, nature reserve or Aboriginal area in order to meet the conservation objectives of the Act.

New South Wales has a large network of onshore and offshore protected areas that are established, protected and managed under the *National Parks and Wildlife Act* 1974 by the National Parks and Wildlife Service (NPWS).

There is one onshore reserve and no marine reserves intersected by the EMBA. This onshore reserve is described in Table 5.5.

The survey area does not intersect any NSW protected areas.

Table 5.3 Victorian marine and coastal protected areas

Name	Distance from survey area	Description
Marine protected areas		
Twelve Apostles MNP	38 km northwest	The Twelve Apostles Marine National Park (75 km^2) is located 7 km east of Port Campbell and covers 16 km of coastline from east of Broken Head to Pebble Point and extends offshore to 5.5 km (Plummer *et al.*, 2003). The area is representative of the Otway Bioregion and is characterised by a submarine network of towering canyons, caves, arches and walls with a large variety of seaweed and sponge gardens plus resident schools of reef fish. The park contains areas of calcarenite reef supporting the highest diversity of intertidal and sub-tidal invertebrates found on that rock type in Victoria (Parks Victoria, 2006b). Benthic sampling undertaken within the park in soft sediment habitats at 10 m, 20 m and 40 m water depths identified 31, 29 and 32 species respectively based upon a sample area of 0.1 m^2. These species were predominantly polychaetes, crustaceans and nematodes with the mean number of individuals decreasing with water depth (Heisler & Parry, 2007). No visible macroalgae species were present within these soft sediment areas (Plummer *et al.*, 2003). These sandy expanses support high abundances of smaller animals such as worms, small molluscs and crustaceans; larger animals are less common. The Twelve Apostles Marine Park is managed in conjunction with the Arches Marine Sanctuary (not intersected by the EMBA) under the Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary (Parks Victoria, 2006b) and is classified as IUCN II. The Plan describes the key environmental, cultural and social values as: • Unique limestone rock formations, including the Twelve Apostles. • A range of marine habitats representative of the Otway marine bioregion. • Indigenous culture based on spiritual connection to sea country and a history of marine resource use. • The wreck of the Loch Ard (shipwreck). • Underwater limestone formations of arches and canyons. • A diverse range of encrusting invertebrates. • A spectacular dive site (Parks Victoria, 2006b).

Name	Distance from survey area	Description
Marengo Reefs MS	38 km northeast	• The Marengo Reefs Marine Sanctuary (12 ha) is in Victorian State waters near Marengo and Apollo Bay on the Great Ocean Road, approximately 220 km southwest of Melbourne. The sanctuary protects two small reefs and a wide variety of microhabitats. Protected conditions on the leeward side of the reefs are unusual on this high wave energy coastline and allow for dense growths of bull kelps and other seaweed. There is an abundance of soft corals, sponges, and other marine invertebrates, and over 56 species of fish have been recorded in and around the sanctuary. Seals rest on the outer island of the reef and there are two shipwrecks (the Grange and Woolamai) in the sanctuary (Parks Victoria, 2007a).
		• The Marengo Reefs Marine Sanctuary Management Plan (Parks Victoria, 2007a) identifies the environmental, cultural and social values as: • Subtidal soft sediments, subtidal rocky reefs and intertidal reefs; • High diversity of algal, invertebrate and fish species; • Australian fur-seal haul-out area; • Evidence of a long history of Indigenous use, including many Indigenous places and objects nearby; • Wrecks of coastal and international trade vessels in the vicinity of the sanctuary; • Spectacular underwater scenery for snorkelling and scuba diving; • Intertidal areas for exploring rock pools; and • Opportunities for a range of aquatic recreational activities including seal watching.
Eagle Rock MS	87 km northeast	Eagle Rock Marine Sanctuary (17 ha) is about 40 km south-west of Geelong, close to Aireys Inlet. The sanctuary extends from high water mark around Split Point between Castle Rock and Sentinel Rock (Parks Victoria, 2005b). It extends offshore for about 300 m and includes Eagle Rock and Table Rock. The main habitats protected by the sanctuary include intertidal and subtidal soft sediment, intertidal and subtidal reefs, and the water column (Parks Victoria, 2005b). It is managed in conjunction with Point Addis Marine National Park and Point Danger Marine Sanctuary.

Name	Distance from survey area	Description
Point Addis MNP	93 km northeast	Point Addis Marine National Park lies east of Anglesea and covers 4,600 hectares. This park protects representative samples of subtidal soft sediments, subtidal rocky reef, rhodolith beds and intertidal rocky reef habitats. The park also provides habitat for a range of invertebrates, fish, algae, birds and wildlife. The world famous surfing destination of Bells Beach is within Point Addis Marine National Park. It is managed under the Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria, 2005b) and is classified as IUCN II. The Plan identifies the following environmental, cultural and social values for the parks and sanctuaries: • Sandy beaches, subtidal soft sediments, subtidal rocky reefs, rhodolith beds and intertidal reefs. • A high diversity of algal, invertebrate and fish species. • A high diversity of sea slugs (opisthobranchs) and other invertebrate communities within Point Danger Marine Sanctuary. • Evidence of a long history of Indigenous use, including many Indigenous places and objects adjacent to the park and sanctuaries near dunes, headlands, estuaries and creeks. • Surf breaks, including those at Bells Beach, which are culturally important to many people associated with surfing. • Coastal seascapes of significance for many who live in the area or visit.
		• Recreational and tourism values • Spectacular underwater scenery for snorkelling and scuba diving. • Intertidal areas for exploring rock pools. • Opportunities for a range of recreational activities. • A spectacular seascape complementing well-known visitor experiences on the Great Ocean Road.
Point Danger MS	111 km northeast	Point Danger Marine Sanctuary (25 ha) is 20 km south-west of Geelong, close to the township of Torquay and nearby Jan Juc. It extends from the high-water mark at Point Danger offshore for approximately 600 m east and 400 m south, encompassing an offshore rock platform (Parks Victoria, 2005b). It is managed in conjunction with Point Addis Marine National Park and Eagle Rock Marine Sanctuary.

Name	Distance from survey area	Description
Barwon Bluff MS	124 km northeast	Barwon Bluff Marine Sanctuary (17 ha) is located at Barwon Heads, approximately 100 km south-west of Melbourne. The Barwon Bluff Marine Sanctuary Management Plan (Parks Victoria, 2007b) identifies the environmental, cultural and social values as: • Intertidal reef platforms with a high diversity of invertebrate fauna and flora. • Subtidal reefs that support diverse and abundant flora, including kelps, other brown algae, and green and red algae. • Calcarenite and basalt reefs extending from The Bluff that are of regional geological significance. • Intertidal habitats that support resident and migratory shorebirds, including threatened species. • Subtidal habitats that support sedentary and mobile fish and are also used by migratory marine mammals. • Marine habitats and species that are of scientific interest and valuable for marine education. • Opportunities for underwater recreation, including visits to subtidal communities that are easily accessible from the shore. • Outstanding coastal vistas, seascapes and underwater scenery. • An important landmark and area for gathering fish and shellfish for the Wathaurong people. • A strong historic and ongoing connection with marine education. • Remnants from the Earl of Charlemont, a heritage-listed shipwreck.
Ex-HMAS Canberra Recreation Reserve	126 km northeast	The Ex-HMAS Canberra Recreation Reserve (142 ha) is located 5.5 km southwest of Point Lonsdale in Bass Strait. The recreation reserve is the site of the ex-HMAS Canberra, a former warship which served the Australian Navy between 1981 and 2005. In October 2009, the vessel was scuttled off Barwon Heads in 28 metres of water and is the first artificial reef in Victoria created specifically for diving. Over time marine life will continue to colonise the wreck and transform it into a spectacular reef.
Port Phillips Heads MNP	132 km northeast	Port Phillip Heads Marine National Park is an area of 35.8 km^2 that is located at the southern end of Port Phillip bay. Many areas within the Port Phillip Heads Marine National Park are popular for a range of recreational activities. The habitats that are found within the park are seagrass beds, sheltered intertidal mudflats, intertidal sandy beaches and rocky shores, subtidal soft substrate and rocky reefs. The bay has a high diversity and abundance of marine flora and fauna that provides a migratory site for wader birds (Parks Victoria, 2006c).

Name	Distance from survey area	Description
Mushroom Reef MS	148 km northeast	Mushroom Reef Sanctuary is located on the Bass Strait coast at Flinders near the western entrance to Western Port Bay and is 80 ha in size. The sanctuary abuts the Mornington Peninsula National Parkland and extends from the high-water mark to approximately 1 km offshore. The sanctuary's key natural values are listed in the Mushroom Reef Marine Sanctuary Management Plan (Parks Victoria, 2005c) as: • Numerous subtidal pools and boulders in the intertidal area that provide a high complexity of intertidal basalt substrates and a rich variety of microhabitats; • Subtidal reefs that support diverse and abundant flora including kelps, other brown algae, and green and red algae; • Sandy bottoms habitats that support large beds of Amphibolis seagrass and patches of green algae; • Diverse habitats that support sedentary and migratory fish species; • A range of reef habitats that support invertebrates including gorgonian fans, seastars, anemones, ascidians, barnacles and soft corals; • A distinctive basalt causeway that provides habitat for numerous crabs, seastars and gastropod species; • Intertidal habitats that support resident and migratory shorebird species including threatened species; • An important landmark and area for gathering fish and shellfish for the Boonwurrung people; and • Excellent opportunities for underwater recreation activities such as diving and snorkelling among accessible subtidal reefs.
Bunurong MNP	193 km northeast Extends over 5 km of coastline 2.5 km east of Cape	Bunurong MNP is significant because of the mixed assemblage of brown algae and seagrass, supporting a high proportion of Victoria's marine invertebrates, including brittle stars, sea cucumbers, barnacles, sea anemones and chitons. Bunurong MNP supports a considerable diversity of habitats and communities. These habitats provide important substrate, food, shelter and spawning and nursery areas for a variety of marine flora and fauna. Six marine ecological communities are present: sandy beaches, intertidal reef platform, subtidal reef, subtidal soft sediments, seagrass and open waters. Intertidal and subtidal reef communities are the most common habitat type and incorporate many microhabitats. Red, brown and

Name	Distance from survey area	Description
	Patterson in south Gippsland and reaches offshore for 3 nm to the limit of Victorian waters.	green alga species, seagrass and seaweeds along with rocky substrate combine to form many microhabitats (Parks Victoria, 2006a). Sandy beaches of the park provide important habitat for invertebrates such as amphipods, isopods, molluscs, polychaetes and crustaceans, and are also a feeding ground for fish and seabirds. Beach-washed materials in sandy beach habitats provide a significant source of food for scavenging birds and contribute to the detrital cycle that nourishes many of the invertebrates, such as bivalves, living in the sand. Overall, the marine flora and fauna are considered largely representative of the Central Victorian Marine Bioregion (Parks Victoria, 2006a).
Bunurong Marine and Coastal Park	191 km northeast Extends 7 km west and 3 km east along the coast from the national park and extends 1 km into the sea.	Bunurong Marine and Coastal Park has rugged sandstone cliffs, broad rock platforms and underwater reefs and significant fossil sites where dinosaur bones over 115 million years old have been excavated (Parks Victoria, 2006a). Bunurong Marine National Park is significant because of the mixed assemblage of brown algae and seagrass, supporting a high proportion of Victoria's marine invertebrates, including brittle stars, sea cucumbers, barnacles, sea anemones and chitons.

Name	Distance from survey area	Description
Wilsons Promontory MNP	235 km northeast Extends along 70 km of coastline on the southern tip	Wilsons Promontory MNP is a distinct bioregion of Victoria's coastline due to the different types of rock present and its position at the boundary between two major ocean currents. Its offshore islands support several colonies of Australian fur-seals and provide breeding sites for many seabirds, including cape barren geese, little penguins, gulls, mutton birds and ospreys (Parks Victoria, 2006d). Wilsons Promontory MNP is the first in Australia to receive a Global Ocean Refuge Award, joining a group of ten marine protected areas that comprise the Global Ocean Refuge System. The award signifies that the park meets the highest science-based standards for biodiversity protection and best practices for management and enforcement. Located at the
	of Wilsons Promontory National Park including Victorian state waters.	southernmost tip of mainland Australia, it's one of the country's best examples of marine biodiversity protection (Parks Victoria, 2006d).
Wilsons Promontory MP	237 km east	Wilsons Promontory Marine Park, together with the Marine Reserve and MNP, make significant contributions to Victoria's marine protected areas. The marine park includes biological communities with distinct biogeographic patterns, including shallow subtidal reeds, deep subtidal reefs, intertidal rocky shores, sandy beaches, seagrass, subtidal soft substrates and expansive areas of open water (Parks Victoria, 2006d). The marine park provides important habitat for several threatened shorebird species and islands within the park act as important breeding sites for Australian fur seals (Parks Victoria, 2006d).

Name	Distance from survey area	Description
Beware Reef MS	486 km northeast	The Beware Reef Marine Sanctuary covers 220 ha and lies 5 km offshore southeast of Cape Conran, in water depths ranging 0 and 40 m. The park's key natural values are listed as: • A diversity of habitats, including subtidal and intertidal reefs, exposed reefs and subtidal soft sediment. • A haul-out area for Australian Fur Seals and New Zealand Fur Seals. • A diversity of invertebrates and fish species. • A reef environment, including shipwrecks, rich in marine biota. • Threatened fauna, including several bird species and marine mammals. • Outstanding landscapes, seascapes and spectacular underwater scenery. • Excellent opportunities for scientific investigation and learning. • Opportunities to build knowledge of marine protected areas and their management and to further understand marine ecological function and changes over time.

Name	Distance from survey area	Description
Point Hicks MNP	522 km northeast	The Point Hicks MNP covers 3,810 ha and extends along 9.6 km of coastline and offshore from the high-water mark to the 3 nm state waters limits to water depths of 88 m. The reefs directly below Point Hicks, Whaleback Rock and Satisfaction Reef are the best-known geological features of the park. Point Hicks itself is a granite headland with a wide rocky and bouldery shore formed up to 10,000 years ago. The park's key natural values are listed as: • A diversity of habitats, including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches; • A very high diversity of fauna, including intertidal and subtidal invertebrates; • Co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters; • A range of rocky habitats; • Mammal mammals such as dolphins, whales and fur-seals; • Transient reptiles from northern waters, including turtles and sea snakes; • Threatened fauna, including whales and several bird species; • Outstanding landscapes, seascapes and underwater scenery; • Outstanding active coastal landforms, such as granite reefs and mobile sand dunes; • Excellent opportunities for scientific investigation and learning; and • Outstanding opportunities to build knowledge of marine protected areas and their management and to further understand marine ecological function and changes over time. A prominent biological component of the subtidal reef areas is kelp and other seaweeds. Large species of brown algae, such as common kelp and crayweed, are present along the open coast in dense stands. Giant species of seaweeds such as string kelp and bull kelp also occur (Parks Victoria, 2006e). The front reefs and Whaleback Reef, which have high relief gutters of up to 15 m have high sessile invertebrate diversity and abundance on the vertical walls. An important characteristic of Point Hicks MNP is its canopy-forming algae (a mixture of crayweed *Phyllospora comosa* and common kelp *Ecklonia radiata*) and small understorey algae. The reef beneath the canopy varies from encrusting and erect sponges to small fleshy red algae. The invertebrate community includes moderate abundances of blacklip abalone (*Haliotis rubra*) and the red bait crab (*Plagusia chabrus*).

Name	Distance from survey area	Description
Cape Howe MNP	591 km northeast	The Cape Howe MNP covers 4,060 ha and extends along 4.8 km of coastline and offshore from the high-water mark to the 3 nm state waters limit to water depths of 105 m (Parks Victoria, 2006f). The waters of the park contain both high-profile granite and low-profile sandstone reefs. The park's key natural values are listed as: • Diversity of habitats including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches; • Co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters; • Marine mammals such as whales, dolphins, Australian fur-seals and New Zealand fur-seals;
		• Transient reptiles such as green turtles from northern waters; • Threatened fauna including whales and birds; • Foraging area for a significant breeding colony of Little Penguins from neighbouring Gabo Island; • Outstanding active coastal landforms within and adjoining the park, such as granite and sandstone reefs; • Outstanding landscapes, seascapes and spectacular underwater scenery; • Victoria's most easterly Marine National Park abutting one of only three wilderness zones on the Victorian coast; • Excellent opportunities for scientific investigation and learning; • Outstanding opportunities to build knowledge of marine protected areas and their management, and to further understand marine ecological function and changes over time. Subtidal soft sediment communities are the most widespread communities in the park, with the diversity of invertebrates expected to be high. Common fish are herring cale (*Odax cyanomelas*), leatherjacket (*Meuschenia freycineti*), striped mado (*Atypichthys strigatus*), banded morwong (*Cheilodactylus spectabilis*) and damselfishes (*Parma microlepis* and *Chromis hypsilepis*). Its deep (30 to 50 m) sandstone reefs are heavily covered with a diverse array of sponges, ascidians and gorgonians. Transient mammals such as southern right whales, humpback whales, killer whales, Australian fur-seals, New Zealand fur-seals, bottlenose dolphins and common dolphins are transient visitors to the park.
Coastal/onshore protected areas (where the EMBA intersects shorelines)		

Name	Distance from survey area	Description
Great Otway National Park	26 km north	The Great Otway National Park (103,185 ha) is located near Cape Otway and stretches from the low water mark inland on an intermittent basis from Princetown to Apollo Bay (approximately 100 km). Landscapes within the park are characterised by tall forests and hilly terrain extending to the sea with cliffs, steep and rocky coasts, coastal terraces, landslips, dunes and bluffs, beaches and river mouths. There is a concentration of archaeological sites along the coast, coastal rivers and reefs. The park provides habitats for the conservation of the rufous bristlebird, hooded plover, white-bellied sea eagle, fairy tern, Caspian tern and Lewin's rail and native fish such as the Australian grayling. (Parks Victoria and DSE, 2009). The park's key natural values are listed as: • Large areas of intact native vegetation and habitats of the Otway Ranges, Otway Plain, Warrnambool Plain bioregions; • Areas of forest in excellent condition, including old growth forest, cool temperate rainforests and wet forests; • Large portions of the Barwon and Otway Coast river basins, linking largely unmodified headwaters to streams and rivers including the Aire, Gellibrand and Barwon rivers, then on to estuaries and the sea; • A large area of essentially unmodified coastline, linking the land to marine ecosystems and MNPs;. • An abundance of biodiversity, with many species and communities found nowhere else in Victoria, some of which are rare and threatened, and including some species of national significance such as the Spottailed Quoll, Smoky Mouse and Tall Astelia; • Many sites of geological and geomorphological significance including Artillery Rocks, Dinosaur Cove, Lion Headland, Moonlight Head to Milanesia Beach, Point Sturt and View Point; and • The majority of the Aire Heritage River corridor.

Name	Distance from survey area	Description
Point Nepean National Park	134 km northeast	Point Nepean National Park (527 ha) is located at the tip of the Nepean Peninsula on the Mornington Peninsula, approximately 90 km south of Melbourne. Many of Point Nepean’s natural, cultural heritage and social values are recognised as having national, state or regional significance. The park’s key natural values are listed as (Parks Victoria, 1998): • Nationally listed fauna species, including one endangered and one vulnerable fauna species and 11 fauna species; • Coastal bird populations of state significance, including the Hooded Plover and the Shy Albatross; • State geomorphological significance associated with the dune calcarenite cliffs, rock stacks, and shore platforms; • Relatively undisturbed Bass Strait shoreline and intertidal habitats of high scientific significance for research and at least of state significance as feeding habitats for many bird species; • Evidence of many thousands of years of use of the area by the Boonwurrung people; • Evidence of some of the earliest European settlement in Victoria, including pastoral activities (archaeological remains of early dwellings) and lime burning, with possibly the earliest intact limestone building in Victoria (the Limestone Shepherd’s Hut); and • Significant remains of Colonial and Commonwealth fortifications dating from the 1880s, remnants, features and areas in the National Park, including Fort Nepean and South Channel Fort.
Mornington Peninsula National Park	136 km northeast	The Mornington Peninsula National Park is situated 70 km south of Melbourne and runs along the coast from Point Nepean, at the western tip of the peninsula, to Bushrangers Bay, where it turns inland along the Main Creek valley until it joins the Greens Bush section (Parks Victoria, 1998a). A narrow coastal strip between Simmons Bay and Flinders also forms part of the park, as does the South Channel Fort in Port Phillip Bay. The park’s key natural values are listed as: • Largest and most significant remaining areas of native vegetation on the Mornington Peninsula; • Numerous sites and features of geomorphic significance, particularly along the coast (cliffed calcarenite coast, sandy forelands and basalt shore platforms);

Name	Distance from survey area	Description
		• Only representation in the Victorian conservation reserve system of four particular land systems formed within the Southern Victorian Coastal Plains and the Southern Victorian Uplands; • Many significant native plants and vegetation communities, and the most extensive remnant coastal grassy forest habitat on the Mornington Peninsula; • Highly scenic landscape values along the ocean coast and at Port Phillip heads; and • Many significant fauna species, including populations of the nationally significant hooded plover, over 30 species of state significance and many species of regional significance. • High quality marine and intertidal habitats, with some pristine areas within Point Nepean.
Flinders Foreshore Coastal Reserve	156 km northeast	The Flinders Foreshore Coastal Reserve is located adjacent the township of Flinders on its eastern foreshore. The town is popular with holidaymakers and the reserve protects the beach and foreshore areas. There is no management plan for the Flinders Foreshore Coastal Reserve.
Phillip Island Nature Park	154 km northeast	Phillip Island Nature Park spans multiple locations across the island from Cape Woolamai in the east, Smiths Beach in the South, Summerlands in the west and Cowes in the north. Due to its proximity to adjacent settlements, the Nature Park hosts a range of recreational activities including surfing, swimming, fishing, walking, running and bike riding. Cape Woolamai's cliffs are used by experienced rock climbers that allow for spectacular views of coastal scenery. The Cape is also the home to Phillip Island's largest shearwater rookery and numerous little penguin colonies. The penguins' nightly return from the ocean to their nests (the 'Penguin Parade' at Summerlands beach, outside the EMBA) is a key drawcard for tourists to Victoria and this part of the coastline. The Park also encapsulates Seal Rocks in the west, which is an important seal haul out site (PINP, 2018).
French Island National Park	172 km northeast	The French Island National Park is located 10 km south of Tooradin, and French Island MNP is adjacent to the northern shoreline of French Island National Park in Western Port Bay. Extending 15 km along the shoreline, the park covers an area of 2,800 ha. It includes one of Victoria's most extensive areas of saltmarsh and mangrove communities along with mudflats of state geomorphological significance (Parks Victoria, 1998b).

Name	Distance from survey area	Description
Kilcunda Harmers Haven Coastal Reserve	181 km northeast 1 km west of Cape Paterson west to Kilcunda.	Kilcunda-Harmers Haven Coastal Reserve is a 180 ha reserve for the protection of the coastal flora habitat. Coastal habitat at Harmers Haven has a high diversity of vegetation communities, many of which are considered rare, depleted or endangered within the Bass Coast Shire, with almost 300 recorded flora species including plants of national, state and regional conservation significance (Parks Victoria, 2006a).
Cape Liptrap Coastal Park	201 km east northeast	Cape Liptrap Coastal Park protects extensive heathland and coastal forest vegetation communities, including scented paperbark, common heath, scrub she-oak, dwarf she-oak, pink swamp-heath, prickly teatree, silver banksia and bushy hakea. Several rare fauna species occur in the park including the hooded plover, swamp antechinus and powerful owl (Parks Victoria, 2003).
Wilsons Promontory National Park	236 km east	Wilsons Promontory National Park covers an area of 50,460 ha and is the oldest existing national park in Victoria having been permanently reserved since 1905 (Parks Victoria, 2002). The park has outstanding natural values and is an important range for plants and animals including threatened species. Wilsons Promontory National Park is renowned for its coastal scenery and recreational activities including walking, camping, sightseeing, viewing wildlife, fishing and boating (Parks Victoria, 2002). The park contains habitat that supports more than 296 species of fauna, 40 of which are threatened species. Records of over 30 species of native mammals (one-third of all Victorian species) and half of all Victorian bird species have been recorded at the park (Parks Victoria, 2002).
Seal Islands Wildlife Reserve	275 km east	Seal Islands is east of Wilsons Promontory. Seal Island is one of the two largest breeding sites for the Australian fur seal. There is no management plan for Seal Islands Wildlife Reserve.
Marlo Coastal Reserve	464 km northeast	There is no publicly available formal written information regarding the Marlo Coastal Reserve. Information from the Draft Marlo Foreshore Management Plan (DSE, 2013) indicates that the reserve covers the Marlo River and adjacent banks, extending seawards only so far as the sand dunes.

Name	Distance from survey area	Description
Cape Conran Coastal Park	477 km northeast	Cape Conran Coastal Park covers an area of 11,700 ha and is bounded by Marlo Coastal Reserve to the west, Croajingolong National Park to the east (eastern shore of Sydenham Inlet), State forest and private property to the north, and the Tasman Sea, at low water mark, to the south (Parks Victoria, 2005c). The park's key natural values are listed as: • Rich and diverse vegetation, including damp and lowland forest, woodlands, various types of heathland, swamp, coastal and riparian communities; • The Dock Inlet catchment, a pristine example of a coastal stream system with Cape Conran Coastal Park and associated wetlands terminating in a freshwater coastal lagoon; • The undisturbed Yeerung River supporting predominantly native fish is one of only two entirely lowland rivers in the region draining directly to the sea; • Almost 50 species of threatened fauna including six endangered nationally, and 14 bird species listed under international migratory bird agreements; • At least 40 species of threatened flora, including the Bonnet Orchid and Leafless Tongue-orchid which are both vulnerable nationally; • Extensive heathland areas in excellent condition harbouring populations of threatened fauna, including the Ground Parrot and Smoky Mouse; • Sydenham Inlet, part of the Bemm Heritage River corridor, supporting expansive seagrass meadows that provide important habitat for fish and waterbirds; • High scenic values associated with the diverse geological formations of the park's headlands, its coastal estuaries and heathy plains; and • Excellent examples of coastal dynamics such as sand movement, wave action and river outflows. • The seagrass beds within Sydenham Inlet sustain a diverse range of native fish and are critical to the maintenance of regional fish populations (Parks Victoria, 2005c).

Name	Distance from survey area	Description
Croajingo-long National Park	504 km northeast	Croajingolong National Park covers an area of 88,355 ha and extends along 100 km of the coast, from Sydenham Inlet in the west to the NSW border in the east, with the mean low water mark of the coast forming the park's southern boundary (Parks Victoria, 1996). Two major physiographic units are represented in the park, these being coastal tablelands and coast dune complexes (some vegetated and some mobile). The ocean beaches of the park attract migratory seabirds and waders, including little, crested and fairy terns and the hooded plover, while the wetlands provide habitat for a rich assemblage of waterfowl and native fish such as spotted galaxias, gudgeon, bass and the Australian grayling. According to Parks Victoria (1996), the park's key natural values are listed as: • A wide variety of highly significant coastal landforms including tidal inlets, estuaries and lagoons, dune-blocked lake and swamp systems, freshwater interdune lakes, extensive sand dunes and sand sheets, and prominent rocky cliffs; • Many sites recognised for their geological and geomorphological significance; • Habitats supporting over 1,000 recorded native plant species, 87 of which are listed as threatened in Victoria and have their primary stronghold in the Park; • Ninety species of orchids, including all five of Australia's lithophytic and epiphytic orchids; • Significant and well-developed sites of Warm Temperate Rainforest in the lower reaches of a number of rivers; • Coastal Heathland, a community considered to be extremely species rich, and covering up to 10% of the park;
		• Habitats supporting 43 species of threatened native fauna, including the little tern, ground parrot, eastern bristle-bird, eastern broad-nosed bat, and Australian fur-seal; • The Skerries, one of only four Australian fur-seal colonies in Victoria and an important breeding site for penguins and other seabirds; • Records of one third of Victoria's, and one quarter of Australia's, bird species; • Some of the richest amphibian habitats in Victoria; • Highly significant coastal streams and catchments that are relatively undisturbed, with an absence of introduced fish species and good populations of native fish species; and • Localities with among the highest wilderness quality in the State, outside the Mallee, and two of the three coastal wilderness areas in Victoria.

Table 5.4 Tasmanian marine and coastal protected areas in the spill EMBA

Note: where there are no official management plans available for protected areas, information has been obtained from the Protected Planet (2020) database

Name	Distance from survey area	Description
Marine Protected Areas		
Kent Group Marine Reserve and Kent Group National Park	323 km east It is surrounded by the Beagle AMP. They occur in the middle of eastern Bass Strait, approximately halfway between the northern tip of Flinders Island and Wilsons Promontory.	Kent Group Marine Reserve comprises five granitic islands and extends from the high-water mark to three nautical miles offshore. The marine reserve is divided into two zones; the western half is a 'no-take' zone where all marine life is protected and the eastern half is a 'restricted-take' zone where some fishing is permitted. The Kent Group is the southern stronghold for several species including the violet roughy, mosaic leatherjacket, Wilsons weedfish, maori wrasse and one spot puller. It is also the most southerly location to see the eastern shovelnose ray and the snakeskin wrasse. Giant cuttlefish (one of the largest cuttlefish species in the world, reaching up to 80 cm in length) are commonly seen at the Kent Group. Seagrass beds are found at depths of greater than 20 m in Murray Pass due to the very clear waters in the area. In deeper waters, sponge gardens are very common, covering 40% of habitat in water depths greater than 40 m. Unusual stony corals (*Plesiastrea versipora*) are found in deeper waters and in areas shaded by cliffs where light levels are too low for algae to grow. Kent Group National Park is an important Australian fur-seal breeding site and is the largest of only five sites in Tasmanian waters. It is secure from high seas when pups are young and vulnerable. The islands are also important sanctuaries for the common diving petrels and fairy prions and are home to significant colonies of short-tailed shearwaters, little penguins, sooty oystercatchers, cormorants and terns (PWST, 2017).
Onshore Protected Areas (where the EMBA intersects shorelines)		
Councillor Island Nature Reserve	50 km east	Councillor Island Nature Reserve is a 10.5 ha granite reserve east of King Island. There is no management plan for this reserve.

Lavinia State Reserve	42 km east	Lavinia State Reserve is located on the north-east coast of King Island. The reserve contains a number of rare birds, including the endangered orange-bellied parrot (DPIPWE, 2013). It includes the Lavinia Ramsar site and two freshwater lakes. Lavinia Beach is a popular location for surfing and fishing.
Sea Elephant Conservation Area	47 km east	Sea Elephant Conservation Area covers an area of 7.31 km^2 and is located on the east coast of King Island. The critically endangered orange-bellied parrot uses the Sea Elephant estuary as a stopover on its Bass Strait crossings. There is no management plan for this area.
Cataraqui Point Conservation Area	26 km west	Cataraqui Point Conservation Area is located on the west coast of King Island covering an area of 3.05 km^2 and extending from the coast to 100-200 m inland. The conservation area is designated as IUCN Category V and there is no management plan in place.
Porky Beach Conservation Area	25 km east	Porky Beach Conservation Area is located on the west coast of King Island covering an area of 4.55 km^2 and extending from the coast to 100-200 m inland. The conservation area is designated as IUCN Category V and there is no management plan in place.
City of Melbourne Bay Conservation Area	47 km east	The City of Melbourne Bay Conservation Area is located on the east coast of King Island and covers an area of 2.11 km^2. The area is designated as IUCN Category V, which is a protected landscape/seascape. There is no management plan for this area.
New Year Island Game Reserve	22 km east	New Year Island Game Reserve is a 130 ha IUCN Category VI protected area located 22 km east of the survey area. The reserve is a granite island lying to the northwest of King Island allowing for the sustainable hunting of game species (hunting season is April). The island forms part of the King Island IBA due to breeding seabirds and waders. Species include the short-tailed shearwater, fairy prion, pacific gull, silver gull and sooty oystercatcher.
Christmas Island Nature Reserve	23 km east	Christmas Island Nature Reserve is a 95 ha IUCN Category 1a. The reserve is located 23 km east of the survey area and contains seabird rookeries and important nesting areas for little terns and hooded plovers.
Albatross Island Nature Reserve	90 km east	Albatross Island Nature Reserve is a land mass of approximately 18 ha located 12 kilometres west of Hunter Island. Albatross Island is reserved as the second largest shy albatross breeding colony, and the only one in Bass Strait, with an estimated 5,000 pairs.

Petrel Islands Game Reserve	114 km southeast	The Petrel Islands Game Reserve covers an area of 0.41 km^2 and is located between Hunter, Three Hummock and Robbins Island off the northwest Tasmanian coast. The Game Reserve is designated IUCN Category VI, which is a protected area with sustainable use of natural resources. Seabird and shorebird species including little penguins, short-tailed shearwaters, common diving-petrels, white-faced storm-petrels and pacific gulls are known to breed in the Reserve. There is no management plan for this reserve.
Nares Rocks Conservation Area	93 km southeast	Nares Rocks Conservation Area covers an area of 0.03 km^2 and is located off the west coast of Hunter Island. It is designated as IUCN Category V, which is a protected landscape/seascape. There is no management plan for this area.
Three Hummock Island State Reserve	105 km east	The Three Hummock Island State reserve covers the entirety of the 70 km^2 granite island, located off the northwest coast of Tasmania. The island forms part of the Hunter Island Group Important Bird Area (IBA), where seabirds and shorebirds including the pied and sooty oystercatcher, hooded plover and short-tailed shearwater are known to breed (BirdLife International, 2020). There is no management plan for this reserve.
Hunter Island Conservation Area	95 km east	The Hunter Island Conservation Area covers an area of 73 km^2 and is designated as IUCN Category V, which is a protected landscape/seascape. The Conservation Area forms part of the Hunter Island Group IBA because it lies on the migration route of the orange-bellied parrot (BirdLife International, 2020). There is no management plan for this area.
Harbour Islets Conservation Area	98 km southeast	The Harbour Islets are a group of two adjacent small rocky island, joined at low tide, part of Tasmania's Trefoil Island Group. The Harbour Islets Conservation Area is 0.13 km^2 and forms part of the Hunter Island Group Important Bird Area which has been detailed above. There is no management plan for the Harbour Islets Conservation Area.
Henderson Islets Conservation Area	99 km southeast	The Henderson Islets are a group of two adjacent small rocky islands, with a combined area of 0.41 km^2, lying close to Cape Grim, Tasmania's most north-westerly point in Bass Strait. The Conservation Area forms part of the Hunter Island Group IBA. There is no management plan for this area.
Seacrow Islet Conservation Area	96 km southeast	The Seacrow Islet Conservation Area covers an area of 0.05 km^2 and is located in Tasmania's Trefoil Island Group. Seabird and shorebird species include the little penguin, short-tailed shearwater, fairy prion, pacific gull and sooty oystercatcher breed on Seacrow Islet. The Conservation Area is designated as IUCN Category VI, which is a protected area with sustainable use of natural resources. There is no management plan for this area.
Bird Island Game Reserve	98 km southeast	The Bird Island Game Reserve is 0.59 km^2 and forms part of the Hunter Island Group IBA. The Conservation Area is designated as IUCN Category VI, which is a protected area with sustainable use of natural resources. There is no management plan for this reserve.

Name	Distance from survey area	Description
Stack Island Game Reserve	101 km southeast	Stack Island Game Reserve covers an area of 0.38 km^2 and is part of the Hunter Island Group IBA. The reserve is known to be used as a breeding location by seabirds and shorebirds. The reserve is designated as IUCN Category VI, which is a protected area with sustainable use of natural resources. There is no management plan for this reserve.
The Doughboys Nature Reserve	94 km southeast	The Doughboys Nature Reserve covers an area of 0.2 km^2 and is located near Cape Grim on the north western coast of Tasmania. The reserve forms part of the Trefoil Island Group and the Nature Reserve is designated as IUCN Category 1a, which is a strict nature reserve. There is no management plan for this reserve.
Calm Bay State Reserve	101 km southeast	The Calm Bay State Reserve covers an area of 3.21 km^2 and is located on the northwest coast of Tasmania. The reserve is designated as IUCN Category II. There is no management plan for this reserve.
Slaves Bay Conservation Area	102 km southeast	Slaves Bay Conservation Area covers an area of 0.42 km^2 and is located on the northwest coast of Tasmania. This area is designated as IUCN Category VI, which is a protected area with sustainable use of natural resources. There is no management plan for this area.
West Point State Reserve	100 km southeast	West Point Conservation Area covers an area of 5.57 km^2 and is located on the west coast of northwest Tasmania. The reserve is designated IUCN Category III, which is a natural monument or feature. This region of the Tasmanian coast is characterised by moderate energy wave action and rocky shores with intermittent sandy beaches.
Arthur-Pieman Conservation Area	104 km southeast	The Arthur-Pieman Conservation Area stretches along the north-west coast of Tasmania and covers an area of 1,030 km^2. Much of the reserve is located between the Arthur River in the north, the Pieman River in the south and the Frankland and Donaldson Rivers to the east. The Conservation Area is renowned as homeland of the North West Aboriginal People where vast middens, hut depressions and rock art are evidence of the landscape's cultural heritage. The Conservation Area contains a large portion of Tasmania's extensive peatlands and some of the largest dune fields in the State. Several vegetation communities in the reserve have been identified to be of conservation significance (PWS, 2002).
Pasco Group Conservation Area	195 km east	Pasco Group Conservation Area covers an area of 1.11 km^2 and spans four islands, the closest of which to shore is located 1.5 km off the northwest coast of Flinders Island. The area is a known site for seabird breeding. There is no management plan in place.

Name	Distance from survey area	Description
Roydon Island Conservation Area	196 km southeast	Roydon Island Conservation Area covers an area of 37 ha and is located 750 m off the northwest coast of Flinders Island. It is a known site for seabird breeding. There is no management plan in place.
Low Point Conservation Area	191 km east	Low Point Conservation Area covers an area of 2.8 km^2 and is located on the north coast of Flinders Island. The coastline of this area is a mix of rocky shores and stretches of sandy beach. Low Point Conservation Area is designated IUCN Category VI and there is no management plan in place.
Sentinel Island Conservation Area	187 km east	Sentinel Island is located 1.2 km off the north coast of Flinders Island. The Conservation Area covers an area of 0.15 km^2 and is a known site for seabird breeding. There is no management plan in place.
Killiecrankie Nature Recreation Area	195 km east	Killiecrankie Nature Recreation Area covers an area of 8.5 km^2 and is located on the north coast of Flinders Island. The coastline of this area is a mix of rocky shores and stretches of sandy beach. Killiecrankie Nature Recreation Area is designated IUCN Category VI and there is no management plan in place.
Curtis Island Nature Reserve	265 km east It is surrounded by the Beagle AMP.	Curtis Island Nature Reserve supports up to 390,000 breeding pairs of short-tailed shearwaters (*Puffinus tenuirostris*). Tasmanian Aborigines have harvested shearwaters (or muttonbirds as they are also referred to) and their eggs for many generations and a number of families continue this important cultural practice. The shearwater is one of the few Australian native birds that is commercially harvested. During the shearwater season, chicks are taken for their feathers, flesh and oil. The industry was established by early European sealers and their Aboriginal families. The recreational harvesting of short-tailed shearwaters is limited to the period of the open season that is declared each year where a licence must be obtained. The shearwater is the most abundant Australian seabird. Approximately 23 million short-tailed shearwaters breed in about 285 colonies in south-eastern Australia from September to April. About 18 million of these arrive in Tasmania each year after a six-week flight from the Arctic region. There are known to be at least 167 colonies in Tasmania and an estimated 11.4 million burrows. The largest colony is on Babel Island off the east coast of Flinders Island, which has three million burrows. Their colonies are usually found on headlands (that allow for an easy take-off and landing) and islands covered with tussocks and succulent vegetation such as pigface and iceplant (PWST, 2017).

Name	Distance from survey area	Description
Devils Tower Nature Reserve	267 km east	Devils Tower are two small granite islands that are part of the Curtis Group and are located in the Bass Strait between Wilsons Promontory and Tasmania. It is designated IUCN 1a, which is a strict nature reserve, which allows minimal human use and is noted as being important for breeding seabirds and waders. There is no management plan for this reserve.
Hogan Group Conservation Area	296 km east	The Hogan Group is located in Bass Strait south of Wilsons Promontory. The Hogan archipelago is an important seabird location and supports major breeding colonies of many species (Carlyon *et al*., 2015). It is designated as IUCN Category IV which is habitat/species management area. There is no management plan for the Hogan Group Conservation Area.
East Moncoeur Island Conservation Area	258 km east	East Moncoeur Island is part of Tasmania's Rodondo Group. It is designated as IUCN Category V which is a protected landscape/seascape. There is no management plan for the East Moncoeur Island Conservation Area.
West Moncoeur Island Nature Reserve	254 km east	West Moncoeur Island Nature Reserve is an area of 0.14 km^2 that is situated 2.5 km east of East Moncoeur Island. West Moncoeur is part of the Rodondo Group. It supports large breeding colonies of Australia fur-seals (Carlyon *et al*., 2015).
Cone Islet Conservation Area	266 km east	Cone Islet Conservation Area covers an area of 0.06 km^2 and is part of the Curtis Island group. Cone Islet lies in the northern Bass Strait between Furneaux Group and Wilsons Promontory in Victoria. There is no management plan for the area.
Rodondo Island Nature Reserve	244 km east	Rodondo Island is located in Bass Strait, approximately 10 km south of Wilsons Promontory. Both Australian and New Zealand fur-seal have haul-out sites on Rodondo Island (Carlyon *et al*, 2015). It hosts a number of breeding seabirds, with the short-tailed shearwater being the most common (Carlyon *et al*, 2015).
Sugarloaf Rock Conservation Area	267 km east	Sugarloaf Rock is a small granite island that covers an area of 1.07 ha. It is part of Tasmania’s Curtis Group, lying in northern Bass Strait between the Furneaux Group and Wilson’s Promontory. This island is a known breeding site for the fairy prion and common diving-petrel along with known haul-out site for the Australian fur-seals. There is no management plan for Sugarloaf Rock Conservation Area.

Table 5.5 New South Wales coastal protected areas in the spill EMBA

Name	Distance from survey area	Description
Nadgee Nature Reserve	612 km northeast	The park's key natural values are listed by NPWS (2003) as: • The only coastal wilderness area in NSW; • A variety of coastal landforms, including dissected low tablelands, coastal plain, estuaries and lagoons, cliffs and sea caves; • Coastline has national significance for its diversity of geology and geomorphological features; • Contains several NSW-listed threatened plant species listed; • Contains 48 species of native mammal, 216 bird species, 28 reptile species and 16 amphibians; • Intertidal rock platforms have a rich, well-developed littoral fauna and Nadgee Point/Black Head has the most diverse biota of any headland in NSW south of Narooma; and • Contains some extensive Aboriginal shell middens in sand dunes. • Seabirds reported as using the rock platforms and beaches include short-tailed shearwater, crested and little terns, hooded plover, pied oystercatcher and gannet.

5.2. Regional Environmental Setting

Using the Interim Marine and Coastal Regionalisation for Australia (IMCRA) classification, the survey area lies mainly within the Western Bass Provincial Bioregion (PB34) and the West Tasmania Transition Bioregion (PB09) (Figure 5.7). The characteristics of the Otway marine bioregion environment include very steep-moderate offshore gradients, high wave energy and cold temperate waters subject to upwelling events (i.e., the Bonney Upwelling and West Tasmanian Upwelling) (IMCRA, 1998). Currents are generally slow, but moderately strong through the entrance to Bass Strait. Upwelling water is nutrient rich and corresponds with increases in the abundance of zooplankton which attracts baleen whales and other species (including EPBC-listed species) which feed on the plankton (krill). Shoreline habitats of the Otway coastline include penguin colonies, fur-seal colonies and bird nesting sites. The substrate in the Otway bioregion is predominantly deep carbonates with some areas of sandy carbonates.

In addition, the following IMCRA provincial bioregions are intersected by the EMBA (Figure 5.7):

- Tasmanian Shelf;
- Bass Strait Shelf Province;
- Southeast Shelf Transition; and
- Southeast Transition.

5.3. Physical Environment

5.3.1. Climate

Bass Strait is located on the northern edge of the westerly wind belt known as the 'Roaring Forties'. In winter, when the subtropical ridge moves northwards over the Australian continent, cold fronts generally create sustained west to south-westerly winds and frequent rainfall in the region (McInnes & Hubbert, 2003). In summer, frontal systems are often shallower and occur between two ridges of high pressure, bringing more variable winds and rainfall.

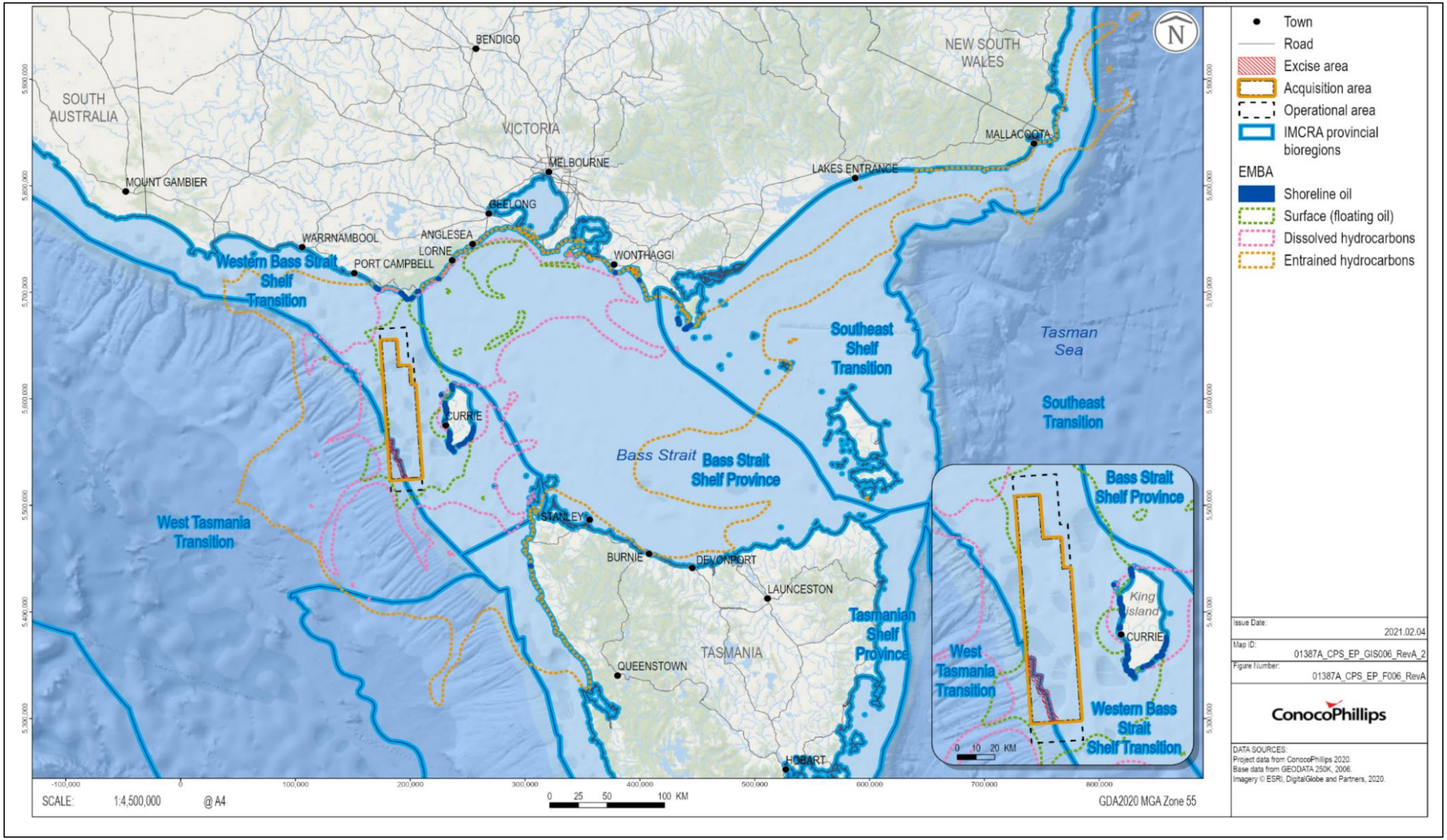
Occasionally, intense mesoscale low-pressure systems occur in the region, bringing very strong winds, heavy rain, and high seas. These events are unpredictable in occurrence, intensity, and behaviour, but are most common between September and February (McInnes & Hubbert, 2003).

5.3.2. Temperature and Rainfall

Historical (1995 – 2020) average air temperatures recorded at the closest Bureau of Meteorology (BoM) weather station at King Island airport (approximately 27 km east of the survey area) for the MSS survey period (September and October) range from 14.6°C. to 15.4°C (BoM, 2020).

Mean annual rainfall is 854 mm, with the highest totals falling in June, July and August (BoM, 2020). Lower mean monthly rainfall totals of 85 mm to 71.3 mm are expected during September and October, respectively.

Figure 5.7 IMCRA provincial bioregions intersected by the EMBA



5.3.3. Winds

RPS (2020) acquired high-resolution wind data from 2009 to 2017 (inclusive) across their modelling domain from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR). Table 5.6 lists the monthly average and maximum winds derived from the CFSR station located nearest to the centre of the survey area.

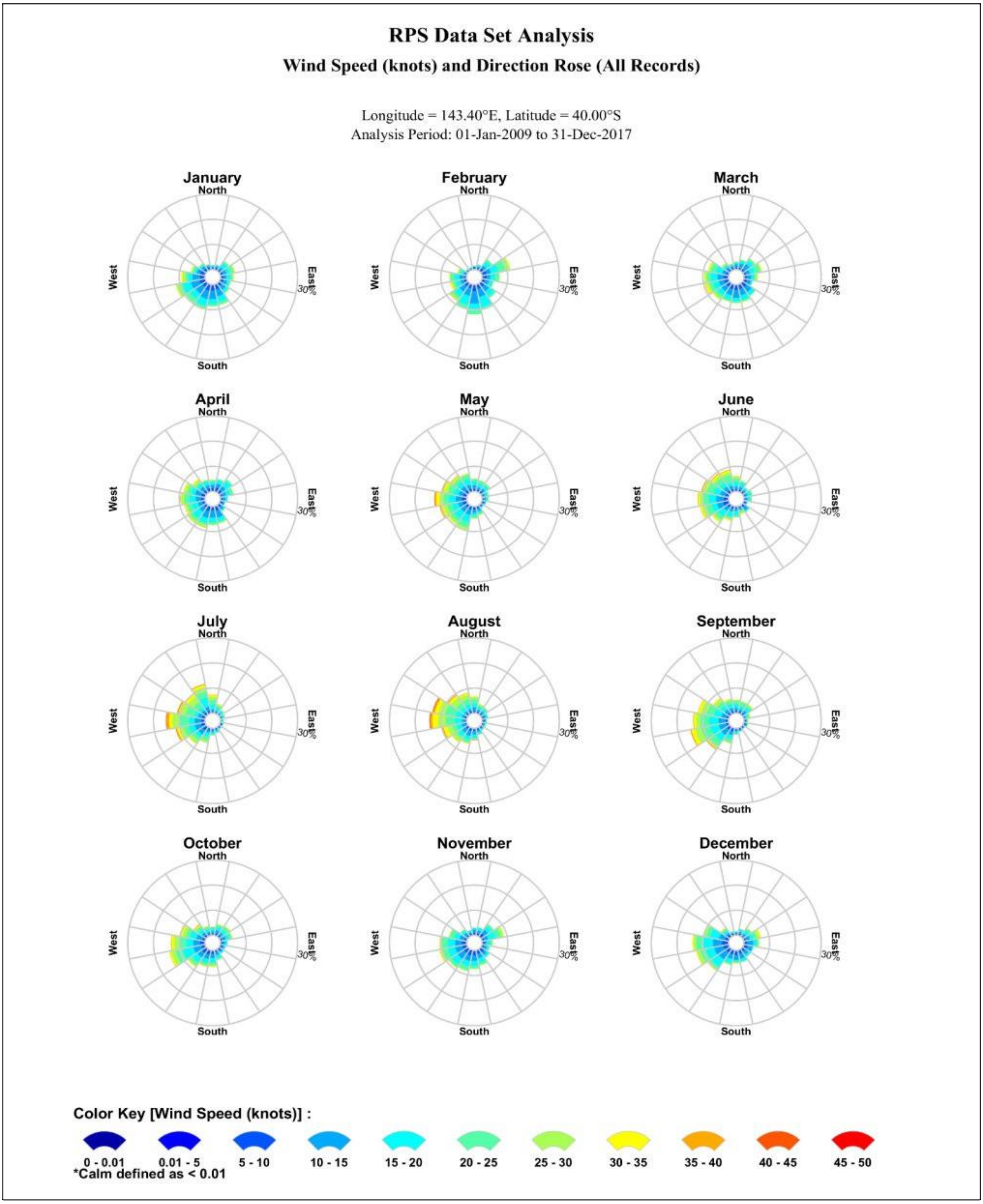
Monthly wind rose distributions from 2009 to 2017 (inclusive) are shown in Figure 5.8, which clearly indicates the dominance of western winds for most of the year with the windiest months from June to September (RPS, 2020).

Table 5.6 Predicted average and maximum wind speeds for the representative wind station nearest to the centre of the survey area

Month	Average wind speed (knots)	Maximum wind speed (knots)	General direction (from)
January	15	43	Southwest
February	15	46	South-southwest and East-northeast
March	15	41	West-southwest and northeast
April	15	49	West (Variable)
May	17	50	West (Variable)
June	18	46	West (Variable)
July	19	45	West - Northwest
August	20	47	West - Northwest
September	18	50	West
October	17	45	West
November	15	39	West
December	15	41	West
Minimum	**15**	**39**	
Maximum	**20**	**50**	

Source: RPS (2020).

Figure 5.8 Monthly wind rose distributions from 2009-2017 (inclusive) for the representative wind station closest to the centre of the survey area



5.4. Oceanography

5.4.1. Currents and Tides

There is a slow easterly flow of waters in Bass Strait and a large anti-clockwise circulation (DoE, 2015a). The Leeuwin Current influences water flows in the survey area, transporting warm, sub-tropical water southward along the Western Australian (WA) coast and then eastward into the Great Australian Bight (GAB), where it mixes with the cool waters from the Zeehan Current running along Tasmania's west coast (DoE, 2015a). The Leeuwin and Zeehan currents are stronger in winter than in summer, with the latter flowing into Bass Strait during winter (Figure 5.9).

Bass Strait experiences strong tidal currents primarily driven by tides, winds and density-driven flows over the relatively shallow continental shelf. Tidal waves enter Bass Strait from the east and west almost simultaneously and as a result in the centre of the strait there is an area with small tidal currents where the two waves meet. The magnitude of the tidal currents increases as the distance from the central strait increases with relatively strong tidal currents at either end. The times and magnitudes of tides within Bass Strait are relatively uniform and predictable. However, the effects of meteorological phenomena may be significant, causing variations in level and also changing the phasing or timing of the tide (Sandery and Kampf, 2005).

Tides are semi-diurnal with some diurnal inequalities (Jones and Padman, 2006; Easton, 1970), generating tidal currents along a north-east/south-west axis, with speeds generally ranging from 0.1 to 2.5 m/s (Fandry, 1983). The maximum range of spring tides in western Bass Strait is approximately 0.8 to 1.2 m, however the tidal ranges and velocities vary rapidly in the western entrance to Bass Strait (IMCRA, 1998).

Near the seabed, currents run parallel with the coast and can exceed 0.5 m/s when generated by a storm (Woodside, 2003). Close to the shore where water depths are less than 10 m, the currents are of variable speed and are often strong. Current speeds are estimated to range from 0.31 m/s for a mean spring tide to 0.5-1 m/s at the adjacent Thylacine Field (Woodside, 2003) located approximately 23 km west of the survey area.

Table 5.7 provides the average and maximum surface current speeds from combined HYCOM and tidal currents at the centre of the survey area (RPS, 2020).

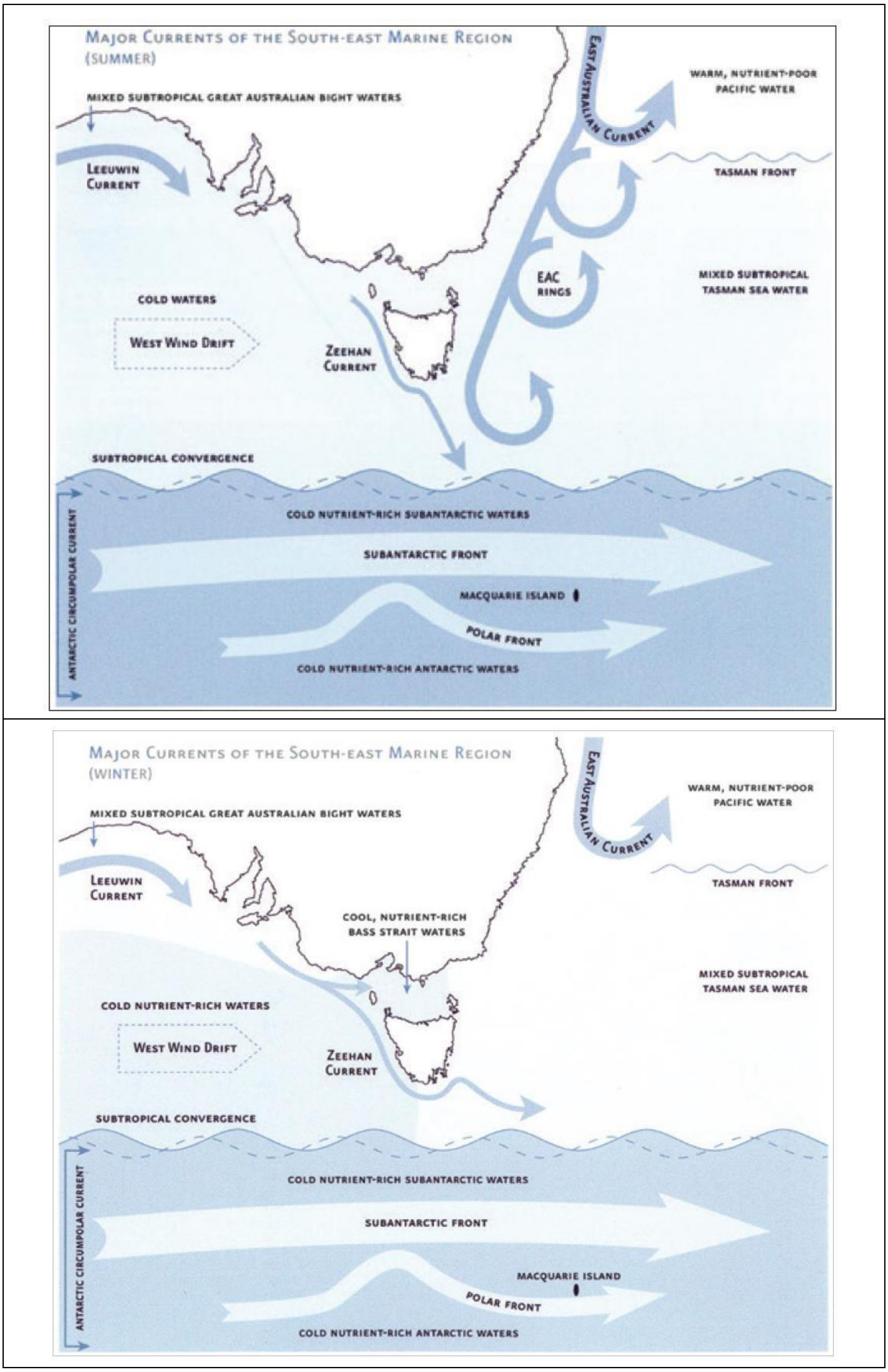
Figure 5.10 illustrates the monthly surface current rose distributions from the combination of HYCOM ocean current data and HYDROMAP tidal data near the survey area from 2009 to 2017 (inclusive) (RPS, 2020). This data indicates that surface currents flow predominantly southeast during the winter months, with no particular trend during summer.

Table 5.7 Predicted monthly average and maximum surface current speeds at the centre of the survey area

Month	Average wind speed (knots)	Maximum wind speed (knots)	General direction (from)
January	0.20	0.69	Variable
February	0.17	0.75	Variable
March	0.22	0.74	Variable
April	0.20	0.84	Southeast
May	0.23	0.78	Southeast
June	0.22	0.72	Southeast
July	0.26	0.97	Southeast
August	0.26	0.84	Southeast
September	0.25	0.74	East - Southeast
October	0.22	0.65	East (variable)
November	0.20	0.55	Variable
December	0.21	0.70	Variable
Minimum	**0.17**	**0.55**	
Maximum	**0.26**	**0.97**	

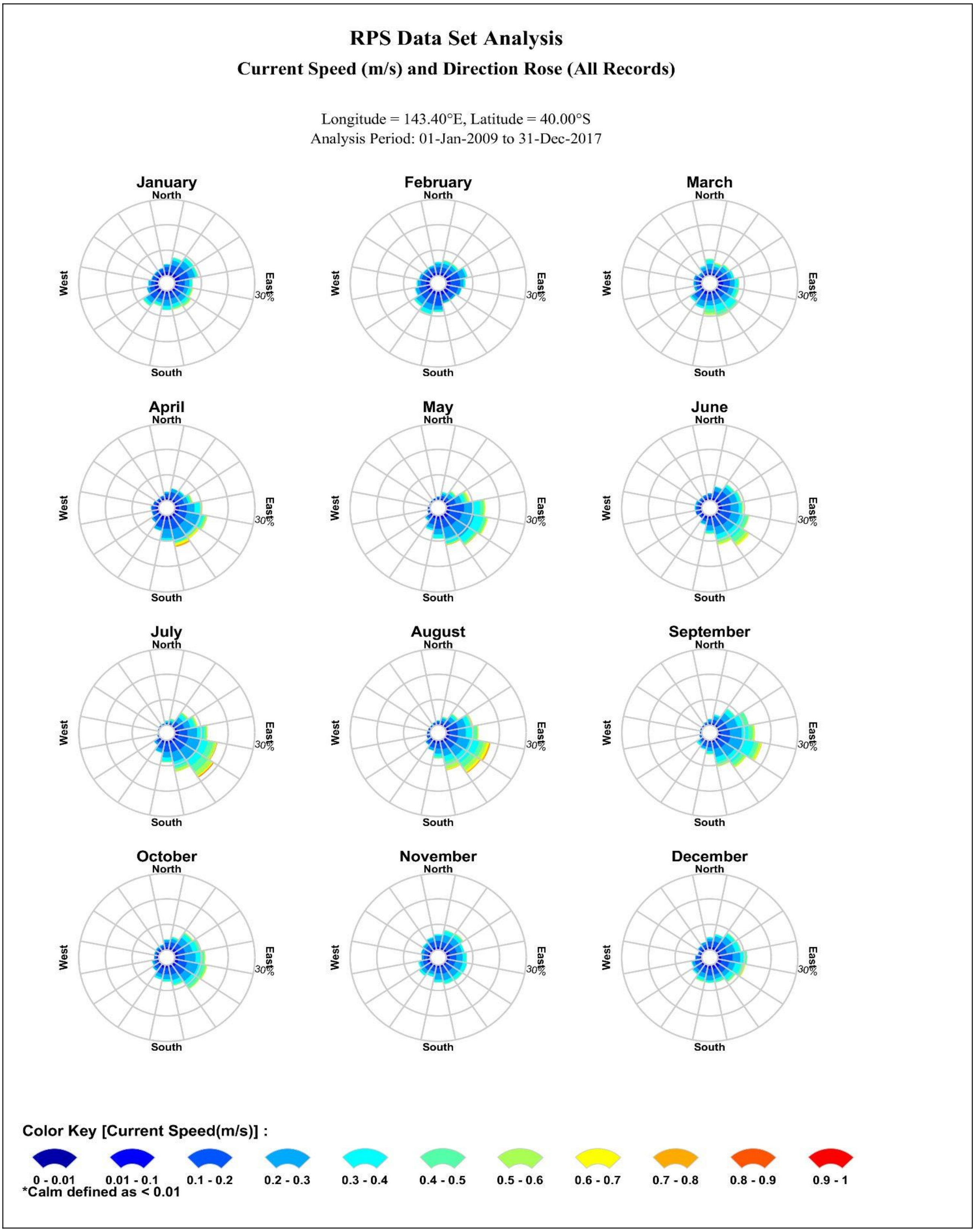
Source: RPS (2020).

Figure 5.9 Major ocean currents in south-eastern Australian waters during summer (top) and winter (bottom)



Source: DoE (2015a).

Figure 5.10 Monthly surface water current roses plots from 2009-2017(inclusive) at the centre of the survey area



Source: RPS (2020). The convention for defining current direction is the direction the current flows towards.

5.4.2. Waves

In Bass Strait, the interaction between sea and swell and the resultant wave motion is complicated by the islands and Australian mainland coastline embayments, peninsulas and headlands. This restricts the access of swell from the Southern Ocean into Bass Strait. Some swell is blocked completely and some refracted by the seabed and modified as it passes into shallower waters of Bass Strait. There are also waves generated by wind within Bass Strait and the conditions at any location will be the result of these two wave-energy bands (Falconer and Lindforth, 1972).

The local wave climate is derived principally from locally generated wind waves mostly from the west and southwest. Wave heights range from 1.5 m to 2 m with periods of 8 s to 13 s, although heights of 5 m to 7 m can occur during storm events.

5.4.3. Water Temperature

The shallowness of Bass Strait means that its waters more rapidly warm in summer and cool in winter than waters of nearby regions (DoE, 2015a). Waters are cold temperate with the mean sea surface temperatures varying from 13°C in winter to 18°C in summer (RPS, 2020). The far eastern region of Bass Strait (i.e., Flinders Island area) is influenced during winter months by warm waters, making this region warmer than other Tasmanian waters at that time (IMCRA, 1998).

During winter, the South Australian current moves dense, salty warmer water eastward from the Great Australian Bight into the western margin of Bass Strait. In winter and spring, waters within the strait are well mixed with no obvious stratification, while during summer the central regions of the straight become stratified (RPS, 2020).

RPS (2020) reports that the temperature in the top 30 m of the water column in the region (based on the World Ocean Atlas) varies from 13 to 17°C across the year. In the shallower waters of the EMBA such as the Bunurong Marine National Park (MNP) and Bunurong Marine Park, Parks Victoria (2006a) notes that surface water temperatures range from 13°C in the cooler months to 17.5°C in the warmer months.

Figure 5.11shows the variation in water temperature seasonally and over depth for the data point closest to the survey area.

5.4.4. Water Quality

The nutrient concentrations in Central Bass Strait are low compared to that of what is seen at its extremities (Gibbs et al.,1986; Gibbs, 1992). It is hypothesised that this could be due to the biological demands of the Bass Strait waters consuming much of the nutrients before moving into Central Bass Strait (Gibbs, 1992).

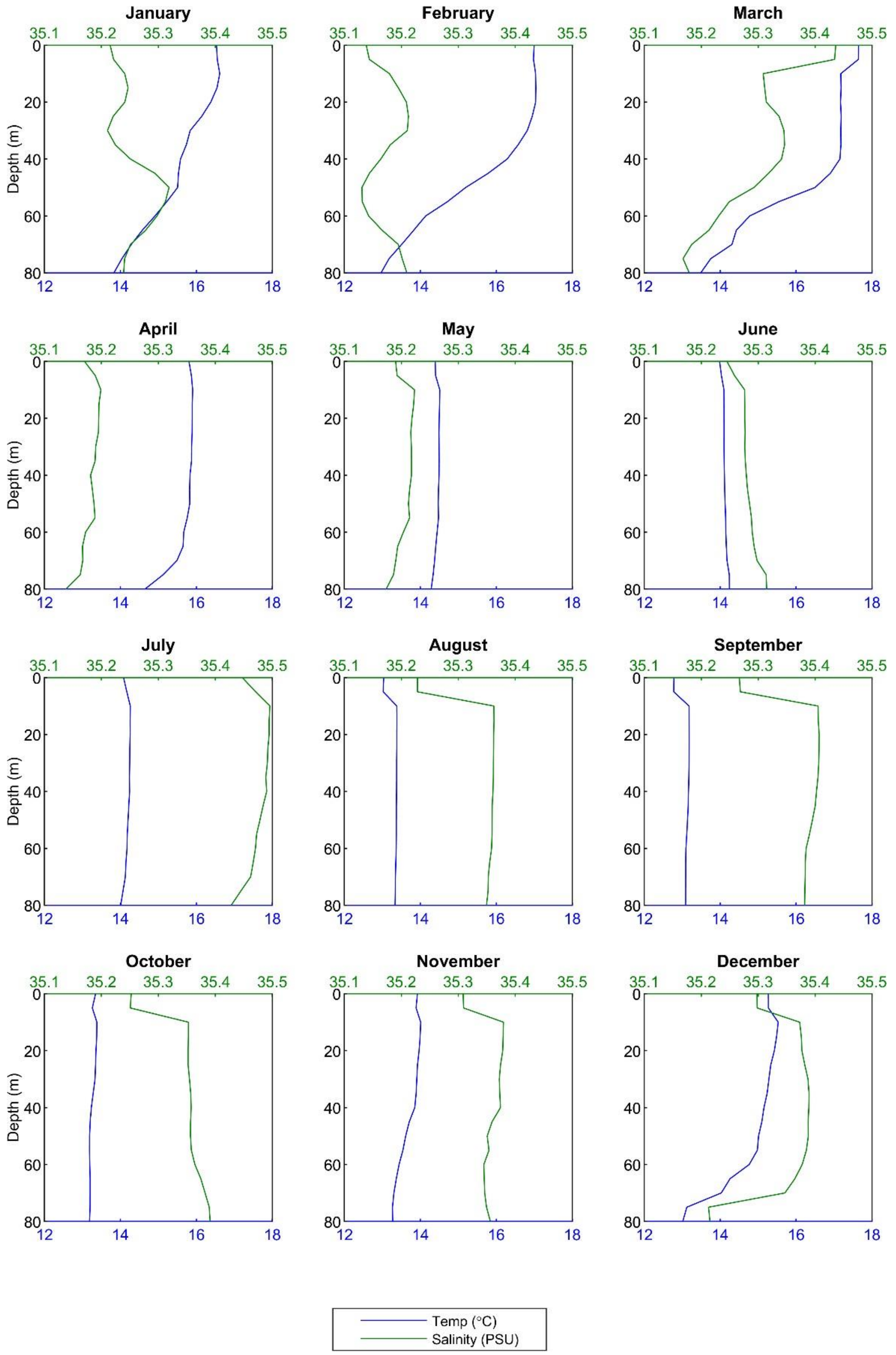
In the nearshore areas of the EMBA, water quality may be negatively affected through the discharge of polluted waters from rivers, which drain catchments dominated by stock grazing and small coastal settlements (Parks Victoria, 2006a).

5.4.5. Salinity

RPS (2020) reports that the average monthly salinity (based on the World Ocean Atlas database) over the water depth range of 30 m is approximately 35.0 practical salinity units (PSU) year-round.

Figure 5.11 shows the slight variation in salinity both seasonally and over depth for the data point closest to the survey area.

Figure 5.11 Temperature (blue line) and salinity (green line) profiles for the survey area



Source: RPS (2020). Depth of 0 m is the water surface.

5.4.6. Ambient Ocean Sound

Physical and biological processes contribute to natural background sound. Physical processes include that of wind, waves, rain and earthquakes, whilst biological noise sources include vocalisations of marine mammals and other marine species.

Wind is a major contributor to noise between 100 Hz and 30 kHz and can reach 85-95 dB re 1µPa2/Hz under extreme conditions (WDCS, 2004). Rain may produce short periods of high underwater sound with a flat frequency spectra to levels of 80 dB re 1µPa2/Hz and magnitude 4 earthquakes have been reported to have spectral levels reaching 119 dB re 1µPa2/Hz at frequency ranges of 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).

Turnpenny and Nedwell (1994) found that in sensitive species such as the cod, continuous ambient sound alone resulted in auditory masking, and that sound had to be 20 dB above ambient sound to be audible. Table 5.8 presents a comparison of biological and anthropological sounds in that may occur in the EMBA.

Table 5.8 Sound intensity and pressure (dB re 1µPa @ 1 m from source) for some common marine sources

Source	Sound intensity (dB re 1 µPa)	Frequency (Hz)	Reference
Natural sound			
Ambient sea sound	80-120	Varied	2
Undersea earthquake	272	50	2
Seafloor volcanic eruption	255+	Varied	2
Lightning strike on sea surface	250	Varied	2
Iceberg calving, shoaling and disintegration	220-245	Varied	5, 6
Bottlenose dolphin click	Up to 229	Up to 120,000	2
Breaching whale	200	20	2
Blue whale vocalisations	190	12 – 400 (16 – 25 dominant)	2
Blue whale moans	188	12 – 390 (16 - 25 dominant)	1
Southern right whale vocalisations	172-186	30 – 2,200 (50 – 500 dominant)	1
Humpback whale vocalisations	144-174	30 – 8,000 (song) (120 – 4,000 dominant) 50 – 10,000 (social calls)	1, 3
Sperm whale clicks	Up to 235	100 – 30,000	2
Anthropogenic sound			
Seismic acoustic source (32 guns)	178-210	Most energy 5 to 200 Hz	1
Ship sound (close to hull)	200	10 - 100	2
Survey vessel	110-135 (without thrusters) 121-146 (with thrusters)	20-1,000	4
Fishing trawler	158	100	3
7 m outboard motorboat	156	630	3
Tanker (179 m)	180	60	3
Supertanker (340 m)	190	7	3

Source	Sound intensity (dB re 1 µPa)	Frequency (Hz)	Reference
Containership (274 m)	181	8	3
Navigation transponders	180 – 200	7,000 – 60,000	3
SSS	220 – 230	50,000 – 500,000	3
Bottom profilers	200 – 230	400 – 30,000	3
Helicopter flyover (Bell 212)	142 – 155	162	1, 3
Drill rig (*Ocean Bounty* semi-submersible)	145 maximum (>120 for 1% of time at 5.1 km)	20 – 1,000 (15-30 dominant)	7
FPSO (maximum at *Griffin Venture*)	176	10 – 500 (up to 2,000)	8
References			
1 – Richardson et al (1995).	*3 – WDCS (2004).*	*5 – Chapp et al (2005).*	
2 – APPEA (2006).	*4 – Total (2004).*	*6 – Matsumoto et al (2014).*	
7 – Woodside (2003).	*8 – Apache Energy (2008).*		

5.4.7. Seabed

Bass Strait

The bathymetry of Bass Strait is gently sloping with water depths increasing gradually from the shore to a maximum of about 1,000 m in the survey area as shown in Figure 5.12. The region's seabed is characterised by a mixture of basins, terraces, plateaus, banks, deep escarpments, canyons and areas of continental rise (DEH, 2006).

Mainland Tasmania and the Bass Strait islands belong to the same continental landmass as mainland Australia. The continental shelf is narrow along the east coast of Tasmania but broadens in the northwest and northeast, underlying Bass Strait and the Otway and Gippsland basins. The central part of Bass Strait contains a depression that exchanges water with the ocean to the north of King Island. The main seafloor feature of western Bass Strait is a ridge that extends from King Island to northwest Tasmania.

The southern shelf or coastal boundary of the Australian mainland is a maximum width of 200 km in the central Great Australian Bight (GAB) which narrows to 20 km on the Bonney coast of South Australia/Victoria (Butler et al., 2002). Bass Strait, to the east of the Bonney coast, consists of a broad shallow region, bordered on the eastern and western sides by very deep waters of the continental slope. The depth of the shelf at the Bonney coast increases gradually to 100 m where a distinct increase in steepness is observed (Butler et al., 2002). The continental slope and abyssal plain are connected by several very large and steep canyons along the Bonney coast, which are thought to contribute to upwelling events and local biodiversity (Butler et al., 2002).

To the west of Tasmania there are also numerous canyons cut from the continental shelf at about 300 m depth to the abyssal plain (at about 3500 m depth) with the shallower continental margin characterised by gentle to moderate sloping ground (NOO, 2002). On the continental shelf, the seabed slopes gradually upwards in a northerly and easterly direction across the shelf to a depth of about 30 m within 1 km of the coastline.

Survey area

The survey area is located on the outer edge of the Australian continental shelf with a small amount of acquisition over the continental slope in the southwest of the survey area.

The movement of sediments from the continental shelf to the abyssal plain has been modelled for the west Tasman margin. The shelly sands of the outer continental shelf (70% calcium carbonate) grade into ooze on the slope (60 to 65% calcium carbonate derived from the remains of small calcareous organisms called foraminifera). Deeper on the abyssal plain, the sediments are pelagic ooze (less than 50% carbonate).

Similarly, sand concentrations also grade from the outer shelf (60% sand by weight) down to the slope (10–15% sand by weight) through to the abyssal plain (less than 10% sand by weight) (NOO, 2002). The Folk classification for the seabed sediment type within the survey area is gravelly sand-gravelly muddy sand with a mean grain size of 0.25 to 0.5 mm (Passlow *et al.*, 2005). The average seabed sediment grain size across Bass Strait is illustrated in Figure 5.13.

Spill EMBA

The seabed in the nearshore parts of the spill EMBA is mapped only at a coarse scale for the OSRA using LiDAR data. This section describes the seabed in the areas intersected by the spill EMBA, broken down into OSRA mapping sections (moving from the west of the spill EMBA to the east).

Victoria

- Apollo Bay (OSRA Map 07) – the nearshore seabed west of Cape Otway is characterised by gently sloping sandy sediments. South of Cape Otway is an extensive area of subtidal reefs that extent east around the Cape.
- Lorne (OSRA Map 08) – the nearshore seabed at Apollo Bay is characterised by gently sloping sandy sediments and an absence of reef habitat. To the east, nearshore reef habitat is common with sandy sediments dominant further away from the coast. Cape Patton, Point Hawdon and Point Grey are the exception to this general pattern, whereby reef habitat is dominant throughout the mapped nearshore area.
- Anglesea (OSRA Map 09) – From Fairhaven to Jan Juc, the nearshore environment is primarily sandy with subtidal rocky reef habitat present further away from the coast. Adjacent Torquay, subtidal rocky reef is dominant within the Point Danger Marine Sanctuary.
- Bellarine Peninsula South (OSRA Map 10) – East of Torquay to Point Lonsdale, the nearshore sediments are mainly sandy with subtidal rocky reef habitat dominant further away from the shoreline. Within Port Phillip Bay, the northern Mornington Peninsula coast is dominated by an uninterrupted extent of nearshore sandy sediments from Point Nepean to Sorrento.
- Mornington Peninsula South (OSRA Map 14) – the nearshore seabed of the southern Mornington Peninsula coast from Point Nepean to Flinders is predominantly subtidal rocky reef and rocky substrate with intermittent patchy areas of sandy sediments. East of Flinders, aquatic vegetation is present in the nearshore environment among sandy sediments and an absence of hard substrate.
- Phillip Island (OSRA Map 15) – the nearshore seabed of the northern and western coast of Phillip Island is dominated by subtidal rocky reef and hard substrates with sandy sediments present further away from the coast. The southern nearshore seabed of Phillip Island is dominated by subtidal rocky reef with intermittent and sparse areas of sandy sediments from Summerland to Surf Beach. East of Surf Beach until Cape Woolamai, sandy seabed is common with only some interspersed areas of rocky substrate.
- Kilcunda (OSRA Map 17) – the seabed intersected by the EMBA adjacent Kilcunda comprises distinct patches of subtidal rocky reef and sandy sediments. Around Cape Paterson and the Bunurong MNP, extensive areas of subtidal rocky reef are dominant (up to 1 km wide in some areas) with sandy sediments present further offshore. The seabed of Venus Bay is exclusively sandy sediments with no areas of subtidal rocky reef mapped. Anderson Inlet is not intersected by the EMBA.

- Cape Liptrap (OSRA Map 18) – there are extensive areas of subtidal rocky reef mapped off the coast of Cape Liptrap. East of the cape adjacent Walkerville is an area of mixed sandy sediment with offshore reef before transitioning to continuous sandy sediments and an absence of hard substrate in Waratah Bay.
- Wilsons Promontory West (OSRA Map 19) – the western parts of Wilsons Promontory intersected by the EMBA are dominated by sandy sediments, with small and isolated areas of rocky reef located around the offshore islands.
- Wilsons Promontory East (OSRA Map 20) – the eastern parts of Wilsons Promontory intersected by the EMBA are dominated by sandy sediments, with small and isolated patches of reef.
- Marlo (OSRA Map 26) – the nearshore seabed adjacent the township of Marlo is dominated by sandy sediments with two small sections of subtidal rocky reef east of Ricardo Beach.
- Bemm River (OSRA Map 27) – the seabed adjacent Cape Conran features nearshore subtidal rocky reef before transitioning to predominantly sandy seabed to the east. Subtidal rocky reef is present south of Pearl Point before becoming mostly sandy sediments again further to the east.
- Point Hicks (OSRA Map 28) – the nearshore seabed intersected by the EMBA is dominated by sandy sediments, with patches of subtidal reef.
- Mallacoota (OSRA Map 29) – the areas of nearshore seabed intersected by the EMBA south of Mallacoota are dominated by subtidal rocky reef with intermittent areas of sandy sediments. East of Mallacoota is dominated by sandy sediments with areas of reef concentrated around the offshore islands of Gabo Island and Tullaberga Island. Mallacoota inlet and its seagrass communities are not intersected by the EMBA.

The following information provides a description of the key seabed features listed above:

Subtidal rocky reef

Rocky reefs provide a stable seabed for a wide range of plants and animals including kelps and other seaweeds and encrusting invertebrates such as sea squirts, sponges and bryozoans. In turn fixed biota provide habitat and food for mobile animals including molluscs, octopus, crustaceans, and a wide range of fish species. There have been a wide range of studies of nearshore reef biota in Victoria including work for the Environment Conservation Council's marine coastal and estuarine investigation (Ferns and Hough, 2000). The nearshore reefs along Victoria's open coastline are characterised by an abundance of brown kelps, with a diverse understorey of red, green and brown seaweeds, sea squirts, sponges, bryozoans, crustaceans and molluscs. There is a degree of variation in the composition of biota on the reefs along the coast but in general most species are represented widely along the Victorian coast. Parks Victoria (2006a) notes that the Bunurong MNP and Bunurong Marine Park (both sites with significant areas of subtidal rocky reef and rock platforms) have the highest diversity of intertidal and shallow subtidal invertebrate fauna recorded in Victoria on sandstone.

Sandy substrate

The shifting sands of unsheltered nearshore seabed are often too mobile for the development of marine floral communities and lack the necessary hard substrate required for anchoring. As such, these environments can appear barren and featureless on the surface. Nevertheless, a rich abundance of faunal communities may be present among the sands including species of molluscs, bivalves, annelids, crustaceans, and echinoderms.

Seagrass communities

Seagrasses are often called nursery habitats because the leafy underwater canopy they create provides shelter for small invertebrates (such as crabs, shrimp and other types of crustaceans), small fish and juveniles of larger fish species. Seagrass leaves absorb nutrients and slow the flow of water, capturing sand, dirt and silt particles, which, along with their roots trap and stabilise the sediment, which helps improve water clarity and quality and reduces erosion of coastlines, as well as providing suitable habitat for benthic infauna. Seagrass beds are an important component of unique food webs whereby the seagrass may be consumed directly by grazers, provide substrate for epiphytic organisms to colonise and eventually nutrients for detritivores (Parks Victoria, 2005a).

Tasmania

Seamap Australia (2017) presents benthic spatial data and has been used in place of OSRA mapping to describe in part the seabed within the Tasmanian section of the EMBA. The nearshore seabed of the northwest coast of Tasmania from Stanley to Hunter Island is mapped as predominantly sand, with seagrass present in the strait between Robins Island and Tasmania. The seabed around the Kent Group is mapped as predominantly sand with areas of hard consolidated substrate present close to the shoreline. Nearshore seabed mapping of King Island and the west coast of Tasmania is not included in the Seamap database.

Figure 5.12 Bathymetry of Bass Strait and the survey area

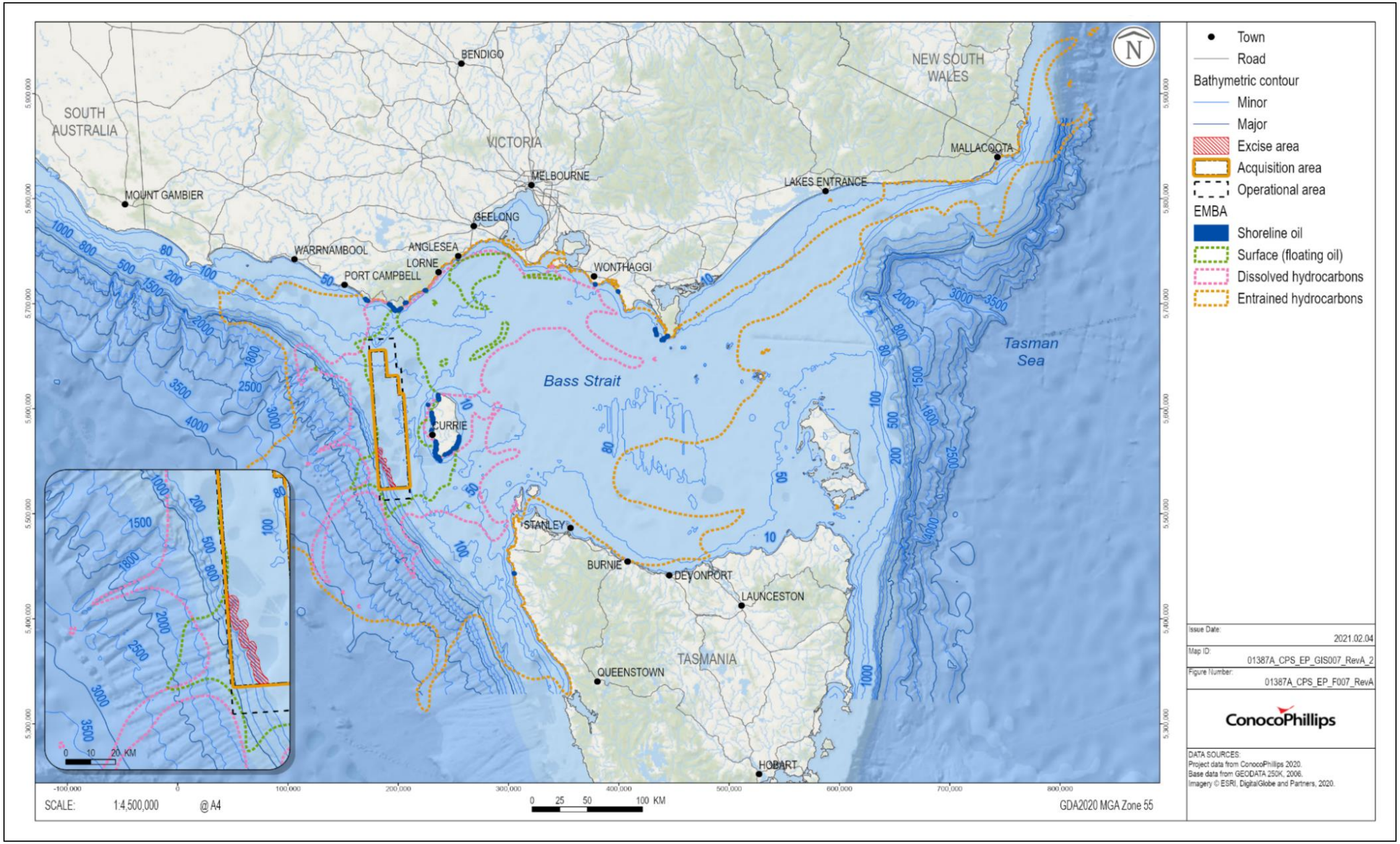
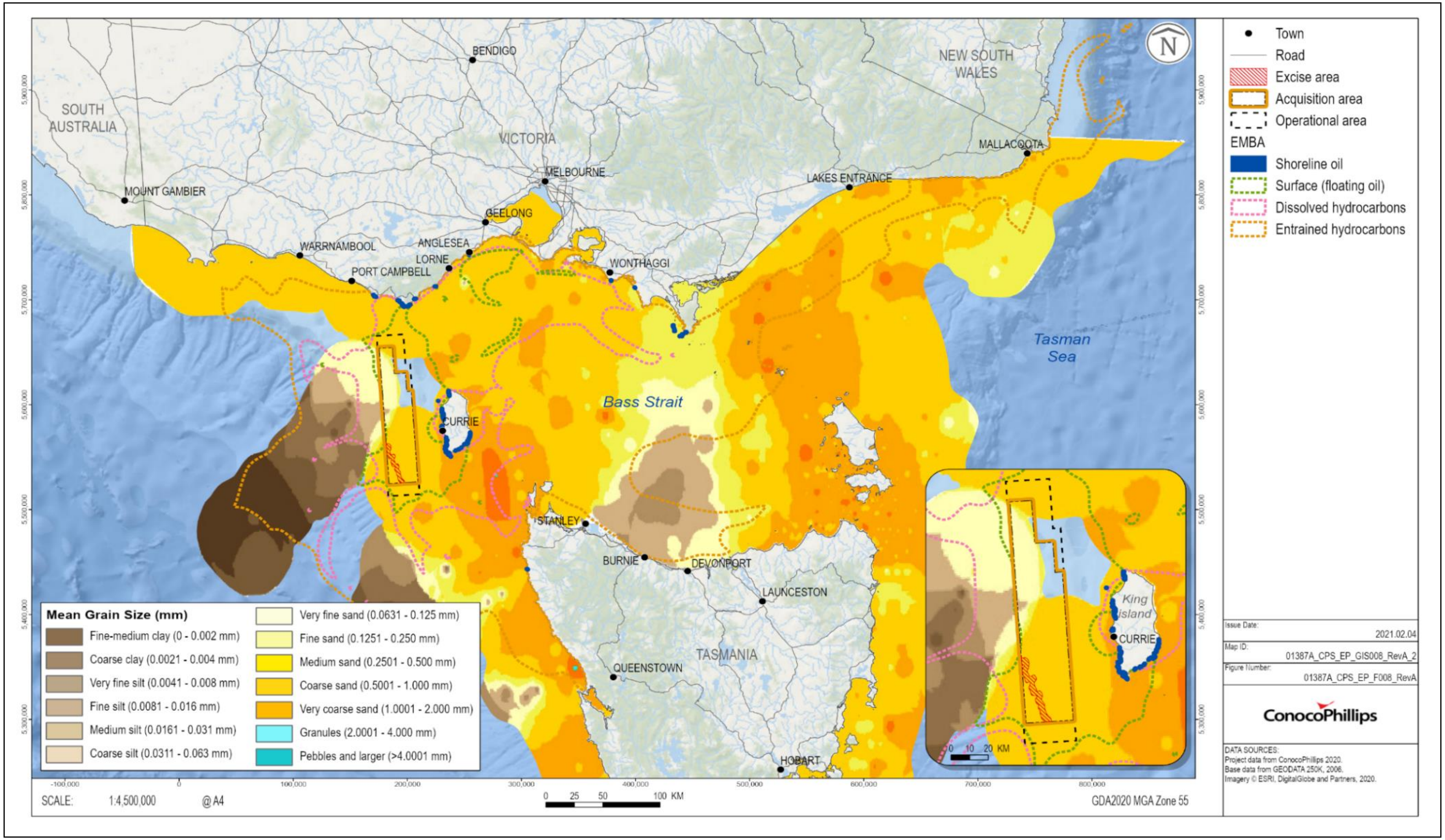


Figure 5.13 Average seabed sediment grain size across Bass Strait



5.4.8. Shorelines

This section describes the shoreline in the areas intersected by the spill EMBA (shoreline, dissolved and entrained MDO). Areas potentially exposed to shoreline loading are the northern, western and south-eastern coastline of King Island and isolated spots along the Port Campbell, Cape Otway, Bass and Wilson Promontory coastline.

The following description of shorelines is based on available literature, Google Earth satellite imagery and OSRA mapping.

Modelled exposure to shoreline hydrocarbons

- King Island (north, west, southeast coasts) - the western and south-eastern coastline is predicted to be exposed to shoreline loading of hydrocarbons. The west coast of the Island is predominantly rocky shoreline with some areas of sandy beaches. The longest stretch of beach is located on the northwest coast of the island.
- Port Campbell (OSRA map 05) – the shoreline is predominantly sand beach, intertidal shore platform and mixed sand beach and shore platform. South of Princetown is the Glenelg River Estuary and identified shorebird habitat on the adjacent sandy beach.
- Cape Otway West (OSRA map 06) – the EMBA intersects the west, south and east coasts of Cape Otway. This coastline is dominated by intertidal shore platforms and rocky substrate in general with the near absence of sand beach.
- Apollo Bay (OSRA map 07) – the section of coastline that may be exposed to shoreline loading is dominated by intertidal shore platforms, rock platforms and some areas of sandy beach.
- Kilcunda (OSRA map 17) – the coastline of Cape Paterson is dominated by intertidal shore platform and rock platform with the complete absence of sand beach in the section potentially exposed to shoreline loading.
- Wilson Promontory West (OSRA map 19) –the offshore islands in this sector potentially intersected by shoreline loading are all dominated by intertidal shore platforms and provide important breeding habitat for little penguins (see Section 5.5.9), Australian fur-seals and New Zealand fur-seals (see Section 5.5.7). All the islands are protected within the Wilsons Promontory Marine National Park (MNP) and Wilsons Promontory Marine Park.

Modelled exposure to dissolved and/or entrained phase hydrocarbons (no shoreline loading) Victoria

- Cape Otway West (OSRA Map 06) - the shoreline south of Wattle Hill is dominated by rock platform with a short stretch of sandy beach located at Milanesia Beach. From Johana Beach until Point Flinders, sand beach is dominant with interspersed areas of rock platform as well the Johanna and Aire River Estuaries. At Cape Otway, there is extensive rock platform with interspersed areas of mixed sand beach and intertidal shore platform.
- Apollo Bay (OSRA Map 07) – East of Cape Otway, the shoreline is a mixture of sand beach and intertidal shore platform. Hooded plover habitat is identified from the Park River Estuary to Shelly Beach. From Marengo to Skenes Creek, sand beaches are dominant in the sheltered area of Apollo Bay. From Skenes Creek until Wye River, the shoreline is a mixture of sand beach and rock platforms, interspersed with the Smythes Creek, Carrisbrook Creek, Grey River and Kennet River Estuaries.
- Lorne (OSRA Map 08) – From Wye River to Lorne, the shoreline is characterised by a mixture of sand beach and intertidal shore platform with shorebird habitat identified throughout. At Lorne and Fairhaven, uninterrupted stretches of sand beach at present. Shorebird roosting and feeding is identified at the Painkalac Creek Estuary.
- Anglesea (OSRA Map 09) – From Anglesea to Barwon Heads, sand beach is the dominant shoreline type with intermittent stretches of rock platform and intertidal shore platform present. At the Anglesea River

Estuary, shorebird feeding habitat has been identified as well as at Addiscot Beach, Thompson Creek Estuary and Thirteenth Beach.

- Bellarine Peninsula South (OSRA Map 10) – The Barwon River Estuary and shorebird roosting sites are present in this section and sand beach is dominant from Barwon Heads to St Leonards. The northern shoreline of the Mornington Peninsula is primarily sandy beach from Point Nepean to Sorrento with sparse areas of intertidal shore platform.
- Mornington Peninsula South (OSRA Map 14) – The southern Mornington Peninsula coastline from Point Nepean to Flinders is a mixture of sand beach and intertidal shore platform, with an uninterrupted stretch of sand beach present at Gunnamatta Beach. Shorebird habitat and feeding sites are identified in the Point Nepean National Park, Pelly Point, Cape Schanck, and West Head. North of Flinders towards Balnarring, a mixture of sand beach and intertidal shore platform is present along with numerous identified shorebird roosting sites, particularly around Shoreham.
- Phillip Island (OSRA Map 15) – Sand beaches and intertidal shore platform are dominant on the north shoreline of Phillip Island with shorebird habitat identified from Cowes to Summerland. Off the coast of Summerland is Seal Rocks, which is a known breeding and haul-out site for Australian fur-seals. On the southern coast of Phillip Island, sand beach and rock platforms are common. From Surf Beach to Cape Woolamai, sand beach is dominant. The Cape Woolamai coast on the eastern edge of the island is dominated by sandy beach and sand dunes with some isolated areas of cobble/shingle beach. The sandy beach is identified habitat for coastal bird species.
- Kilcunda (OSRA Map 17) – starting near Venus Bay, the west-facing beaches continue to be dominated by sandy beaches. West of Anderson Inlet, the shoreline is dominated by mixed sand beach/shore platform and intertidal shore platform. North of Harmers Haven, the shoreline is again dominated by sandy beaches, interspersed by mixed sand beach/shore platform through to San Remo.
- Cape Liptrap (OSRA map 18) – the EMBA intersects Waratah Bay, which comprises mostly sandy beaches and intertidal shore platforms. The shoreline around Cape Liptrap is dominated by mixed sand beach/shore platform in the southern area, shifting to mixed cobble/shingle beach/shore platform on the western side of the cape. North of this point, the shoreline is dominated by sandy beaches with small sections of mixed sand beach/shore platform in the more southerly reaches. These sandy beaches are noted to have large numbers of hooded plovers and are backed by the Cape Liptrap Coastal Park.
- Wilsons Promontory West (OSRA map 19) – the western parts of Wilsons Promontory intersected by the EMBA are dominated by intertidal shore platforms and interspersed by sandy beaches, particularly in the bays (e.g., Oberon Bay, Norman Beach (Tidal River) and Darby Beach. The offshore islands in this sector (Kanowna, Cleft, Anser Group, Wattle, McHugh, Glennie Group and Norman islands) are all dominated by intertidal shore platforms and provide important breeding habitat for little penguins (see Section 5.5.9), Australian fur-seals and New Zealand fur-seals (see Section 5.5.7). All the islands are protected within the Wilsons Promontory Marine National Park (MNP) and Wilsons Promontory Marine Park.
- Wilsons Promontory East (OSRA Map 20) – the shoreline of Wilsons Promontory East is dominated by intertidal shore platform in areas exposed directly to the sea. Sheltered bays, such as Waterloo Bay and Sealers Cove, are dominated by sandy beach and mixed sand beach/shore platform. At these locations, Freshwater Creek estuary and Sealers Creek estuary meet Bass Strait.
- Marlo (OSRA Map 26) – the shoreline adjacent the township of Marlo is predominantly sandy beach until the Snowy River estuary, which is continuously open. East of Marlo is continuous sandy beach until Cape Conran where there are areas of intertidal shore platform. Areas of the sandy beach are noted as shorebird roosting sites and Hooded plover habitat.
- Bemm River (OSRA Map 27) – The Bemm River section is predominantly sandy beach east of Cape Conran until Pearl Point, which is noted as mixed sand beach/shore platform. The shoreline east of Pearl Point is sandy beach other than the Tamboon and Sydenham Inlet estuaries, which are both noted as intermittently open. Coastal bird habitat and tern nesting sites are noted as both of the estuary sites.

- Point Hicks (OSRA Map 28) – the shoreline intersected by the EMBA is primarily sandy beach with isolated areas of intertidal shore platform and mixed sand beach/shore platform. The Thurra River estuary and Mueller River estuary (both intermittently open) are present east of Point Hicks. The Wingman Inlet estuary (continuously open) is located adjacent the Skerries and is identified as hooded plover habitat.
- Mallacoota (OSRA Map 29) – the shoreline intersected by the EMBA is dominated by mixed sand beach/shore platform with some continuous areas of sand beach present at Secret Beach and Quarry Beach. Four intermittently open estuaries are located along this stretch of coast. The shoreline east of Mallacoota is dominated by sand beach with mixed sand beach/shore platform present at Cape Howe on the Victoria/NSW border.

Tasmania – potential for contact with shoreline loading

- From Whistler Point in the north of King Island to Cataraqui Point in the south of the island, the dominant coastal feature is rocky shoreline with small cliffs 5 m above the high-water mark (ListMap, 2020). There are small stretches of coarse grain sand beach or shoreline located in sheltered bays and coves, most notably at Fitzmaurice Bay and Porky Beach (ListMap, 2020). The capital of King Island (Currie) is also located along this stretch.
- South of Cataraqui Point, around the southern cape of King Island, very steep or vertical cliffs are present until Surprise Point, which features a pebble, cobble or boulder beach (ListMap, 2020). Extended stretches of coarse sand beach are located at Surprise Bay and Colliers Beach.
- North of Whistler Point, there is a long stretch of coarse sand beach located at Cooper Bluff and Yellow Rock Beach (ListMap, 2020). At Cape Wickham on the northern cape of King Island, rocky shorelines are dominant until Disappointment Bay where a long stretch of sandy beach extends from Rocky Point down the east coast of the island until Naracoopa (ListMap, 2020).

Table 5.9 presents the coastal sensitivities of King Island in the EMBA. Figure 5.14 illustrates the coastal receptors of King Island.

Table 5.9 Coastal sensitivities of King Island

Environmental Receptor	Location (anti-clockwise from Cape Wickham)									
	Cape Wickham to Cape Farewell (Cape Wickham Conservation Area)	Cape Farwell to Quarantine Bay	Quarantine Bay to Peerless Point (Porky Beach Conservation Area)	Currie Harbour	Stingray Bay to Seal Rocks (Cataraqui Point Conservation Area)	Seal Rocks State Reserve	Surprise Point to Stoke Point (Stokes Point Conservation Area)	New Year Island Game Reserve	Spokes Point to Bold Head	Bold Head to Naracoopa
Coastal types and habitats										
Sub-tidal rocky reef	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Rock shoreline/ platform	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Sandy beach	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Pebble or shingle beach	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Estuary/Wetland	No	Yes	No	No	No	No	No	No	No	No
Steep Rocky Cliffs	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Species presence										
Seagrass meadows	No									
Giant kelp	No									
Saltmarsh	No	Yes	No	No	No	No	No	No	No	No
Seaweed farming	Yes	Yes	Yes	No	Yes	No	No	No	No	No
Shorebird colonies	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
Seabird rookery	Yes	Yes	Yes	No	Yes	No	No	Yes	No	No

Green cells = presence of receptor, red cells = absence of receptor.

Figure 5.14 King Island shoreline sensitivities (ListMap, 2020)

5.5. Biological Environment

The key sources of information for the species that may be present in the spill EMBA are presented in this section from data obtained via the EPBC Act PMST, SPRAT, ALA, Shorebirds 2020 and VBA databases.

5.5.1. Benthic assemblages

Survey area

A search of the ALA database identified 224 benthic species likely to be present in the survey area including starfish, brittle stars, sea urchins, sea snails, anemones, sponges, bivalves, crabs, shrimp, lobsters and bristle worms (listed in Appendix 12). None of these species are listed as threatened under the EPBC Act. A search of the VBA database for the survey area did not identify any benthic species.

Spill EMBA

The VBA database identified 92 benthic species likely to be present within the EMBA, including crabs, shrimp, sea snails, lobster, seastars and sea urchins (listed in Appendix 13).

The most abundantly recorded species include:

- Black-lip abalone (Haliotis rubra) (265 sightings);
- Common warrener (Lunella undulatus) (109 sightings);
- Common periwinkle (Austrocochlea constricta) (84 sightings);
- Striped-mouth conniwink (Bembicium nanum) (68 sightings); and
- Cleft-fronted shore crab (Guinsuia chabrus) (55 sightings).

The ALA database identified 3,327 benthic species within the EMBA, including limpets, tusk shells, cones, sea snails, mussels, cockles, oysters, brittle stars, sea cucumbers, sea urchins, feather stars, starfish, anemones, corals, sponges, bristle worms, bryozoans, shrimp, crabs, prawns and lobsters (listed in Appendix 12). Some of the broad groupings identified in the EMBA are described in Table 5.10.

Boreen et al (1993) examined 259 sediment samples collected over the Otway Basin and the Sorell Basin of the west Tasmanian margin. Samples were taken during two research cruises (January/February 1987 and March/April 1988) on the RV Rig Seismic using dredges, corers, grabs and a heat-flow probe. Based on assessment of the sampled sediments the authors concluded the Otway continental margin is a swell-dominated, open, cool water, carbonate platform.

Williams et al (2009) notes that in surveys conducted along the shelf edge (150-400 m water depths, where the continental shelf drops away sharply to form the continental slope), the following key habitats occur:

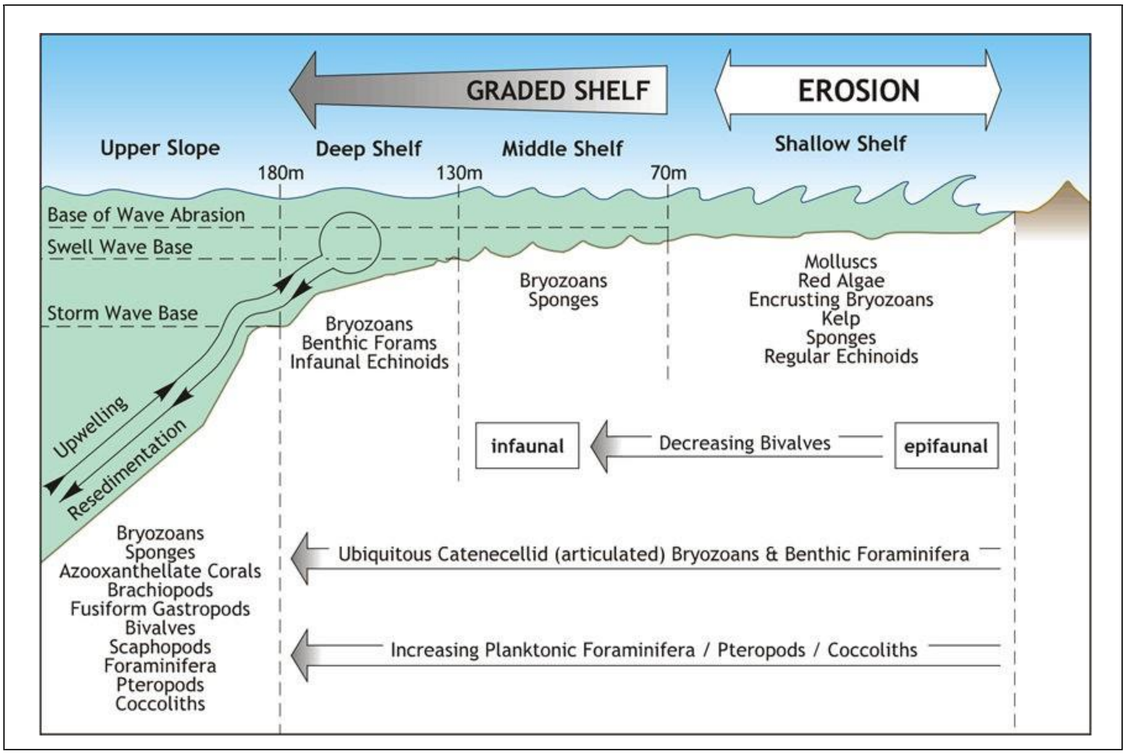
- Bryozoan thickets (dominated by emergent bryozoans and small erect sponges and ascidians), where giant crabs are caught;
- Low and/or encrusting bryozoans and sponges;
- Low microfauna in association with detritus; and
- Absence of epifauna (often with bioturbation.

A conceptual model was developed that divided the Otway bioregion continental margin into four depth related zones consisting of the shallow shelf, middle shelf, deep-shelf, shelf edge/upper slope (Figure 5.15). The spill EMBA is across all five zones. A description the benthic environment and species supported in each shelf is provided below:

- Shallow shelf (0 to 70 m) – contains exhumed limestone substrates that host dense encrusting mollusc, sponge, bryozoan and red algae assemblages with epifauna such as bivalves. This is observed in the Apollo Marine Reserve where the seafloor has many rocky reef patches inter-dispersed with areas of sediment and in places has rich benthic fauna dominated by sponges (DoE, 2015a). South-east Australia is also recognised as having one of the richest macrophyte floras in the world (409 genera with 1124 species) and the benthic algal communities include more than 200 species of which 165 species are rare (Butler et al., 2002).

- Middle shelf (70 to 130 m) - a zone of swell-wave shoaling and production of mega-rippled bryozoan and sponge sands;
- Deep shelf (130 to 180 m) - described as having accumulations of intensely bioturbated, fine, bioclastic sands supporting bryozoans, benthic forms and in-faunal echinoids; and
- At the shelf edge/upper slope (greater than 180 m) - supports aphotic bryozoan/sponge/coral communities.

Figure 5.15 Model of the geomorphology of the Otway Continental Margin (Boreen *et al*., 1993)



The Bass Strait region is known to consist of marine invertebrates such as porifera (sponges); cnidarians (e.g., jellyfish, corals, anemones, sea-pens); bryozoans (filter feeders); arthropods (e.g., sea spiders); crustaceans (e.g., rock lobster, giant crab, krill); molluscs (e.g., bivalves, sea slugs, gastropods); echinoderms (e.g., urchins, sea cucumbers); and annelids (e.g., polychaete worms). General information on marine invertebrates that may be present in the survey area and spill EMBA is provided in Table 5.10.

There is little targeted information available on the nature or distribution of epibiota in the survey area and central Bass Strait, but data is available for the wider Bass Strait from the Museum of Victoria biological sampling programs conducted from 1979 to 1983 (Wilson and Poore, 1987).

Studies by the Museum of Victoria (Wilson and Poore, 1987; Poore et al., 1985) found that invertebrate diversity was high in southern Australian waters although the distribution of species was patchy, with little evidence of any distinct biogeographic regions. The results of invertebrate sampling undertaken in shallower inshore sediments indicate a high diversity and patchy distribution. In these areas, crustaceans, polychaetes, and molluscs were dominant (Parry et al., 1990). This information can be used to extrapolate existing conditions for central Bass Strait.

Generally, the epibiota of the region is sparse and characterised by scallops and other large bivalve molluscs, crabs, seasquirts, seapens, urchins, lampshells, polychaete worms, sponges and bryozoans. A variety of mobile crabs, prawns and brittle stars are also relatively common. Many of the mobile epibiota appear to occur in aggregations from time to time (scallops, prawns and crabs) while some of the fixed epibiota occur in patches (sponges and bryozoans). For example, trawling conducted for the Museum of Victoria biological sampling programs recorded large hauls of sponges along some trawl transects. The main hauls of sponges were located in an arc around southern Bass Strait (Passlow, et al., 2006). These sessile invertebrates, including sponges, bryozoans, hydroids and ascidians, form single species or mixed aggregations on the seabed that increase the vertical structure of benthic habitat and provide shelter from predators on the seafloor (Maldonado et al., 2017). Due to the increased habitat complexity that sponge assemblages provide, these areas are associated with localised increases in biodiversity (Maldonado et al., 2017). It is likely that the sponges referred to in Butler et al (2002) and Maldonado et al (2017) provide a similar ecosystem function when aggregations form in Bass Strait.

According to DPIPWE (2020a), very little is known of Tasmania's offshore marine ecosystems as there have only been limited surveys of benthic biota. However, it is known that unvegetated soft sediments (sand, mud and other unconsolidated substrates) are the dominant feature of the subtidal marine environment in Tasmania, comprising around 75% of the seabed in nearshore areas (Parsons, 2011). The apparently barren appearance of these areas is deceptive and hides a diversity of life, as well as important nursery habitats and rare species limited to Tasmanian waters. There are few places to hide, so many species living on sand and mud have developed special mechanisms for protection, such as camouflage or being adept at quickly burrowing into the sediment, such as the spotted flounder (Ammoteris lituratus) and girdled goby (Nesogobius maccullochi) (Parsons, 2011).

These sediments generally have a lower productivity than seagrass and macroalgal beds due to the absence of large photosynthesising plants, however they are often rich in small invertebrates that live on microscopic algae, bacteria and food particles in the passing water. These in turn provide food for larger surface dwelling and burrowing invertebrates, which in Tasmanian waters are dominated by crustaceans, polychaete worms, gastropods and bivalve molluscs (Parsons, 2011).

Table 5.10 Marine invertebrates likely to be present in the survey area or spill EMBA

Invertebrate	Description
Porifora (Sponges)	Sponges are sessile, multicellular organisms that have bodies full of pores and channels allowing water to circulate through the animal which provides food and oxygen and remove wastes. The flow is actively generated by the beating of flagella and filter bacteria and phytoplankton from the water which passes through them (Bond & Harris, 1988). Porifera flourish in waters where water movement is strong (Butler *et al*., 2002). Sponges do not have nervous, digestive or circulatory systems. Sponges 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). Large sponges are a host to a myriad of commensal invertebrates including crustaceans, molluscs, worms and echinoderms as well as microorganisms. Only a few specialised species prey on sponges due to their highly developed chemical defences. For fish they are generally unpalatable but may present shelter and food in the form of associated species (Butler *et al*., 2002). Based on the ALA search results for the survey area and EMBA, sponges are likely to be present in the survey area, particularly in marine canyons.
Hydrozoans (Colony-forming polyps)	Species are found in almost every marine habitat type except heavy surf zones. They are most abundant and diverse in warm shallow waters probably reflecting food abundance. Most species have a planktonic larval stage which is pelagic before settling onto benthic substrates and developing a polyp. A founding polyp produces new polyps by budding. In many colonies, polyps are polymorphic with different structures reflecting different functions. Polyps produce “adult” sexually-reproducing medusae which are free- swimming and release sperm and eggs in the water (broadcast spawners) where fertilisation occurs. Colonies are usually sessile benthic, but some notably the siphonophores are pelagic floaters. Most hydrozoans are predators or filter-feeders. Filter feeders trap small zooplankton, pelagic hydrozoans show selectivity in prey types taking mainly fish larvae, soft bodied invertebrates or micro-crustaceans. Predators can include snails, worms, fish and crustaceans (University of Michigan, 2018). Based on the ALA search results for the survey area and EMBA, hydrozoans are likely to be present in the survey area, particularly in marine canyons.

Invertebrate	Description
Bryozoans (Aquatic filter feeding animals)	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 they 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 begins to reproduce asexually (by budding) after settlement. 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 seabed to colonise. For species which do not brood but release eggs, fertilised eggs become part of the plankton stream for approximately two 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). Most bryozoans use chemicals as well as spines as a predator deterrent and thus have only relatively few specialised predators (Butler et al., 2002). Based on the ALA search results for the survey area and EMBA, bryozoans are likely to be present in the survey area, particularly in marine canyons.
Annelids (worms)	Annelids are a large phylum of segmented worms, including polychaetes, clitellates, ragworms, earthworms and leeches. Polychaetes are brightly coloured segmented worms. Most are less than 10 cm long, although they can range from 1 mm to 3 m and include forms such as sand worms, tube worms and clam worms. They are found in all habitats from the supra-littoral to the deepest parts of the ocean. Some such as the feather-duster worms are sedentary, living in tubes buried in sand/mud and feed by trapping food particles in mucus or by ciliary action. Others such as the clam worm are active mobile predators which capture prey in jaws (University of Michigan, 2018). Most polychaetes have separate sexes - male and female and the sperm and eggs are released into the surrounding water through ducts or openings. The fertilised eggs hatch into larvae, which float among the plankton, and eventually metamorphose into the adult form by adding segments (MESA, 2017). Based on the ALA search results for the survey area and EMBA, annelids are likely to be present in the survey area.

Invertebrate	Description
Ascidians	All ascidians (sea squirts) are sessile, sac-like marine invertebrate filter feeders and include both solitary and colonial species. These species have a digestive, circulatory and nervous system but lack any special sensory organs. Reproduction includes both asexual budding and sexual reproduction with a free-living larval stage. The species 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 to 24 hours and prior to hatching have been floating free in the water for up to 3 days. They are therefore subject to current dispersal which contributes to gene flow and removes risks of isolation. The colonial species are seldom free swimming for more than one hour and attach to substrates rapidly. In temperate and cold seas, breeding is usually seasonal and restricted to the warmer season but in tropical waters it may continue throughout the year (Shenkar, 2008). Limited information on predators is available but they include some fish, molluscs and sea-stars. As some species are known to contain toxins which deter predators and settling larvae, most solitary and colonial species a great ability to rapidly repair any damage through vegetative growth (Butler et al., 2002). Based on the ALA search results for the survey area and EMBA, ascidians are likely to be present in the survey area.
Molluscs (Gastropod – abalone)	Univalve gastropods can live for up to 20 years and grow to a shell length of over 20 cm. Abalone feed on algae and predators include crabs, rock lobster, octopi, fish and rays. Blacklip abalone is the predominant species which is fished in the area although greenlip abalone is also present. Blacklip abalone is found in shallow depths between 5 to 20 m and can be found in caves and crevices and on sheltered reefs. Greenlip abalone is found in shallow reef habitats (5 to 40 m) and rough water at the base of steep granite cliffs. Abalone is a broadcast spawner with spawning with the species spawning from Spring to Autumn (Kailola et al., 1993). Abalone habitat is present along the west coast of King Island. Based on the ALA search results for the survey area and EMBA, molluscs are likely to be present in the survey area.
Molluscs (Cephalopod)	For information on cephalopods refer to Section 5.5.5
Crustaceans	Marine crustaceans form an extremely large, diverse arthropod taxon that includes animals such as crabs, lobsters, shrimps, prawns and krill. Like other arthropods, crustaceans have an exoskeleton, which they moult to grow. Crustaceans occupy a wide range of ecological niches, filling the roles of primary producers, predators and detritivores. Commercially important crustacean species include the SRL (Jasus edwardsii) and the giant crab (Pseudocarcinus gigas). Krill (Nyctiphanes australis) is a common coastal species in southern Australian waters endemic to the subtropical convergence zone and play an important role in the ecological significance of upwelling events. The species has a maximum weight of approximately 0.02 g, a maximum length of 17 mm, and estimated life span of one

Invertebrate	Description
	year and has a depth distribution of surface to 150 m water depths (Nicol & Endo, 1999). Studies into the feeding habits of krill identified that the species consumed detritus, diatom and crustacean fragments and sponge spicules (Dalley and McClatchie, 1989). The species occurs in dense aggregations close inshore off the coast of Tasmania (Nicol and Endo, 1997). The species broods its eggs until they hatch rather than spawning them directly into the water column. *N. Australis* reaches sexual maturity after about four months and the female lays several broods of eggs in one season). *N. australis* is one of the most important dietary items for jack mackerel, short-tailed shearwater, fairy prion, Australian salmon, skipjack tuna and tiger flathead as well as other abundant fish and seabirds (Nicol and Endo, 1997). Based on the ALA search results for the survey area and EMBA, crustaceans are likely to be present in the survey area.

Marine Canyons

The southwest part of the survey area overlaps multiple marine canyons, which incise the continental slope and connect the deep-sea of the Southern Ocean with the continental shelf of Bass Strait (Schlacher *et al*., 2007). These topographic and geomorphic features are known to be sites of enhanced biodiversity, particularly regarding benthic environments. Canyons are topographically complex seascapes, contain diverse bottom types, act as conduits for the passage of material down the continental slope and profoundly modify the hydrodynamic regime of the continental margin (Schlacher *et al*., 2007). Material sourced from the shallow continental shelf of Bass Strait is exported in the form of sediments and organic matter, including detached macrophytes such as kelp and seagrass. Due to the unique topographic characteristics of canyons and their generation of a non-uniform rise passage from the shelf to the seafloor, canyons can intensify mixing and the formation of cyclonic eddies (Allen et al., 2001). As such, canyons are sites of both upwelling (Kämpf 2005), and downwelling (Wåhlin 2002). These hydrodynamic effects can contribute to pelagic productivity, manifested in increased plankton biomass in and around canyons (Cartes et al., 1994, Genin 2004). This in turn may also contribute to canyons acting as critical fish habitats and refuges from bottom-contact fishing in areas of highly rugged topography (Yoklavich *et al*., 2000).

Sponges (Porifera) play a key structural and functional role in the marine benthos. Sponges can profoundly modify the physical properties of the seafloor and influence the composition, abundance, and distribution of the fauna (Bett & Rice 1992). The ecological significance of sponges arises from several traits and mechanisms. Sponges form dense aggregations (‘sponge beds’) significantly contributing to the biomass of benthic communities (Klitgaard & Tendal 2004, Conway *et al*. 2005). As structure-forming invertebrates, sponges add structural complexity and increase the diversity and quality of fish habitat (Pirtle 2005). They host a great diversity of other invertebrates (Henkel & Pawlik 2005). Sponges act as ecosystem engineers profoundly modifying the surrounding seafloor via current baffling, enhancement of bacterial biomass in sediments, sediment trapping, the creation of spicule mats, and the formation of biogenic structures and hard substratum in otherwise low-relief habitats (McClintock *et al*., 2005).

In 2004, seafloor mapping and collection of sponges was undertaken at five prominent marine canyons in southeast Australia. Four of these canyons are located within the EMBA including King Island Canyons, Hole Hole, Pieman Canyon and Big Horseshoe Canyon (Figure 5.16) (Schlacher *et al*., 2007). The survey identified a rich sponge fauna array in the canyons with a relatively small collecting effort. A total of 14 sled samples yielded 165 species, 65 genera, 41 families and 10 orders (Schlacher *et al*., 2007). Broad comparison with seamounts in the Tasman and Coral Seas indicate that the canyon megabenthos may rival or exceed that of seamounts in terms of sponge richness. Seamounts are conventionally regarded as benthic hotspots in the deep sea, characterised by high levels of benthic biomass, diversity and endemism (Richer de Forges et al., 2000). The comparatively high levels of species richness found in the canyons would thus suggest a broader role of abrupt topographies in generating areas of high megabenthic biodiversity in the deep sea. Strong currents in canyons (Wåhlin 2002) may enhance the food supply to filter feeders. Interactions between abrupt, sloping topographies, such as canyons, and impinging currents greatly amplify near-bottom flows, resulting in enhanced delivery of particulate food to sessile filter feeders including sea whips, sponges, and basket stars (Genin 2004).

The study found that sponge species richness declined with depth but was positively linked to spatial heterogeneity of bottom types (Schlacher *et al*., 2007). As such, it is likely that areas of the seafloor containing a broader range of bottom types (e.g., mixed rocky and sandy/muddy bottoms) contained more species than areas with more uniform seafloor properties. Site-to-site variation in diversity and species composition within individual canyons suggests that biological patterns are likely to be finer-grained than the spatial scale of conventional geomorphological units (Schlacher *et al*., 2007). Therefore, a single or a few canyons are unlikely to accurately represent the regional faunal diversity, because of the strong biotic separation of communities between canyons and the limited distributional ranges of the component species.

Figure 5.16 Marine Canyons sampled in southeast Australia

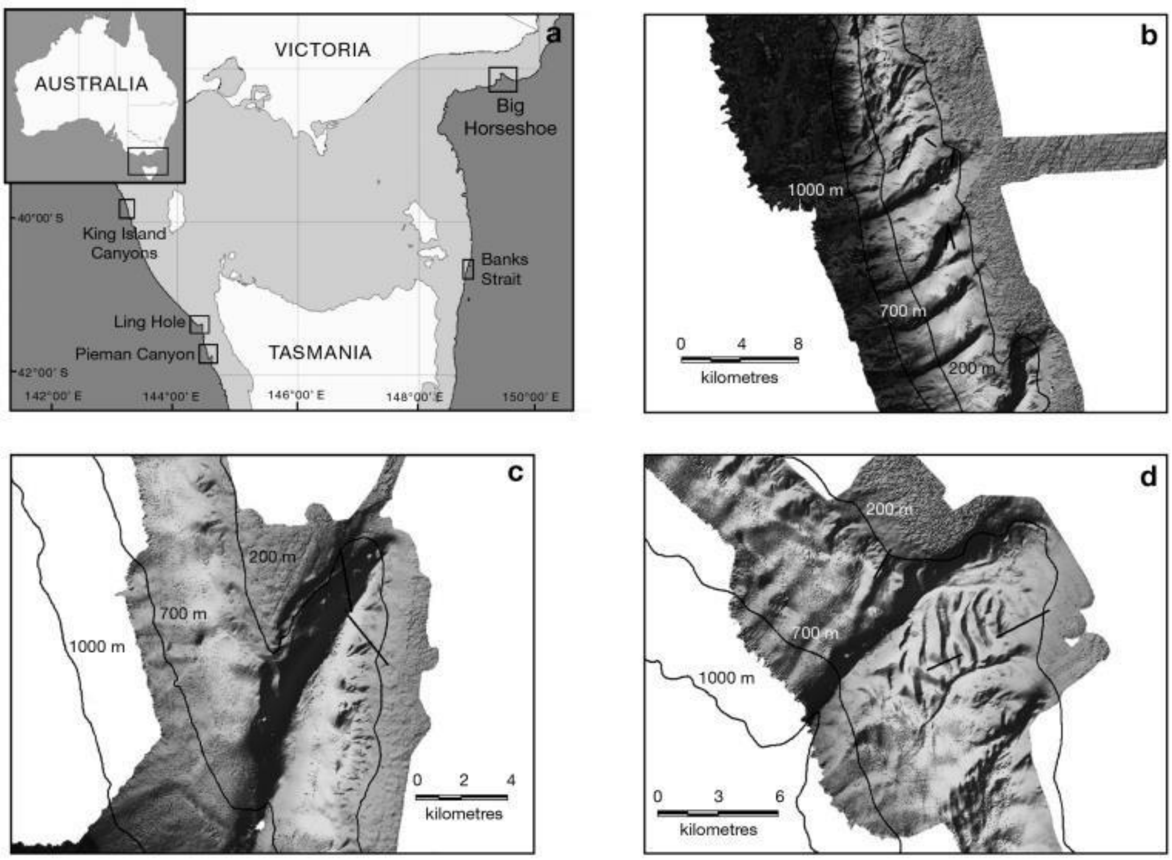


Fig. 1. (a) Locations of canyon sampling sites off southeastern Australia; (b) King Island canyons; (c) Pieman canyon; (d) Ling Hole canyon. Depth contours are 200, 700 and 1000 m as labelled; locations of sled transects are shown as straight lines

Source: Schlacher et al (2007).

Benthic species of key commercial interest have been identified in the survey area and EMBA. Descriptions of these target species are provided below.

Southern rock lobster

A comparison of presence and absence for the SRL between the database searches for the survey area and spill EMBA is presented in Table 5.11 below.

Table 5.11 Presence of Southern Rock Lobster according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No record	Recorded	No record
EMBA	No record	Recorded	Recorded

The southern rock lobster (SRL) (*Jasus edwardsii*) is a commercially important species that was recorded in the ALA database search of the survey area and EMBA. It is found on coastal reefs from the south-west coast of Western Australia to the south coast of New South Wales, including Tasmania and the New Zealand coastline. Southern rock lobsters are found to depths up to 150 m (DPI, 2009). In the Gippsland region, SRL habitat occurs as patchy, discontinuous low-profile reef running parallel to the coast.

The life cycle of the SRL is complex. After mating in April to July (SRL, 2021), fertilised eggs (numbering from 100,000 up to 1,000,000) are carried under the tail of the female for approximately 4-6 months before being released, typically between September and November. Once released, SRL larvae, or phyllosoma, live in the plankton and undergo 11 developmental stages over a period of between 12 and 24 monthss (Hartmann *et al*., 2013; SRL, 2021) while being carried by ocean currents, often far beyond the continental shelf.

In its submission to ConocoPhillips during the EP public exhibition phase, DPIPWE stated that the area west of King Island is an important source of SRL larvae to Tasmania, with larvae drifting eastward from South Australia and western Victoria. This is supported by Hartmann et al (2013), who state that modelling of larval dispersal suggests that Tasmanian recruits mainly originate from South Australia and Victoria (Hartmann *et al.*, 2013). FRDC (2021a) states that larval release occurs over wide spatial scales, and release across the continental shelf allows for good dispersal due to the high currents of southern Australian waters. Genetic analysis indicates that SRL present across southern Australia is a single stock (FDRC, 2021a). Recent stock assessments estimate that egg production in 2016-17 was 21% of the unfished level, indicating that stock biomass is unlikely to be depleted and that recruitment is unlikely to be impaired (FRDC, 2021a). Hartmann *et al* (2013) states that larvae are not retained inshore on the continental shelf (i.e., most of the survey area) but rather, they live in oceanic waters and are transported over large distances. There is also no pattern in historical stock data between levels of egg production and future recruitment, and variations in.

At the end of the phase of being carried by ocean current, phyllosoma larvae moult and metamorphose into a puerulus larvae (a transparent miniture version of the adult), still living in the water column but not feeding (SRL, 2021). During this phase, the puerulus swims towards the shore and when the puerulus encounter reef in shallower waters than their drifting phase, they settle and moult again and turn into pigmented juvenile lobsters (SRL, 2021).

SRL grow by moulting or shedding their exoskeleton, and the frequency of the moulting cycle declines with age from five moults a year for newly settled juveniles to once a year for mature adults. TSIC advises that moulting for adults occurs in September and October, with the new soft shell leaving the lobsters more vulnerable to predation. Males grow faster and larger than females, reaching 160 mm in carapace length after ten years. Females generally reach 120 mm in the same period. Growth rates also vary spatially, with growth faster in the east than in the west (DPI, 2009). It can take between three and 10 years for SRL to reach commercial fishing size (SRL, 2021).

Adult SRL are carnivorous and feed mostly at night on a variety of bottom dwelling invertebrates such as molluscs, crustaceans and echinoderms. The main predators of SRL are octopus, sharks and reef fish such as wrasse and ling (SRL, 2021). In Victoria, the abundance of SRL decreases from west to east reflecting a decreasing area of suitable rocky reef habitat (DPI, 2009). Most adult SRL remain within the same region (moving less than 1 km), though some tagged SRL have moved more than 80 km between inshore and offshore reefs (SRL, 2021). It is expected that where rocky reef is present in the survey area and spill EMBA, SRL are likely to be present.

Giant crab

A comparison of presence and absence for giant crab between the database searches of the survey area and EMBA is presented in Table 5.12 below.

Table 5.12 Presence of Giant Crab according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	Recorded	No records
EMBA	No records	Recorded	No records

The giant crab (*Pseudocarcinus gigas*) is a commercially important species in the region and endemic to the waters of southern Australia (DoE, 2014). The species resides on muddy or rocky bottoms in waters of the Southern Ocean at depths of 20–840 m, though is most abundant at 110–180 m (upper continental slope of the shelf) in the summer before moving deeper onto the upper slope at depths of 190–400 m in the winter, likely related to changing water temperatures (Levings & Gill, 2010). Williams *et al* (2009) notes that giant crabs observed during surveys along the continental slope were using ledges and sponges for shelter.

The species feeds on carrion and slow-moving benthic species including gastropods, crustaceans and starfish. They breed in June and July, and the female carries up to two million eggs for about four months. Upon hatching between October and November, the larval duration is around 50 days with larvae 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). Recruitment is not distributed evenly, with some areas having higher juvenile abundance than others, which is not a function of habitat but larval drift and ocean current movements (FRDC, 2021b).

The species is long-lived (30+ years) and slow-growing (reaching 12-14 cm length at maturity and up to 20 cm and 10 kg) (FRDC, 2021b). Juveniles moult their carapace every three to four years and adult females about once every nine years. This greatly limits the breeding frequency, as mating is only possible in the period immediately after the old carapace has been shed, and the new is still soft.

Harvesting of the species has been undertaken for decades, though total allowable catch has been decreasing in Victoria significantly since 2004 from 62 tonnes to just 10 tonnes by 2020 (VFA, 2020). Aspects of the species' biology (e.g., slow-growing and low breeding frequency) make the species vulnerable to overfishing.

Given its habitat preferences and mapped fishing activity (edge of the continental slope), giant crabs are known to be present in the shelf slope in the southwest of the survey area and most abundantly at 110-180 m depths.

Scallops

A comparison of presence and absence for commercial scallop between the database searches of the survey area and EMBA is presented in Table 5.13 below.

Table 5.13 Presence of Scallops according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	No records	No records

Commercial scallop (*Pecten fumatus*) is a commercially important species that are present throughout Bass Strait, with a distribution along the southeast Australian coast from central NSW, Victoria, SA and Tasmania. They are found partially buried in soft sediment ranging from mud to coarse sand. Scallops aggregate into beds, with healthy scallops recessing their convex right valve beneath the sediment such that the flat left valve is level or slightly below the sediment surface (AFMA, 2017a; Przeslawski *et al*., 2016b). Commercial scallops are mainly found at depths of 10-20 m but may also occur to depths of 120 m. While mainly sedentary, scallops can swim by rapidly opening and closing their shells, usually when disturbed by predators (AFMA, 2017a). Scallops feed on prey and detritus, while they are prey for starfish, whelks and octopus (AFMA, 2017a).

Scallops reach reproductive maturity after one year but do not spawn until the second year. Commercial scallops usually have a life span of between five and nine years, but wild populations have been known to die off rapidly after 3-5 years in some situations (AFMA, 2017a; Haddon *et al*., 2006). Adult scallops normally spawn over an extended period between June and November, with individuals producing up to one million eggs (AFMA, 2017a). In Victoria, a spawning peak appears to take place in spring (September, October and November) (DPI, 2005). Information provided by SIV indicates spawning occurs from September to December. Larval scallops drift as plankton for up to six weeks before first settlement, with peak settlement occurring in mid-late September (AFMA, 2017a; Przeslawski *et al*., 2016b). They attach to a hard surface such as seaweed or mussel and oyster shells and remain attached until reaching around 6 mm in length. The small scallops then detach themselves and settle into sediments and bury in so that only the top flat shell is visible. The juvenile scallops grow quickly and reach marketable size within 18 months (VFA, 2017). Scallop settlement is highly variable both temporally and spatially (VFA, 2017). Scallop populations are known to be highly variable and experience natural mortality rates ranging from 11% to 51% (DPI, 2005) and the population dynamics are poorly understood (Smith et al., 2016).

Harvesting of commercial scallop has been undertaken in Bass Strait for decades. As presented in Section 5.7.5, areas east of King Island within the EMBA have been the site of recent scallop fishing effort. It is clear that the seabed conditions of this area are conducive to commercial scallop fishing. However, no recent scallop fishing has been recorded in the waters of the survey area.

5.5.2. Plankton

Plankton is a key component in oceanic food chains and support nearly all marine life. Plankton is divided into two groups, namely phytoplankton (microscopic plants) and zooplankton (microscopic animals). Plankton is the dominant biomass of marine ecosystems (CSIRO, 2015).

Phytoplankton are photosynthetic organisms that drift with ocean currents and are mostly microscopic. They comprise of 13 divisions of microscopic algae, including diatoms, dinoflagellates, gold-brown flagellates, green flagellates and cyanobacteria and prochlorophytes (McLeay *et al*., 2003). The survey area lies within the 'temperate neritic' phytoplankton province based on Hallegraeff *et al* (2017) and Hayes et al (2005) (in Eriksen et al., 2019). Phytoplankton biomass is greatest at the extremities of Bass Strait (particularly in the northeast) where water is shallow, nutrient levels are high and ocean currents facilitate occasional planktonic blooms. Phytoplankton is grazed by zooplankton such as small protozoa, copepods, decapods and krill. CSIRO's Australian Ocean Data Network (AODN) contains possibly one data point within the survey area and three more in the immediate vicinity, all located on the continental shelf. These data (Australian Continuous Plankton Recorder [AusCPR] - Phytoplankton Abundance) shows that phytoplankton samples taken at these sites in August 2011 contained centric and pennate diatoms, dinoflagellates and silicoflagellates.

Zooplankton comprise of small crustaceans (such as krill), fish eggs and fish larvae. Zooplankton includes species that drift with the currents and those that are motile (i.e., capable of motion). CSIRO (2015) notes that copepods are the most common zooplankton and are the most abundant animals on earth. Watson and

Chaloupka (1982) reported a high diversity of zooplankton in eastern and central Bass Strait, with over 170 species recorded. However, Kimmerer and McKinnon (1984) reported only 80 species in their surveys of western and central Bass Strait. Many commercial fish and crustacean species (e.g., SRL) have early life stages as zooplankton before settling to the benthic habitat as juveniles or sub adults. CSIRO's Australian Ocean Data Network (AODN) contains possibly one data point within the survey area and five more in the immediate vicinity, all located on the continental shelf. These data (AusCPR - Zooplankton Abundance) shows that zooplankton samples taken at these sites in August 2011 were domainted by copepods, appendicularians, chaetognaths, cnidarians and thaliaceans, with the copepods belonging to the genera *Pleuromamma, Oithona, Clausocalanus* and *Acartia*.

In the EMBA, the seasonal Bonney upwelling is a productivity hotspot, with high densities of zooplankton and are important for fish and whales. This key ecological feature (KEF) is located 128 km northwest from the nearest point of the acquisition area (refer Section 5.1.7.1) and is described below, along with the West Tasmania Upwelling.

Bonney Upwelling

The primary ecological importance of the Bonney Upwelling is as a feeding area for the pygmy blue whale (PBW) (*Balaenoptera musculus brevicauda*). The upwelled nutrient-rich water promotes blooms of coastal krill (*Nyctiphanes australis*), which in turn attracts PBW to the region to feed. The upwelling is one of only three identified feeding areas consistently used by PBW in Australian coastal waters (Butler *et al*., 2002). The upwelling occurs when strong south-easterly surface winds induce warm, nutrient-deficient surface waters away from the coastline. This leads to surface upwellings bringing cool, nutrient-rich deep waters closer to the surface where there is enough sunlight for primary production among planktonic organisms to take place (Hosack & Dambacher, 2012).

Plankton distribution from the upwelling area is dependent upon prevailing ocean currents including the Leeuwin Current, East Australia Current, flows into and from Bass Strait and Southern Ocean water masses. Populations within the survey area are expected to be highly variable both spatially and temporally and are likely to comprise characteristics of tropical, southern Australian, central Bass Strait and Tasman Sea populations.

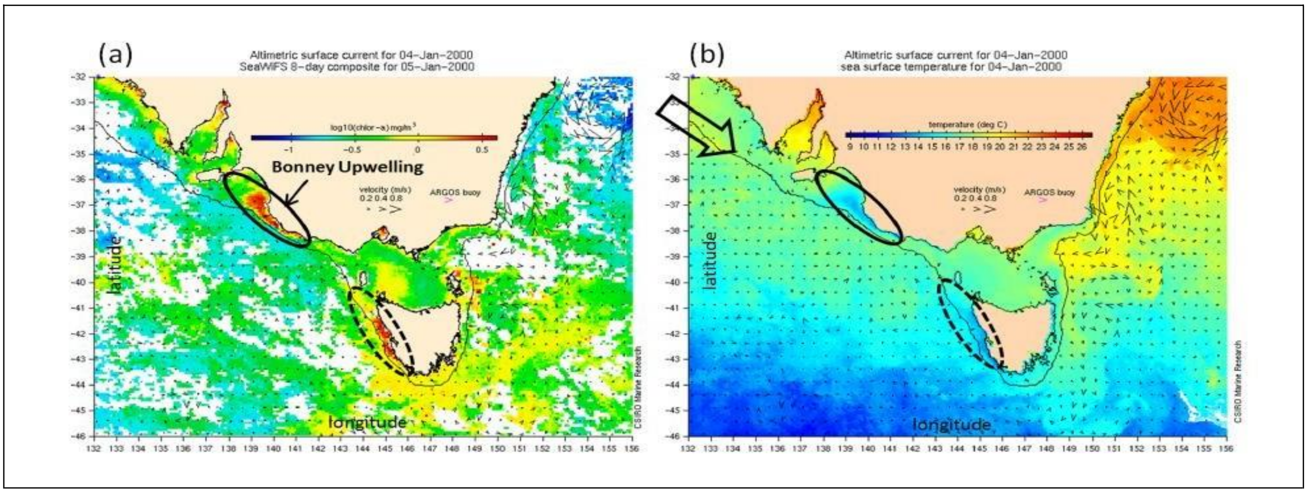
West Tasmanian Upwelling

A detailed analysis of satellite-derived ocean data (chlorophyll a levels) for the periods 1998-2000 and 2005-2014 suggests that the western Tasmanian shelf also accommodates a productive ecosystem (Figure 5.17). Based upon the Kampf (2015) study, this region forms part of the Great South Australian Coastal Upwelling System and experiences two phytoplankton blooms per annum:

1) The first and larger bloom - occurs in the late austral summer months (typically February-April) resulting from favourable winds that occur between December-April. Stronger upwelling winds do not always create phytoplankton blooms.
2) The second smaller bloom - occurs in spring (October) coincident with the onset of spring bloom in the western Tasman Sea. The mechanism for this smaller bloom remains unclear.

Kampf (2015) identifies that the accuracy of satellite data cannot be used to identify upwelling jets however would suggest the existence of upwelling jets on the western Tasmanian shelf. The significance of these jets is that they operate to disperse nutrient-rich water northwards along the shelf and possibly into western Bass Strait. This advective process would explain elevated chlorophyll a level in western Bass Strait – a typical feature of the region during austral summer months. The western Tasmanian upwelling system lies to the west of the Tasmanian mainland and at least 130 km southeast of the acquisition area.

Figure 5.17 Coastal Upwelling Event in early January 2000 evident in satellite derived distributions of (a) MODIS-OC3 chlorophyll a and (b) sea surface temperature. The large arrow in (b) indicates the pathway of the South Australian Current (Kampf, 2015)



5.5.3. Marine Flora

There is a paucity of publicly available information regarding the distribution and abundance of marine flora in Bass Strait, particularly in relation to the deeper waters of the survey area and spill EMBA.

A search of the VBA database for the survey area does not contain any marine flora records. However, VBA records for the EMBA include 139 species of marine flora including red, green and brown algae species. The most commonly recorded genera in the EMBA include *Caulerpa, Cystophora, Melanthalia, Phyllotricha, Plocamium, Rhodymenia, Sargassum* and *Zonaria*. The full list of marine flora species recorded within the EMBA is presented in Appendix 13.

The most abundantly recorded species include:

1) Crayweed (*Phyllospora comosa*) – 440 records. Type of temperate 'forest-forming' seaweed, important as habitat for many marine species and also for producing oxygen and capturing atmospheric carbon. It is found in the oceans around Australia and New Zealand.
2) Red algae (*Jania rosea*) – 377 records. Seaweed with hard, calcareous, branching skeleton and found in sheltered reef habitats, often in crevices or other shaded areas.
3) Brown algae (*Acrocarpia paniculata*) – 210 records. This dark brown seaweed is distributed from the GAB, around Tasmania, through to Port Stephens, NSW. Typically grows to 1 m long.
4) Red algae (*Cheilosporum sagittatum*) – 142 records. This species is a seaweed of temperate waters of Australia from Perth, WA, to Coffs Harbour, NSW, and around Tasmania.
5) Brown algae (*Ecklonia radiata*) – 142 records. Kelp species that is found around the world. The species grows in kelp beds on reefs and where sheltered it can form dense forests. It can be found in the low intertidal zone to depths of approximately 25m.
6) Red algae (*Amphiroa anceps*) – 141 records. Species is distributed all around Australia except for Tasmania.
7) Brown algae (*Cystophora retorta*) – 129 records. Species is from Nickol Bay, WA, to Wilsons Promontory, VIC, and around Tasmania.

The subtidal and intertidal rocky reefs of Bass Strait, located closer to the shoreline of Victoria and Tasmania, are understood to have a high diversity of plant species including seagrasses and macroalgae. In sheltered parts of shallow bays, inlets and estuaries, seagrasses establish extensive underwater meadows that are critical in the early life stages of many fish species (see Section 5.1).

5.5.4. Fish

It is estimated that there are over 500 species of fish found in the waters of Bass Strait, including a number of species of importance to commercial and recreational fisheries (LCC, 1993). Fish species commercially fished in and around the survey area are listed in Section 5.7.5.

There are 46 fish species listed under the EPBC Act with potential to occur in the EMBA and 33 with potential to occur in the survey area (Appendix 10). This includes 15 species listed as threatened, four species listed as migratory and a further 29 listed marine species all of which are Sygnathiformes (seahorses, pipefishes and their relatives) (Table 5.14). Threatened, migratory and marine species are described in this section.

A search of the VBA database for the survey area does not contain any records of fish species. For the EMBA, the VBA records 93 fish species including ray-finned and cartilaginous fish such as sharks, rays, leatherjackets, cowfish, wrasse, perch, gudgeon and hulafish (DELWP, 2020). These general species groupings are described in this section. The most abundantly recorded fish species in the VBA database search for the EMBA include:

- Blue throated wrasse (*Notolabrus tetricus*) – 132 records. This species is widespread in southeast Australia, from about Newcastle (NSW) to Port Lincoln (SA) and around Tasmania. The species usually inhabit deep exposed rocky reefs up to 160 m depth.
- Herring cale (*Olisthops cyanomelas*) – 95 records. This species is widespread in southern Australia from northern NSW to WA and around Tasmania. The species inhabits inshore rocky areas especially amongst kelp in the surge zone where it feeds on algae.
- Purple wrasse (*Notolabrus fucicola*) - 82 records. Found in southern and eastern Australia from Sydney Harbour to Kangaroo Island, SA, and coastal Tasmania. The species inhabits kelp beds on exposed and moderately exposed rocky reefs in depths up to 90 m.
- Mado (*Atypichthys strigatus*) – 68 records. Endemic to temperate waters of eastern and south-eastern Australia, from about Moreton Bay (Queensland) to Apollo Bay (Victoria) and northern and eastern Tasmania. The species is common on rocky reefs and around wharfs, jetties and pylons in coastal areas and in harbours, bays and large estuaries, in water depths up to 30 m.
- Sixspine leatherjacket (*Meuschenia freycineti*) – 59 records. This species is endemic to temperate waters of southern Australia, from south of Coffs Harbour, NSW, to Jurien Bay, WA, and around Tasmania. It is found on shallow to deep reefs in bays, harbours and along the coast in depths to 145 m; juveniles are common in sheltered areas, especially seagrass beds.

ALA database records for the survey area contain records for 40 species of cartilaginous fish with one species listed as conservation-dependent under the EPBC Act (school shark, *Galeorhinus galeus*) as well as 123 species of ray-finned fish.

The orange roughy (*Hoplostethus atlanticus*) and the blue warehou (*Seriolella brama*), both of which are listed as conservation-dependent under the EPBC Act, are recorded in the survey area and a description of these threatened species is provided in this section.

The ALA records 790 ray-finned fish in the EMBA, such as leatherjackets, bream, eels, flounder, cowfish, hatchetfish, dragonfish, pigfish, perch, goby, whiptails, dory, lanternfish, moray, whiting, weedfish, wrasse, flathead, flounder, pipefish, tuna and goatfish. A further 115 cartilaginous fish (sharks, skates and rays) are recorded by the ALA in the EMBA, including carpet sharks, sawsharks, stingrays, lantern sharks and wobbegongs. A description of these general species groupings is provided below.

Harrisson's dogfish (*Centrophorus harrissoni*), the southern dogfish (*C. zeehaani*) and the scalloped hammerhead (*Sphyrna lewini*) were identified in the ALA results for the EMBA and are listed as conservation-dependent under the EPBC Act.

A full list of fish species identified in the survey area and EMBA is presented in Appendix 12 and Appendix 13. Figure 5.18 presents the annual presence and absence of key species considered in this section.

A pre- and post- seismic survey assessment of fish species undertaken by CarbonNet adjacent the township of Golden Beach in Gippsland (360 km east of the acquisition area), recorded 637 individuals from 39 species before and 523 individuals from 43 species after. The survey found that the most abundant (and common) species recorded during both assessments was the barber perch (*Caesioperca razor*) (CarbonNet, 2020).

Table 5.14 EPBC-listed fish species that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
PMST								
Freshwater								
Galaxiella pusilla	Eastern dwarf galaxias	Vulnerable	-	-	No	Yes	-	Recovery Plan
Prototroctes maraena	Australian grayling	Vulnerable	-	-	Yes	Yes	-	Recovery Plan
Oceanic								
Carcharodon carcharias	Great white shark	Vulnerable	Yes	-	Yes	Yes	B, D, F	Recovery Plan
Carcharias taurus	Grey nurse shark (east coast population)	Critically Endangered	-	-	No	Yes	F, M	Recovery Plan
Epinephelus daemelii	Black rockcod	Vulnerable	-	-	No	Yes	-	Conservation Advice
Isurus oxyrinchus	Shortfin mako	-	Yes	-	Yes	Yes	-	-
Lamna nasus	Porbeagle	-	Yes	-	Yes	Yes	-	-
Rhincodon typus	Whale shark	Vulnerable	Yes	-	No	Yes	-	Conservation Advice
Pipefish, seahorses and seadragons								
Heraldia nocturna	Eastern upside-down pipefish	-	-	Yes	Yes	Yes	-	-
Hippocampus abdominalis	Big-belly Seahorse	-	-	Yes	Yes	Yes	-	-

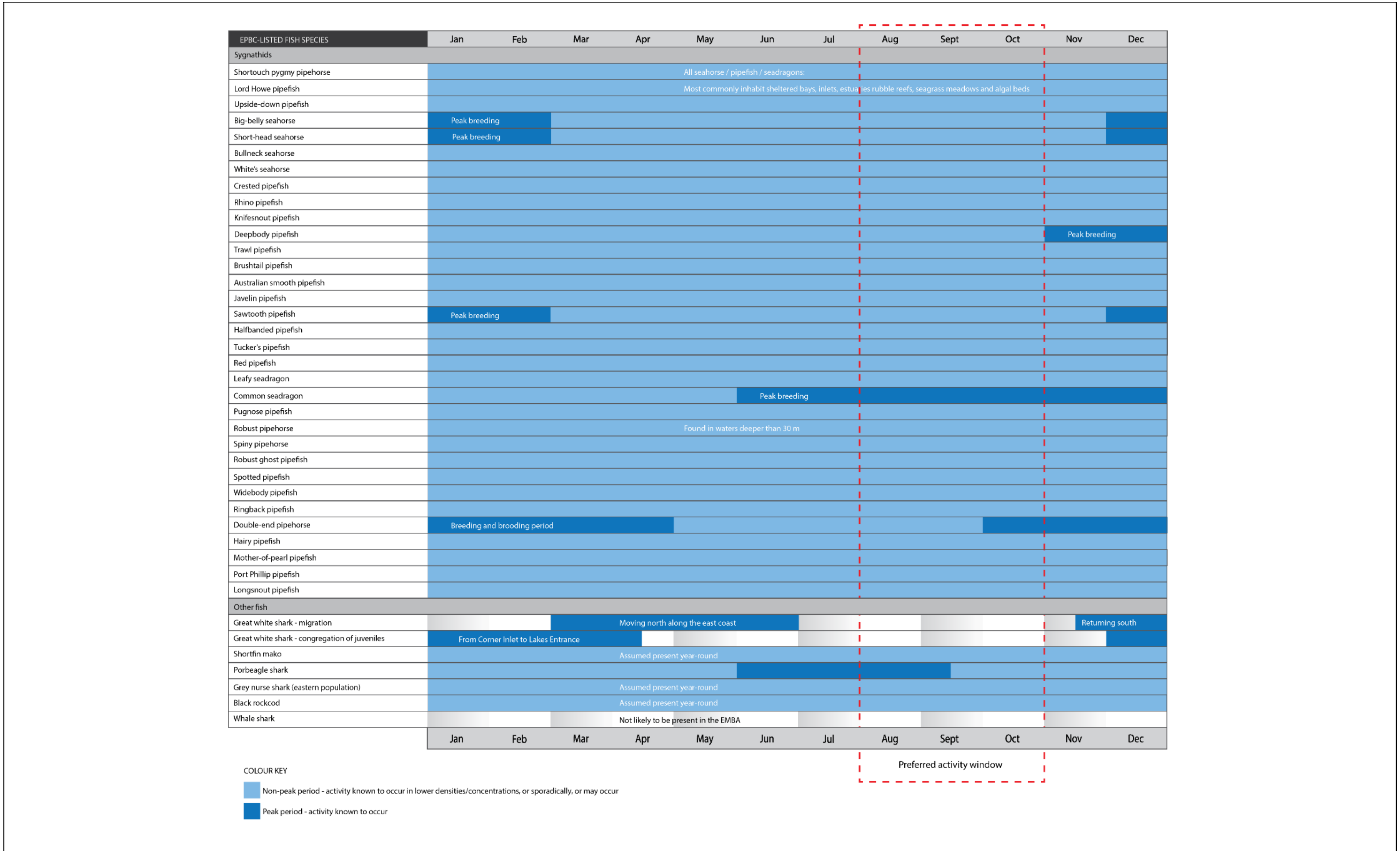
Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Hippocampus breviceps	Short-head seahorse	-	-	Yes	Yes	Yes	-	-
Hippocampus minotaur	Bullneck seahorse	-	-	Yes	No	Yes	-	-
Histiogamphelus briggsii	Crested pipefish	-	-	Yes	Yes	Yes	-	-
Histiogamphelus cristatus	Rhino pipefish	-	-	Yes	Yes	Yes	-	-
Hypselognathus rostratus	Knifesnout pipefish	-	-	Yes	Yes	Yes	-	-
Kaupus costatus	Deepbody pipefish	-	-	Yes	Yes	Yes	-	-
Kimblaeus bassensis	Trawl pipefish	-	-	Yes	No	Yes	-	-
Leptoichthys fistularius	Brushtail pipefish	-	-	Yes	Yes	Yes	-	-
Lissocampus caudalis	Australian smooth pipefish	-	-	Yes	Yes	Yes	-	-
Lissocampus runa	Javelin pipefish	-	-	Yes	Yes	Yes	-	-
Maroubra perserrata	Sawtooth pipefish	-	-	Yes	Yes	Yes	-	-
Mitotichthys mollisoni	Mollison’s pipefish	-	-	Yes	No	Yes	-	-
Mitotichthys semistriatu	Halfbanded pipefish	-	-	Yes	Yes	Yes	-	-
Mitotichthys tuckeri	Tucker's pipefish	-	-	Yes	Yes	Yes	-	-
Notiocampus ruber	Red pipefish	-	-	Yes	Yes	Yes	-	-
Phycodurus eques	Leafy seadragon	-	-	Yes	Yes	Yes	-	-
Phyllopteryx taeniolatus	Common seadragon	-	-	Yes	Yes	Yes	-	-
Pugnaso curtirostris	Pugnose pipefish	-	-	Yes	Yes	Yes	-	-
Solegnathus robustus	Robust pipehorse	-	-	Yes	Yes	Yes	-	-

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Solegnathus spinosissimus	Spiny pipehorse	-	-	Yes	Yes	Yes	-	-
Stigmatopora argus	Spotted pipefish	-	-	Yes	Yes	Yes	-	-
Stigmatopora nigra	Widebody pipefish	-	-	Yes	Yes	Yes	-	-
Stipecampus cristatus	Ringback pipefish	-	-	Yes	Yes	Yes	-	-
Urocampus carinirostris	Hairy pipefish	-	-	Yes	Yes	Yes	-	-
Vanacampus margaritifer	Mother-of-pearl pipefish	-	-	Yes	Yes	Yes	-	-
Vanacampus phillipi	Port Phillip pipefish	-	-	Yes	Yes	Yes	-	-
Vanacampus poecilolaemus	Longsnout pipefish	-	-	Yes	Yes	Yes	-	-
VBA								
Thunnus maccoyii	Southern bluefin tuna	Conservation Dependent	-	-	No	Yes	-	-
ALA								
Brachionichthys hirsutus	Spotted handfish	Critically Endangered	-	-	No	Yes	-	Conservation Advice
Brachiopsilus ziebelli	Ziebell's handfish	Vulnerable	-	-	No	Yes	-	-
Centrophorus harrissoni	Harrisson's dogfish	Conservation Dependent	-	-	No	Yes	-	-
Centrophorus zeehaani	Southern dogfish	Conservation Dependent	-	-	No	Yes	-	-

Galeorhinus galeus	School shark	Conservation Dependent	-	-	Yes	Yes	-	-
Hoplostethus atlanticus	Orange roughy	Conservation Dependent	-	-	Yes	Yes	-	-
Seriolella brama	Blue warehou	Conservation Dependent	-	-	Yes	Yes	-	-
Scientific name	**Common name**	**EPBC Act Status**			**Recorded in**		**BIA within the EMBA?**	**Recovery plan in place?**
		Listed threatened species	**Listed migratory species**	**Listed marine species**	**Survey area**	**EMBA**		
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	-	-	No	Yes	-	-

Definitions	
Listed threatened species:	A native species listed in Section 178 of the EPBC Act as either extinct, extinct in the wild, critically endangered, endangered, and vulnerable or conservation dependent.
Listed migratory species:	A native species that from time to time is 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.

Figure 5.18 The annual presence and absence of key threatened fish species and fish species of fishing value in the survey area and spill EMBA



Dwarf galaxias (EPBC Act: Vulnerable)

A comparison of presence and absence for the dwarf galaxias between the database searches of the survey area and spill EMBA is presented in Table 5.15 below.

Table 5.15 Presence of Dwarf galaxias according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	No records	No records

Habitat suitable to the dwarf galaxias is slow flowing and still, shallow, permanent and temporary freshwater habitats such as swamps, drains and the backwaters of streams and creeks, often (but not always) containing dense aquatic macrophytes and emergent plants (Saddlier *et al*., 2010; DELWP, 2015). Freshwater habitat does not occur within the survey area for this species. There are 46 rivers and wetlands that are listed in the Dwarf Galaxias Action Statement (DELWP, 2015) as being important to the species, none of which are intersected by the EMBA.

There are no records in the VBA or ALA of this species occurring within the EMBA. Neither database has records for this species in the survey area.

Australian grayling (EPBC Act: Vulnerable)

A comparison of presence and absence for the Australian grayling between the database searches of the survey area and spill EMBA is presented in Table 5.16 below.

Table 5.16 Presence of Australian Grayling according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	Recorded
EMBA	Recorded	Recorded	No records

The Australian grayling (*Prototroctes maraena*) is a dark brown to olive-green fish attaining 19 cm in length. The species typically inhabits the coastal streams of New South Wales, Victoria and Tasmania, migrating between streams and the ocean (Backhouse et al., 2008). Spawning occurs in freshwater, with timing dependant on many variables including latitude and varying temperature regimes (Backhouse et al., 2008). The species may be present in and around King Island, although these waters do not represent critical habitat for the species.

The National Recovery Plan for the Australian Grayling (Backhouse *et al*., 2008) lists threatening processes for this species as barriers to movement, river regulation, poor water quality, siltation, introduced fish, climate change, diseases and fishing. These impacts will not result from the activity and will not impact the five recovery objectives stated in the plan.

Great white shark (EPBC Act: Vulnerable)

A comparison of presence and absence for the great white shark between the database searches of the survey area and spill EMBA is presented in Table 5.17 below.

Table 5.17 Presence of Great white shark according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	No records

The great white shark (*Carcharodon carcharias*), a highly mobile migratory species listed as vulnerable, is widely distributed throughout temperate and sub-tropical regions in the northern and southern hemispheres. It is primarily found in coastal and offshore areas of the continental shelf and islands however has been caught in varying depths up to 1280 m (EA, 2002). White sharks are generally observed between the coast and the 100 m depth contour (Bruce *et al*., 2006) with areas of frequent encounter around seal colonies particularly when juveniles are present (EA, 2002). Australian fur-seal colonies are known to occur at Lady Julia Percy Island (Vic) (130 km northwest); Reid Rocks (Tas) (50 km east); and Seal Rocks (Vic) (162 km north east) (Shaughnessy, 1999). New Zealand fur-seal colonies occur at Cape Bridgewater (Vic) (180 km northwest); Lady Julia Percy Island (130 km northwest); Kanowna Island (Vic) (238 km east) and Maatsuyker Island (Tas) (421 km southeast) (Kirkwood *et al*., 2009).

White sharks do not feed exclusively on pinnipeds, feeding also on small cetaceans, finfish (e.g., snapper), other sharks, reptiles and seabirds (EA, 2002). Studies of white sharks sighted at pinniped colonies indicate the sharks appear to be largely transient with only a few longer-term residents (EA, 2002). The location of shark pupping areas in Australia is not known, however juveniles aggregate seasonally in certain areas such as Goolwa (SA), Corner Inlet-Lakes Entrance (Vic), Newcastle-Foster (NSW), Fraser Island (Qld) and Portland (Vic) (161 km northwest) (DOE, 2014d). White sharks appear to return on a seasonal basis and appear to have a degree of fidelity to certain areas (Bruce and Bradford, 2008).

The main threats faced by white sharks in Australian waters are from interactions with commercial and recreational fisheries and shark control programs (such as beach meshing or drum lining) (DAWE, 2020b).

The National Conservation Values Atlas (NCVA) identifies that the Sequoia 3D MSS area overlaps a known distribution BIA for the great white shark in the region. The known distribution BIA reflects areas used by white sharks as they move between nursery areas particularly for juvenile white sharks during autumn/winter/spring (DAWE, 2020b). The white shark may transit the survey area to nursery and foraging locations during the survey (Figure 5.19).

Shortfin mako shark (EPBC Act: Listed migratory)

A comparison of presence and absence for the shortfin mako shark between the database searches of the survey area and spill EMBA is presented in Table 5.18 below.

Table 5.18 Presence of Shortfin mako shark according to PMST, ALA & VBA database searches

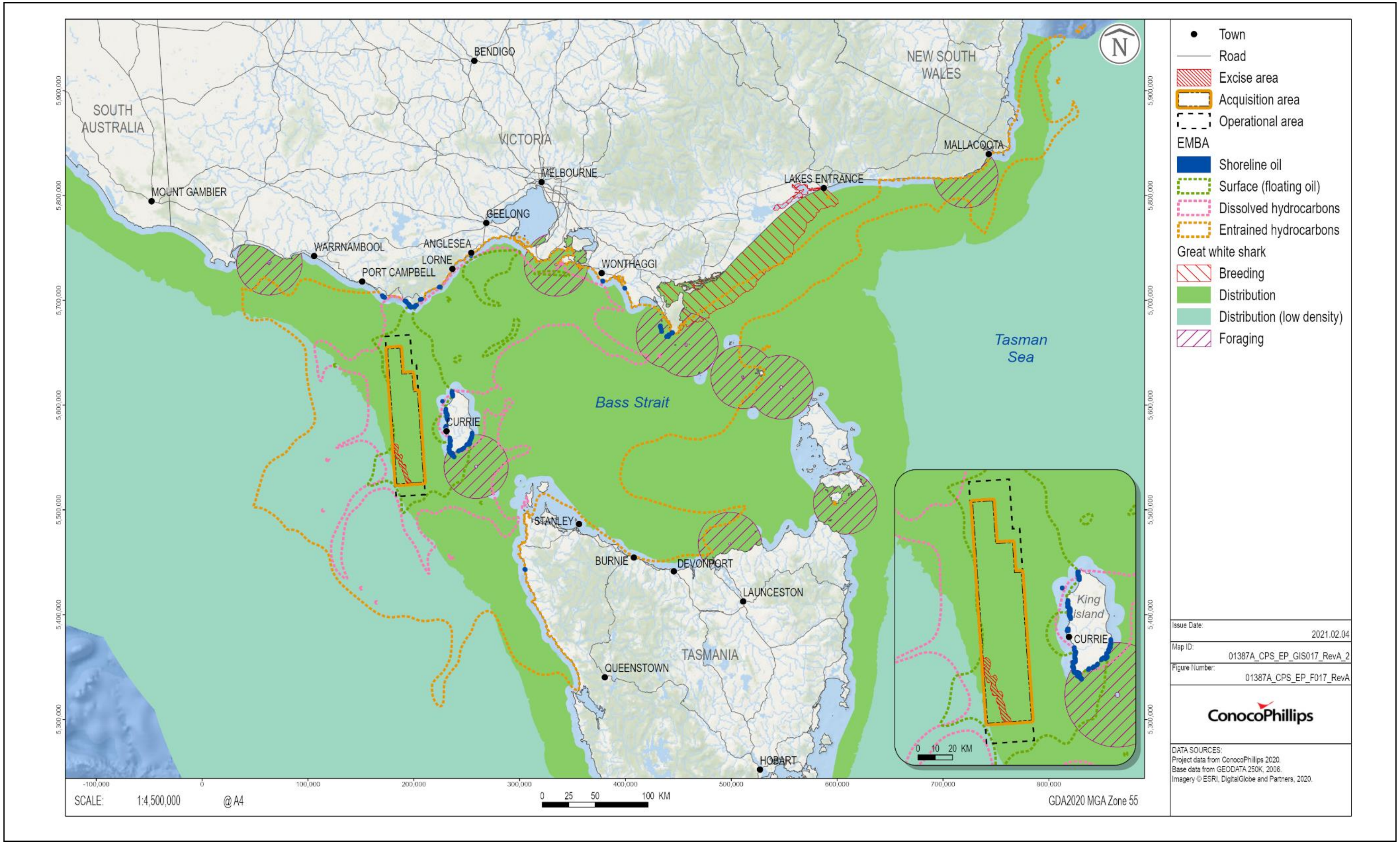
	PMST	ALA	VBA
Survey area	Recorded	Recorded	No records
EMBA	Recorded	Recorded	No records

The shortfin mako shark (*Isurus oxyrinchus*) listed as migratory, is found worldwide in tropical and temperate waters. They are pelagic oceanic swimmers but are occasionally found inshore. In warm, tropical oceans, they swim to depths of 500 m as they prefer cool water (about 18.5°C) however they are seldom found in waters colder than 16oC. The species feeds mainly upon squid and bony fishes including mackerels, tunas, bonitos and swordfish, but may also eat other billfish and small cetaceans (Last & Stevens, 2009).

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 survey area during the survey period however the NCVA does not identify that the survey area is important biological habitat for the species (DAWE, 2020c).

Figure 5.19 Great white shark BIA intersected by the survey area and the EMBA



Porbeagle (mackeral) shark (EPBC Act: Listed migratory)

A comparison of presence and absence for the porbeagle shark between the database searches of the survey area and spill EMBA is presented in Table 5.19 below.

Table 5.19 Presence of Porbeagle (mackeral) shark according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	No records

The porbeagle or mackerel shark (*Lamna nasus*) listed as migratory; is a pelagic, oceanic fish; prefers cool waters (temperatures below 16oC); has a depth range of 715 m and is distributed from latitudes 76°N to 59°S (Froese & Pauly, 2012). The species are abundant on continental shelves but are also found inshore. The mackerel shark feeds mainly on herring, mackerels; cod, white hake, red hake, haddock, cusk, and squid (WoRMs, 2018). Reproduction is oophagous with 1 to 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 Sequoia 3D MSS area is important biological habitat for the species (DAWE, 2020c).

Black rockcod (EPBC Act: Vulnerable)

A comparison of presence and absence for the black rockcod between the database searches of the survey area and spill EMBA is presented in Table 5.20 below.

Table 5.20 Presence of Black rockcod according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	No records

The black rockcod (*Epinephelus daemelii*) is a large cod species distributed in warm temperate to temperate marine waters of south-eastern Australia, from southern Queensland to Mallacoota in Victoria, and rarely south of this point (DSEWPC, 2012a). The species inhabits caves, gutters and crevices generally to depths of 50 m, with juveniles found inshore. Individuals are highly territorial and have small home ranges (DSEWPC, 2012a). The black rockcod is a protogynous hermaphrodite, meaning it changes sex from female to male during its life cycle. The species has declined in number due to angling and spearfishing (DSEWPC, 2012a). Given their known distribution, the black rockcod may occur in suitable habitat within the far-eastern extent of the EMBA north of Mallacoota. The ALA has records of this species occurring within the EMBA, though the VBA does not. Neither database has records for this species in the survey area.

Grey nurse shark (east coast population) (EPBC Act: Critically Endangered)

A comparison of presence and absence for the grey nurse shark between the database searches of the survey area and spill EMBA is presented in Table 5.21 below.

Table 5.21 Presence of Grey nurse shark according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	No records	No records

The grey nurse shark (*Carcharius taurus*) (east coast population) is a large robust species that has become critically endangered due to commercial fishing, spearfishing and protective beach meshing (DoE, 2014a). It was historically widespread in sub-tropical and warm temperate seas and previously recorded from all Australian states except Tasmania and have all but disappeared from Victorian waters (DoE, 2014a). The species currently has a broad inshore distribution throughout sub-tropical to cool temperate waters on the continental shelf, with separate east coast and west coast populations (DoE, 2014a). The east coast population extends from central Queensland to southern NSW, occasionally as far south as the NSW/Victoria border (DoE, 2014a), which coincides with the BIA for their migration and breeding (October to November). The southern extent of this BIA is intersected by the EMBA.

Preferred habitat for grey nurse sharks is inshore rocky reefs or islands, generally aggregating near the seabed in water depths of 10-40 m in deep sandy or gravel filled gutters, or in rocky caves (DoE, 2014a). There are no known aggregation sites located off the Victorian coast (DoE, 2014a). Given the current distribution of the grey nurse shark, it is unlikely to occur within the spill EMBA in significant numbers.

Whale shark (EPBC Act: Vulnerable, listed migratory)

A comparison of presence and absence for the whale shark between the database searches of the survey area and EMBA is presented in Table 5.22 below.

Table 5.22 Presence of Whale shark according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	No records	No records

The whale shark (*Rhincodon typus*) is the world's largest fish and one of only three filter feeding shark species (TSSC, 2015a). They have a broad distribution in warm and tropical waters of the world, and in Australia are known only to occur on the west coast of Western Australia, with a feeding aggregation occurring off the Ningaloo Reef between March and July each year (TSSC, 2015a). The species is not known to migrate through Bass Strait, and it is highly unlikely to occur within the survey area or the EMBA.

Blue warehou (EPBC Act: Conservation Dependent)

A comparison of presence and absence for the blue warehou between the database searches of the survey area and spill EMBA is presented in Table 5.23 below.

Table 5.23 Presence of Blue warehou according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	Recorded	No records
EMBA	No records	Recorded	No records

Blue warehou (Seriolella brama) is a highly mobile schooling species found in shelf and upper slope waters (50-300 m) that aggregate close to the seabed (AFMA, 2021). This species feeds on plankton, krill, crabs and small squid (AFMA, 2021). Eastern and western stock occur in southern Australian waters, with the survey area located in the western stock area (western Tasmania to western Victoria). The western stock is depleted due to overfishing (FRDC, 2021c).

Spawning has been recorded on the Tasmanian west coast from July to September with a peak in mid to late August (Bruce et al., 2001). Distribution of larvae suggests that the species spawns over a large area from Kangaroo Island to southern Tasmania with a major spawning grounds located on the central west and northwest coast of Tasmania. AFMA (2021) reports that spawning spawn an average of three times per season, producing between 430,000 and 1,350,000 eggs per spawning event. DNP (2013) reports that the Zeehan AMP, intersected by the survey area, is a likely nursery ground for blue warehou, with concentrations of larvae recorded in the park. A separate major spawning area occurs off eastern

Victorian/southern NSW with spawning approximately one month earlier than those of western Bass Strait (Bruce et al., 2001).

Orange roughy (EPBC Act: Conservation Dependent)

A comparison of presence and absence for the orange roughy between the database searches of the survey area and spill EMBA is presented in Table 5.24 below.

Table 5.24 Presence of Orange roughy according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	Recorded	No records
EMBA	No records	Recorded	No records

The orange roughy (*Hoplostethus atlanticus*) is a commercially important demersal fish species that is found in ridge and slope waters 180 – 1,800 m deep (DAWE, 2020b). Orange roughy are very long-lived, very slow to mature and have low fecundity relative to other bony fishes. Ageing studies show that they do not mature until their mid-20s to mid-30s, and may grow to 150 years of age. Although widespread, orange roughy migrate hundreds of kilometres to form spawning aggregations over seamounts between June and August in the Southern Hemisphere (DAWE, 2020b). They are synchronous spawners and form dense spawning and feeding aggregations. In 2006, orange roughy were listed as conservation-dependent in Australian waters, with most stocks reported to be well below 20% of estimated pre-fishing equilibrium biomass and closed to targeted fishing (DAWE, 2020b). While there are records for the orange roughy in the survey area, it is highly unlikely that the survey area is a spawning aggregation site due to the lack of seamounts in the area.

School shark (EPBC Act: Conservation Dependent)

A comparison of presence and absence for the school shark between the database searches of the survey area and spill EMBA is presented in Table 5.25 below.

Table 5.25 Presence of School shark according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	Recorded	No records
EMBA	No records	Recorded	No records

School shark (*Galeorhinus galeus*) is a widespread mainly coastal and bottom associated shark found in temperate areas over the continental shelf to about 800 m on the continental slope (DAWE, 2020b).

Juveniles are often found in shallow, inshore bays of Victoria and Tasmania. School sharks also occur well offshore in the Tasman Sea. Although usually found near the bottom, the species ranges through the water column even into the pelagic zone (DAWE, 2020b). The species feeds on bony fishes (bottom-dwelling and pelagic species), squid and octopus. Small juveniles feed on crustaceans, polychaete worms, gastropods and echinoderms. The species is fished throughout its range and heavily exploited due to the excellent quality of its flesh for eating.

Southern bluefin tuna (EPBC Act: Conservation Dependent)

A comparison of presence and absence for the southern bluefin tuna between the database searches of the survey area and spill EMBA is presented in Table 5.26 below. These records suggest it is unlikely that southern bluefin tuna live in or migrate through the survey area.

Table 5.26 Presence of Southern bluefin tuna according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	Recorded	Recorded

Southern bluefin tuna (*Thunnus maccoyii*) are recorded from every Australian state but absent from the coasts of the Northern Territory and northern Queensland, and very rare in central and western Bass Strait (DAWE, 2020b). Elsewhere the species is circum-global in temperate and cold temperate waters of the southern hemisphere. Southern bluefin tuna breed between October and March in an area off Java, Indonesia and migrate down the Western Australian coast during their first year (DAWE, 2020b). Some fish then head west into the Indian Ocean, while others head eastwards into the Great Australian Bight.

Southern bluefin tuna are an extremely valuable and highly prized commercial species. The Australian southern bluefin tuna industry is estimated to be worth more than $100 million annually. Historically the species was heavily fished, with catches reaching 80,000 tonnes per year during the 1960s but by the 1980s catches had halved resulting in quotas. The majority of Australia's Southern bluefin tuna quota is farmed in Spencer Gulf near Port Lincoln (750 km northwest), South Australia where fish are fattened up over several months before being harvested at 30-40 kg. From September to March, schools of mostly immature fish (aged 2-4 years) are enclosed in purse seines in the GAB (DAWE, 2020b) and then slowly towed to Port Lincoln in South Australia and transferred to floating sea cages anchored to the sea floor.

Spotted handfish (EPBC Act: Critically Endangered)

A comparison of presence and absence for the spotted handfish between the database searches of the survey area and spill EMBA is presented in Table 5.27 below.

Table 5.27 Presence of Spotted handfish according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	Recorded	No records

The spotted handfish (*Brachionichthys hirsutus*) is endemic to the Derwent Estuary (northern Tasmania) and adjacent areas in south-eastern Tasmania. It inhabits shallow protected coastal bays with sandy and shelly substrates at depths to 60 m (DSEWPC, 2012b). Spotted handfish prefer areas with features such as shallow shell-filled depressions created by large stingrays, and ripple formations, areas with stalked ascidians, or low relief rocks projecting from the substrate. The spotted handfish is an ambush predator that uses the lure to attract small benthic invertebrates including amphipods, small shrimps and polychaete worms (DSEWPC, 2012b). Spotted handfish spawn from September to October, and females attach an interconnected egg mass of 60–250 large eggs mostly onto stalked ascidians, but also on seagrass, sponges, hydroids or polychaete worm tubes. The female protects the eggs mass for 7-8 weeks until the young hatch.

Ziebell's handfish (EPBC Act: Vulnerable)

A comparison of presence and absence for Ziebell's handfish between the database searches of the survey area and spill EMBA is presented in Table 5.28 below.

Table 5.28 Presence of Ziebell's handfish according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	Recorded	No records

Ziebell's handfish (*Brachiopsilus ziebelli*) is known only from eastern and southern Tasmania - in the southern parts of the D'Entrecasteaux Channel, Cox Bight in south-west Tasmania, and the Forestier and Tasman Peninsulas, and off Bicheno, eastern Tasmania (DAWE, 2020b). The species inhabits rocky areas and soft bottoms, often near rocky patches with sponge and macroalgal communities. Females lay their egg masses around sponges in depths of about 20 m. On hatching, the young settle directly to the bottom near the egg mass (DAWE, 2020b).

Harrisson's dogfish (EPBC Act: Conservation Dependent)

A comparison of presence and absence for Harrisson's dogfish between the database searches of the survey area and spill EMBA is presented in Table 5.29 below.

Table 5.29 Presence of Harrisson's dogfish according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	Recorded	No records

In Australian waters, Harrisson's dogfish (*Centrophorus harrissoni*) is distributed off the Clarence River, New South Wales, to off South East Cape, Tasmania, and from Fraser Seamount, Queensland, to Taupo Seamount, NSW (DAWE, 2020b). Harrisson's dogfish populations are estimated to have declined by more than 90% in parts of their range off southern NSW and eastern Victoria. As a result, the species was listed as Conservation Dependent under the EPBC Act in June 2013.

Southern dogfish (EPBC Act: Conservation Dependent)

A comparison of presence and absence for the southern dogfish between the database searches of the survey area and spill EMBA is presented in Table 5.30 below.

Table 5.30 Presence of Southern dogfish according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	Recorded	No records

The southern dogfish (*Centrophorus zeehaani*) is distributed along the continental slope of southern Australia from off Forster (NSW) to Bunbury (WA), including Tasmania, in depths of 200–700 m, but usually in depths below 400 m (DAWE, 2020b). Southern dogfish undertake day-night migrations across their depth range from relatively deep daytime residence depths (1,000 m) to shallower night-time feeding depths (to 200 m). This species feeds mainly on fishes, crustaceans and squid - mostly on mesopelagic fishes and squid. It migrates up gullies on the continental slope to feed at night on mesopelagic fish that have migrated from deeper waters. Species in genus *Centrophorus* are vulnerable to over-exploitation due to the fact that they are long-lived, late to mature and have small litters (DAWE, 2020b).

This species habitat preferences indicates that it is likely to occur in the spill EMBA but not in the survey area.

Syngnathidae species (EPBC Act: Listed marine species)

There are 29 species of syngnathids (pipefish, seahorse and pipehorse) recorded in the PMST as potentially occurring in the spill EMBA (see Table 5.14). Browne et al (2008) identifies these species exist over a broad geographical range, however within this range their distribution is limited to suitable habitat which is determined by the species' camouflage, size, food source, behaviour and reproduction.

Species can inhabit seagrass and macro-algal habitats, reef habitats, 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 pipefish, seahorse and seadragon species prefer habitats in shallow bays and coastal waters, especially seagrass beds, and on reefs covered with macro-algae where they are well camouflaged. Pipehorses can be found in deeper continental shelf waters but little information on their distribution is available (McClatchie *et al*., 2006). Syngnathids utilise a swim bladder to control their depth within the water column. Given the water depth range of the Sequoia survey area and the seabed sediment type on the continental shelf, these syngnathid species are not expected to be present within the survey area but are likely to be present in the shallow waters of the spill EMBA where suitable habitat exists.

Fish Species Recorded in the ALA and VBA Database Search Results

In addition to the EPBC Act-listed fish species addressed in this section, the ALA records 790 ray-finned fish species and the VBA records 93 fish species within the EMBA. Among the more commonly recorded fish species are morwong, wrasse, perch and whiting. These groups are briefly described here. The full list of VBA records for fish species recorded in the EMBA is presented in Appendix 13, with those from the ALA in Appendix 12. Unless otherwise referenced, descriptive information is sourced from the Fishes of Australia online database (Museums Victoria, 2020).

Morwong

There are seven species of morwong (red, banded, crested, dusky, grey, jackass and blue) recorded in the ALA database within the spill EMBA. Generally, these species usually inhabit coastal waters up to a maximum depth of 400 m though more commonly from 20 m to 100 m. These species are frequently seen around exposed rocky reefs, occasionally near kelp patches and occasionally over adjacent sandy areas.

These species feed on a range of benthic invertebrates, including gastropod and bivalve molluscs, crustaceans, polychaete worms and small sea urchins.

Whiting

There are 15 species of whiting (blue weed, little weed, King George, southern school, western trumpeter, sand, eastern school, mud, trumpeter, stout, slender weed, pencil weed, longray weed and longtail weed) recorded in the ALA database within the spill EMBA. Whiting are coastal marine fish, of which 13 species

occur in Australian waters. The ‘weed’ whiting species recorded Inhabits bays, harbours and coastal waters, usually in seagrass beds and on shallow reefs with good algal cover, in depths of 1-15 m These species may form large schools over sandy and seagrass bottoms in estuaries and sheltered bays. In general, these species feed on polychaete worms, bivalves, gastropod molluscs, crustaceans (crab and amphipods), and ophiuroids. The pencil weed whiting also appear to set up cleaning stations to remove external parasites from other fish.

The largest and most popular of the whiting family is the King George Whiting (KGW). KGW inhabits bays, estuaries and coastal areas with seagrass, macroalgae or sand in depths to 200 m. While juveniles are abundant in seagrass beds, adults prefer deeper channels, gutters and offshore areas. At night, they may also feed in the shallows on the high tide. The species feeds by sucking up small invertebrates such as crustaceans, polychaete worms, molluscs and peanut worms from the substrate.

Given their habitat preferences and database records, it is likely that these whiting species are present in the coastal and shelf waters of the EMBA at all times of the year.

Wrasse

There are 18 species of wrasse (diamond, blackspotted, comb, Castlenau’s, snakeskin, cloud, pruple, crimsonband, inscribed, brownspotted, bluethroat, southern Maori, senator, redband, luculent, rosy, brokenline, bluehead) recorded in the ALA database within the spill EMBA. Wrasse are typically small fish (less than 20 cm long), widespread in southern Australian water, brightly coloured and most found at depths of 2 – 60 m (though the rosy wrasse occurs in depths up to 200 m). They are efficient carnivores, feeding on a wide range of hard-shelled benthic invertebrates such as gastropods, bivalve molluscs, crabs, chitons, limpets and sea urchins (Museums Victoria, 2020). Juveniles feed mostly on small crustaceans such as amphipods and isopods and have also been seen removing parasites from other fish. Generally, wrasses are found in shallow-water habitats such as coral reefs, rocky shores, sheltered sandy areas and in general association with reef habitat where they live close to the substrate. Given their habitat preferences, it is likely that these wrasse species are present within the shallow nearshore waters of the EMBA at all times of the year.

Perch

There are 16 species of perch (butterfly, barber, rosy, splendid, longfin, magpie, pearl, bigeye ocean, reef ocean, blackbanded, halfbanded, banded, eastern orange, Tasmanian, spot-tail and deepsea ocean) are recorded in the ALA database for the EMBA. Butterfly, barber and reef ocean perch are widely distributed across southern Australia and vary in their feeding behaviours. Butterfly and barber perch form large schools that feed on plankton above high-profile rocky reefs, outcrops and dropoffs of 4-100 m water depth. Magpie perch shelter in caves and crevices at night, often sheltering in small groups, where they feed by sucking benthic invertebrates such as molluscs and polychaete worms from the bottom sediment and patches of turf algae (Museums Victoria, 2020). Reef ocean perch feed on squid, shrimp and other fish among coastal rocky reefs and sandy areas usually in deeper water (up to 425 m). Estuary perch are endemic to coastal rivers and estuaries of south-eastern Australia, including coastal rivers in Bass Strait. Adults inhabit brackish water, preferring the upper reaches of estuaries. Adults migrate to the mouths of estuaries to spawn during winter. Given the diverse range of habitats inhabited by perch, these species are likely to be present in waters across the EMBA at all times of the year.

5.5.5. Cephalopods

The PMST and VBA do not record cephalopods (i.e., squid, octopus and cuttlefish) in the survey area or EMBA. However, the ALA database results for the survey area identified six cephalopod species comprising cuttlefish and squid. For the EMBA, the ALA records 32 species of cephalopod including squid, octopus, cuttlefish and nautilus. The full list of cephalopods identified through database searches of the survey area and EMBA are presented in Appendix 12.

Cephalopods are active mobile predators. Generally, cuttlefish and octopus eat crustaceans (including lobsters) living on or near the seabed while squid eat crustaceans and fish. Cephalopods have a high growth rate, their lifespan is short and there is a single reproductive season (Boyle & Rodhurst, 2005).

Cephalopods actively swim by jet propulsion and propagate by sexual reproduction. The individual size and number of eggs (released in a jelly like egg mass) during a reproductive season is variable and ranges from a few large eggs (< 30 mm long) attached to the seabed to numerous (>1 million) small eggs drifting in the plankton. The incubation period is highly temperature dependent and is completed with the hatching of the larval stage which resembles a miniature adult. After breeding the adults die within a short time and in species with a highly synchronised breeding population this can result in conspicuous mass mortality (Boyle & Rodhurst, 2005). Hatchlings have been collected in late spring to summer over a broad area of the southern Australian continental shelf, from 28oS in southern Queensland to 34oS in the western GAB (Jackson & McGrath-Steer, 2003).

Giant squid

The giant squid (Architeuthis sp.) is recorded in the survey area and EMBA. The species is a deep-water, active cephalopod that occur mostly in areas with submarine channels or canyons that cut transversally across the continental shelf features with suitable habitat including high productivity (Guerra et al., 2011).

Habitat water depths are estimated at 500 to 1,000 m (Landman et al., 2004), which are coincident with deep-water trawl fisheries (recorded as the main threat to the species) (Guerra et al., 2011). Studies, combined with photographic evidence, identify the giant squid to be a highly active predator with considerable strength (Winkelmann et al., 2013) and estimates of lifespan vary from 3 to 13 years (Landman et al., 2004). Deepwater pelagic cephalopods and fish are prevalent in gut contents of trawled giant squid, with a diversity of shallow-water benthic or sessile organisms in guts of stranded specimens (Bolstad & O'Shea, 2004). On this basis the species appears to be a pelagic rather than a bentho-pelagic species (Bolstad & O'Shea, 2004).

The location and type of spawning of giant squid are unknown however the eggs are likely to be planktonic as in other squids (Guerra et al., 2011). The species is globally distributed, reported to be from one global species (low genetic diversity) and that it is extremely vagile, possibly dispersing through both a drifting larval stage, or migration of larger individuals (Winkelmann et al., 2013). Given its habitat preferences and rarity, it is considered unlikely to present in the EMBA or survey area at the time of operations.

Gould's squid

Gould's squid (Nototodarus gouldi) is typically found at depths from 50 – 200 m off the subtropical and

temperate coasts of Australia (Atlas of Living Australia, 2020). Gould's squid feeds on crustaceans, fish and cephalopods at night and is in turn prey for birds, large fish, sharks and marine mammals (O'Sullivan and Cullen, 1983). The species is commercially harvested using jigging by the Southern Squid Jig Fishery (see Section 5.7.5) and the population size in Bass Strait varies from year to year. This is primarily due to its short life cycle, the 'boom and bust' nature of its population dynamics and life history characteristics. Gould's squid are likely to be present in the survey area and spill EMBA.

Octopus

The pale octopus (Octopus pallidus) is recorded in the survey area and EMBA. This species is commercially targeted and distributed in Bass Strait where it occurs on sand substrates, often in association with sponge gardens or beds of sea squirts (Museums Victoria, 2020). The species emerges at night to feed on crustaceans and shellfish and spends most of the day camouflaged and hiding (Museums Victoria, 2020). Maori octopus (Octopus maorum), which was recorded in the ALA database search for the EMBA but not survey area, feeds during the day on crabs, abalone, crayfish, mussels, fish and other octopuses (ALA, 2020). The Maori octopus is Australia's largest octopus and forms lairs in crevices and burrows in rocky reef and seagrass meadows where prey species are abundant. Pale octopus and Maori octopus are targeted by the Tasmanian Octopus Fishery (see Section 5.7.5) where they are harvested using unbaited pots. Both species are likely to be present in the spill EMBA.

5.5.6. Cetaceans

Cetaceans are a group of marine mammal that include whales, dolphins and porpoises.

The PMST lists 35 cetacean species that may reside within or migrate through the survey area or EMBA. Of these, five species are listed as threatened, these being the blue whale (*Balaenoptera musculus*), humpback whale (Megaptera novaeangliae), southern right whale (SRW) (*Eubalaena australis*), fin whale (*Balaenoptera physalus*) and sei whale (*Balaenoptera borealis*). Eleven cetaceans are listed as migratory.

Table 5.31 provides details of the species which are listed under the EPBC Act which may have habitat within the survey area and EMBA. A description of species listed in Table 5.31 with a focus on threatened whale species and migratory dolphin species is provided in this section.

Figure 5.20 illustrates the presence and absence of the threatened cetacean species in the survey area and EMBA throughout the year.

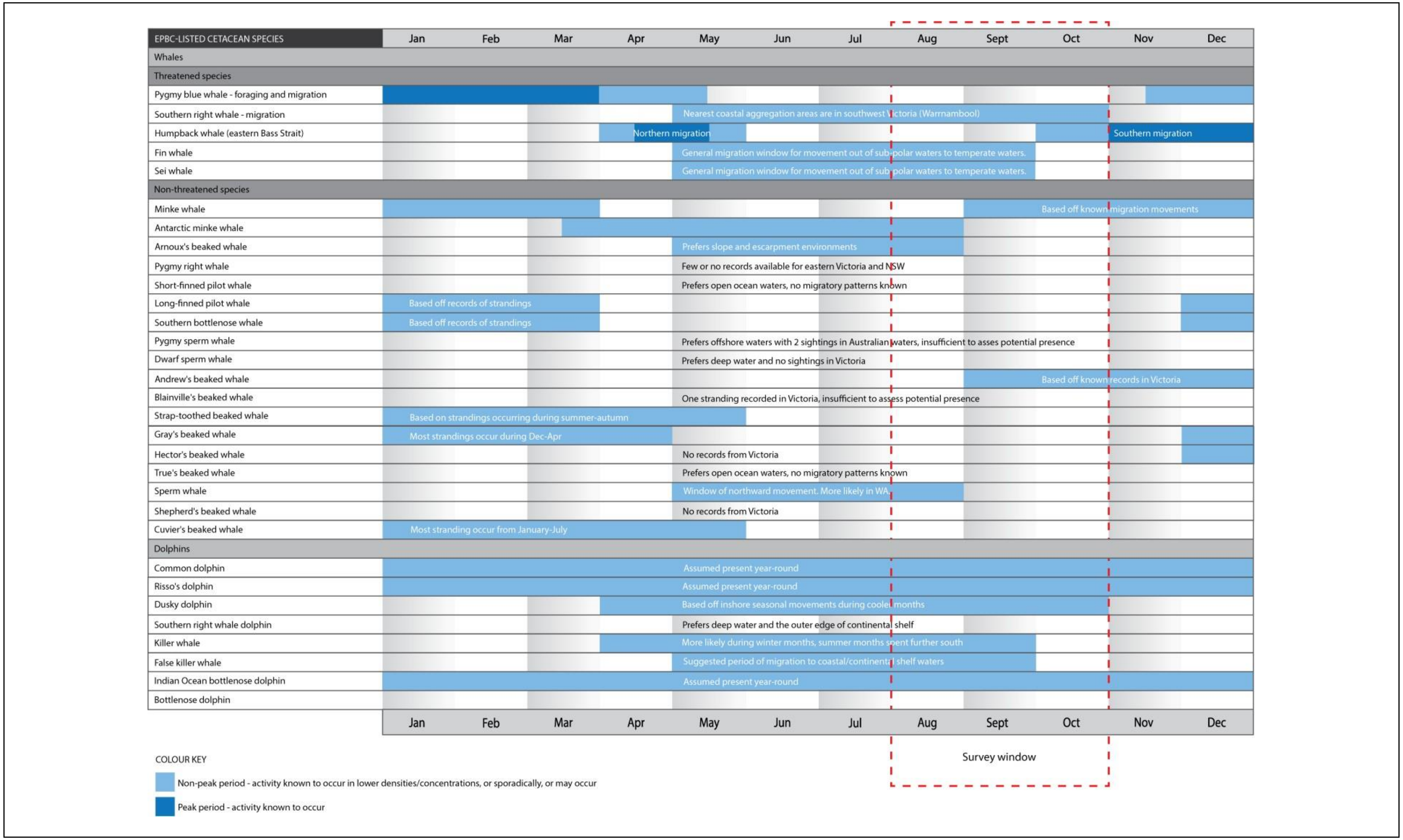
Table 5.31 EPBC-listed cetacean species that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
PMST								
Whales								
Balaenoptera acutorostrata	Minke whale	-	-	Yes	Yes	Yes	-	-
Balaenoptera bonaerensis	Antarctic minke whale	-	Yes	Yes	Yes	Yes	-	-
Balaenoptera borealis	Sei whale	Vulnerable	Yes	Yes	Yes	Yes	-	Conservation Advice
Balaenoptera edeni	Bryde's whale	-	Yes	Yes	No	Yes	-	-
Balaenoptera musculus	Blue whale	Endangered	Yes	Yes	Yes	Yes	F	Recovery Plan
Balaenoptera physalus	Fin whale	Vulnerable	Yes	Yes	Yes	Yes	-	Conservation Advice
Berardius arnuxii	Arnoux's beaked whale	-	-	Yes	Yes	Yes	-	-
Caperea marginata	Pygmy right whale	-	Yes	Yes	Yes	Yes	-	-
Eubalaena australis	Southern right whale	E	Yes	Yes	Yes	Yes	D	Conservation Management Plan
Globicephala macrorhynchus	Short-finned pilot whale	-	-	Yes	Yes	Yes	-	-
Globicephala melas	Long-finned pilot whale	-	-	Yes	Yes	Yes	-	-

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Hyperoodon planifrons	Southern bottlenose whale	-	-	Yes	No	Yes	-	-
Kogia breviceps	Pygmy sperm whale	-	-	Yes	Yes	Yes	-	-
Kogia simus	Dwarf sperm whale	-	-	Yes	Yes	Yes	-	-
Megaptera novaeangliae	Humpback whale	Vulnerable	Yes	Yes	Yes	Yes	F	Conservation Advice
Mesoplodon bowdoini	Andrew's beaked whale	-	-	Yes	Yes	Yes	-	-
Mesoplodon densirostris	Blainville's beaked whale	-	-	Yes	Yes	Yes	-	-
Mesoplodon grayi	Gray's beaked whale	-	-	Yes	Yes	Yes	-	-
Mesoplodon hectori	Hector's beaked whale	-	-	Yes	Yes	Yes	-	-
Mesoplodon layardii	Strap-toothed beaked whale	-	-	Yes	Yes	Yes	-	-
Mesoplodon mirus	True's beaked whale	-	-	Yes	Yes	Yes	-	-
Physeter macrocephalus	Sperm whale	-	Yes	Yes	Yes	Yes	-	-
Tasmacetus shepherdi	Shepherd’s beaked whale	-	-	Yes	No	Yes	-	-
Ziphius cavirostris	Cuvier's beaked Whale	-	-	Yes	Yes	Yes	-	-
Dolphins								

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Delphinus delphis	Common dolphin	-	-	Yes	Yes	Yes	-	-
Grampus griseus	Risso's dolphin	-	-	Yes	Yes	Yes	-	-
Lagenorhynchus obscurus	Dusky dolphin	-	Yes	Yes	Yes	Yes	-	-
Lissodelphis peronii	Southern right whale dolphin	-	-	Yes	Yes	Yes	-	-
Orcinus orca	Killer whale	-	Yes	Yes	Yes	Yes	-	-
Pseudorca crassidens	False killer whale	-	-	Yes	Yes	Yes	-	-
Tursiops aduncus	Indian ocean bottlenose dolphin	-	-	Yes	No	Yes	-	-
Tursiops truncatus s. str.	Bottlenose dolphin	-	-	Yes	Yes	Yes	-	-
VBA								
No additional species identified.								
ALA								
No additional species identified.								

Figure 5.20 The annual presence and absence of threatened cetacean species that potentially occur in the survey area and EMBA



Sei whale (EPBC act: Vulnerable, listed migratory)

A comparison of presence and absence for the sei whale between the database searches of the survey area and spill EMBA is presented in Table 5.32 below.

Table 5.32 Presence of sei whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

Sei whales (*Balaenoptera borealis*) are primarily found in deep water oceanic habitats and their distribution, abundance and latitudinal migrations are largely determined by seasonal feeding and breeding cycles (TSSC, 2015b). These whales are thought to complete long annual seasonal migrations from subpolar summer feeding grounds to lower latitude winter breeding grounds (TSSC, 2015b); details of this migration and whether it involves the entire population are unknown.

Sei whale global population is estimated to have declined by 80 % over the previous three generation period (TSSC, 2015b).

In the Australian region, sei whales occur within Australian Antarctic Territory waters and Commonwealth waters, and have been infrequently recorded off Tasmania, New South Wales, Queensland, the Great Australian Bight, Northern Territory and Western Australia (TSSC, 2015b). There is no known mating or calving areas in Australian waters (TSSC, 2015b).

Sei whales have been sighted 20 to 60 km offshore on the continental shelf in the Bonney Upwelling (128 km northwest of the survey area) opportunistically feeding (Gill et al., 2015). Gill et al (2015) observed 14 individual whales in 12 sightings between November and May for all 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 for foraging at least opportunistically. Recorded sightings for the months of observation are listed below (per 1,000 km of surveyed distance) (no observations undertaken in months not listed):

- September – 0 whales sighted;
- October – 0 whales sighted;
- November – 0.25 whales sighted;
- December – 0.07 whales sighted;
- January – 0.04 whales sighted;
- February – 0.84 whales sighted;
- March – 0.19 whales sighted;
- April – 0 whales sighted; and
- May – 0.21 whales sighted.

The NCVA does not identify any BIA for this species within Australian waters (DAWE, 2020c).

Based on available sighting and upwelling data, it is considered unlikely that this species occurs in the survey area during the survey period (September and October).

Blue whale (EPBC Act: Endangered, listed migratory)

A comparison of presence and absence for the blue whale between the database searches of the survey area and spill EMBA is presented in Table 5.33 below.

Table 5.33 Presence of Blue whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	Recorded	No records
EMBA	Recorded	Recorded	Recorded

The blue whale (*Balaenoptera musculus*) is present in waters off Australia's Antarctic Territory and is widespread in all Australian waters at various times of the year (DAWE, 2020b). The species is oceanic and appears to undertake extensive migrations between warm water (low latitude) breeding areas and cold-water feeding grounds during summer between approximately 20oS and 60-70oS (Bannister et al., 1996; DoE, 2015b). Migration pathways are not known however it is thought the species migrates to Antarctic waters in early summer and leaves in autumn migrating to tropical breeding areas (Indonesian and possibly southwest Pacific waters) during winter (DAWE, 2020b). Blue whales have extensive, global migration patterns that are not known to follow particular coastlines or oceanographic features (Bannister et al., 1996). Exact breeding ground locations are also not known (Bannister et al., 1996) however it is thought a region in deep oceanic waters around the Indonesian archipelago may be significant (DAWE, 2020b).

Migration

There are two recognised subspecies of the blue whale in Australian waters - the true blue whale (*Balaenoptera musculus intermedia*) and the PBW (*Balaenoptera musculus brevicauda*). PBW do not migrate as far south (to approximately 55oS) as the true-blue whale (Bannister et al., 1996). While true blue whales appear to feed mainly, if not exclusively, in the Antarctic, PBW feed in more temperate latitudes. It is therefore likely that records of blue whales feeding in Australian waters between late spring-autumn are PBW (DEH, 2005b). The PBW feeds on pelagic crustaceans (zooplankton including krill, salps and copepods) (DAWE, 2020b). Krill has strong swimming abilities (McClatchie *et al*., 2006b) with vertical migration within the water column between 10-40 m. The PBW distribution around Australia is provided in Figure 5.21 and migration pathways are provided in Figure 5.22.

Photo-identification has confirmed within and between season movement of PBW 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).

The Subtropical Front (confluence of sub-tropical and subantarctic waters between 40-45oS) is likely to be a large-scale feeding area (Mikhalev, 2000; cited in DAWE, 2020b). 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 DAWE, 2020b) (Figure 5.23). 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 PBW 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 DAWE, 2020b).

Figure 5.21 PBW distribution around Australia (DoE, 2015b)

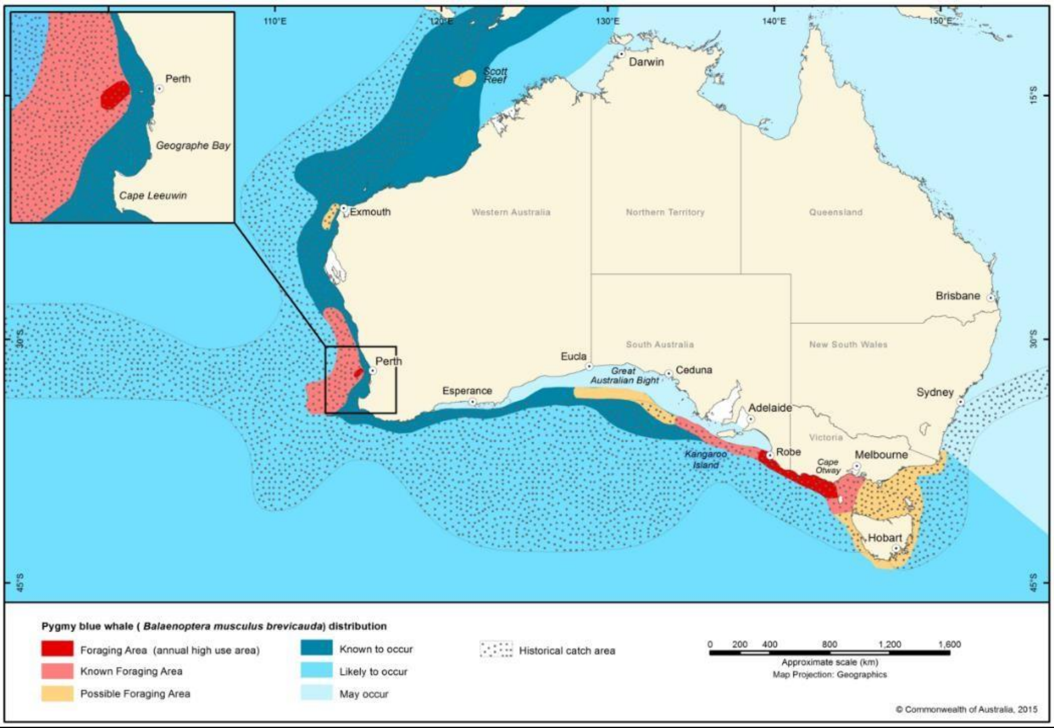


Figure 5.22 PBW migration routes (DoE, 2015b)

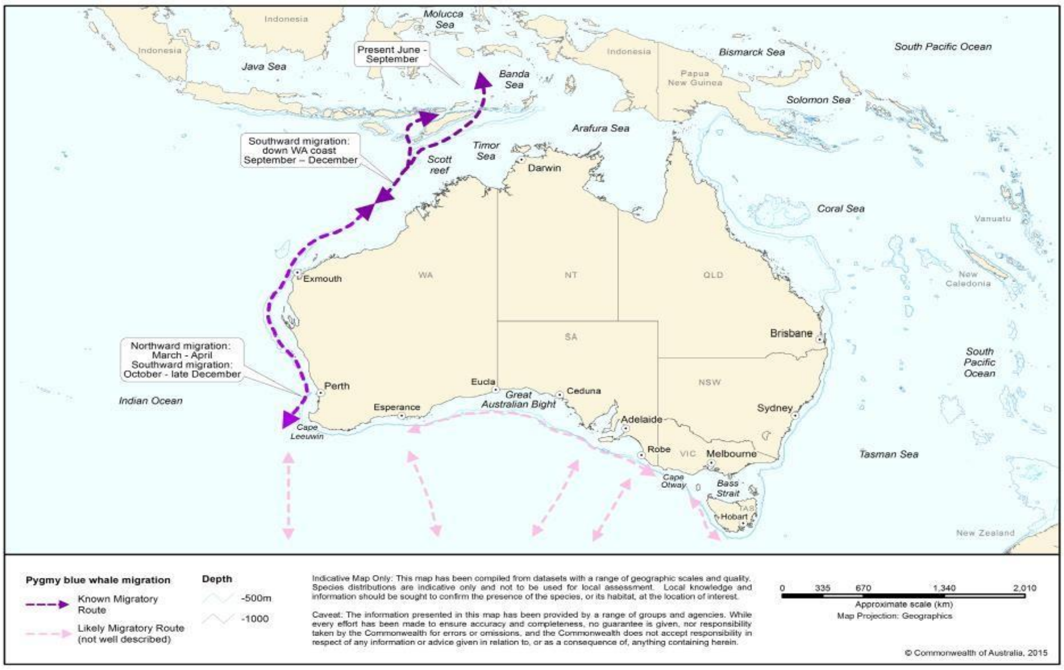
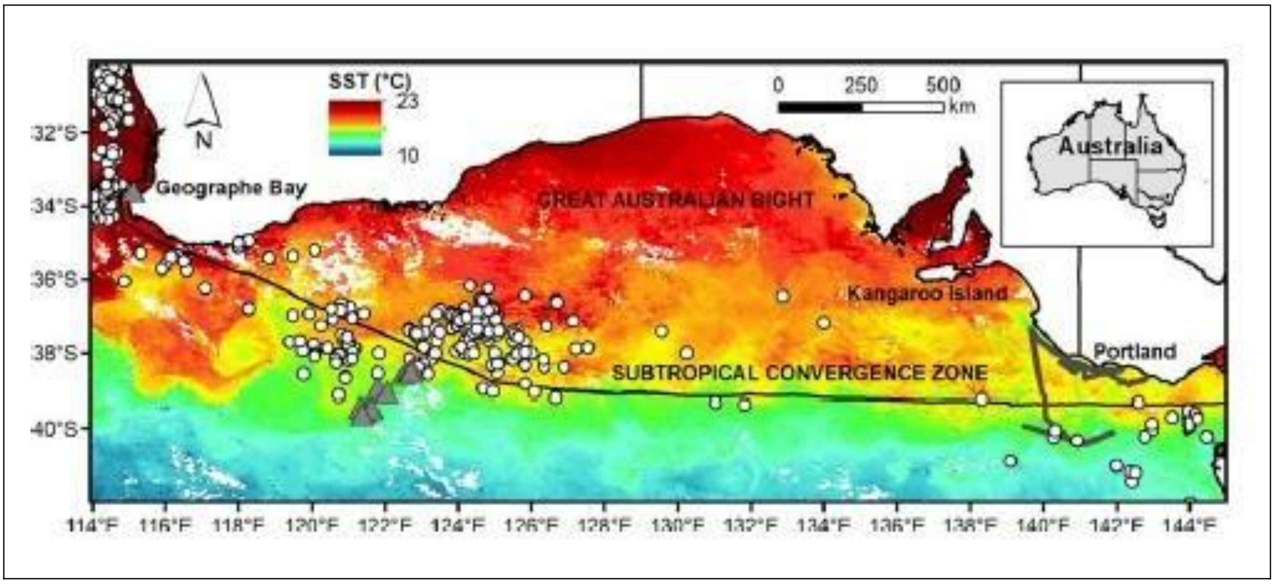


Figure 5.23 Satellite tracking of PBW individuals in the STC zone between 4th of December 2002 – 31st of January 2003 (grey triangles) and historical Soviet whaling catches of PBW (white circles) (Garcia, Rojas *et al.*, 2018)



PBW temporal presence in the Otway Basin

Key feeding areas within Australian waters for the PBW are the Bonney upwelling system, adjacent waters off South Australia and Victoria, and presented in Figure 5.6. The continental shelf area between Robe and Cape Otway is a foraging area with high annual use where the PBW feed on abundant swarms of coastal krill (*Nyctiphanes australis*) nourished by the Bonney Upwelling, a seasonal event where nutrient rich cold waters are pushed to the surface from the deeper ocean (DoE, 2015b) (refer to Section 5.1.7.1). PBW are known to feed predominantly between January to April although within-season variation and distribution trends in Bass Strait have been observed (Gill, 2020). Distribution and timing of PBW in the Bonney upwelling can vary (Gill, 2020). During November and December 2012, large numbers of PBW were sighted in the eastern area of the Bonney Upwelling, just west of Bass Strait (DoE, 2015).

Branch et al (2007), based upon PBW 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 from November and December. Aerial surveys (1998-2001) did not sight PBW 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 DAWE, 2020b).

The Blue Whale Study (BWS), the longest-running blue whale research program in the Southern Hemisphere, undertook a review of relevant research projects pertaining to PBW presence in the Otway Basin (Gill, 2020). The primary research method utilised by BWS was aerial surveys, complemented to a lesser degree by yacht- and small vessel-based studies. Between 1998 and 2003, aerial surveys established the distribution of PBW as presented in Figure 5.24 (Gill, 2020), which correlated to surface swarms of krill during the same period (Figure 5.25). At that time, surveys did not extend beyond Robe or Cape Otway. During the surveys, PBW were sighted between November to May and were absent during surveys conducted between June - October (Gill, 2020). The presence of PBW coincided with the period of active upwelling and the period immediately after active upwelling (April – May) when the region is still enriched by the upwelling (Gill, 2020).

Figure 5.24 Sightings of PBW from aerial survey during 1998 – 2003. Bathymetry shown to 200 m isobath

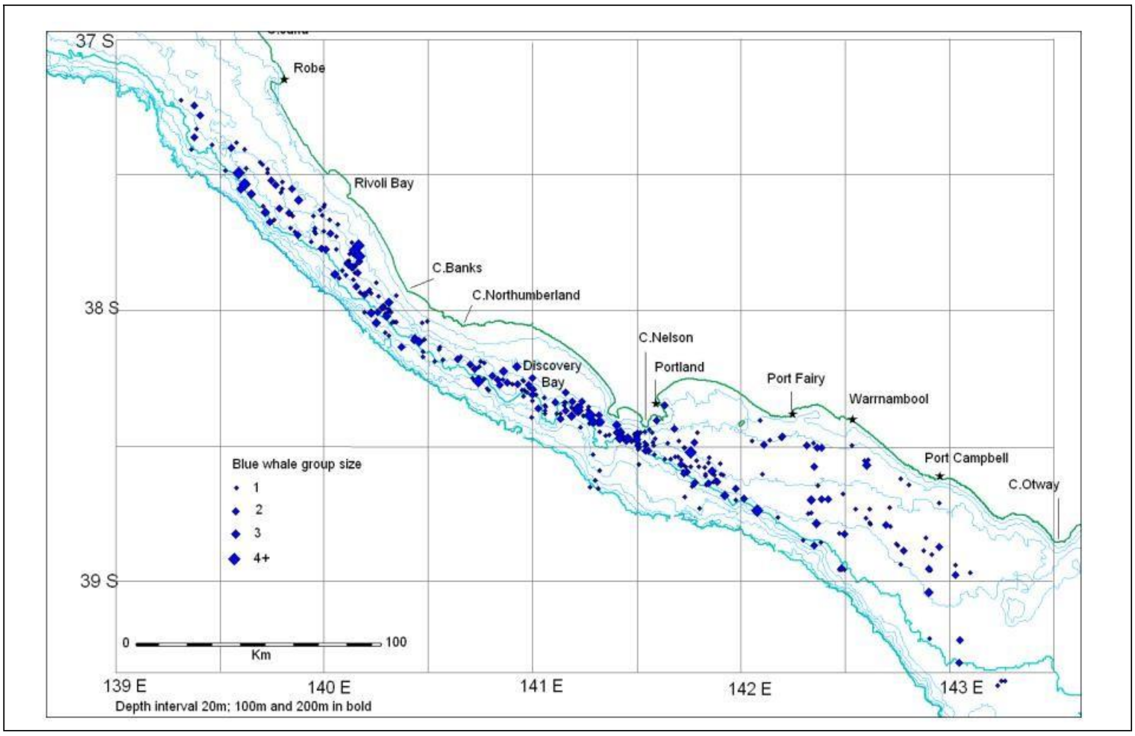
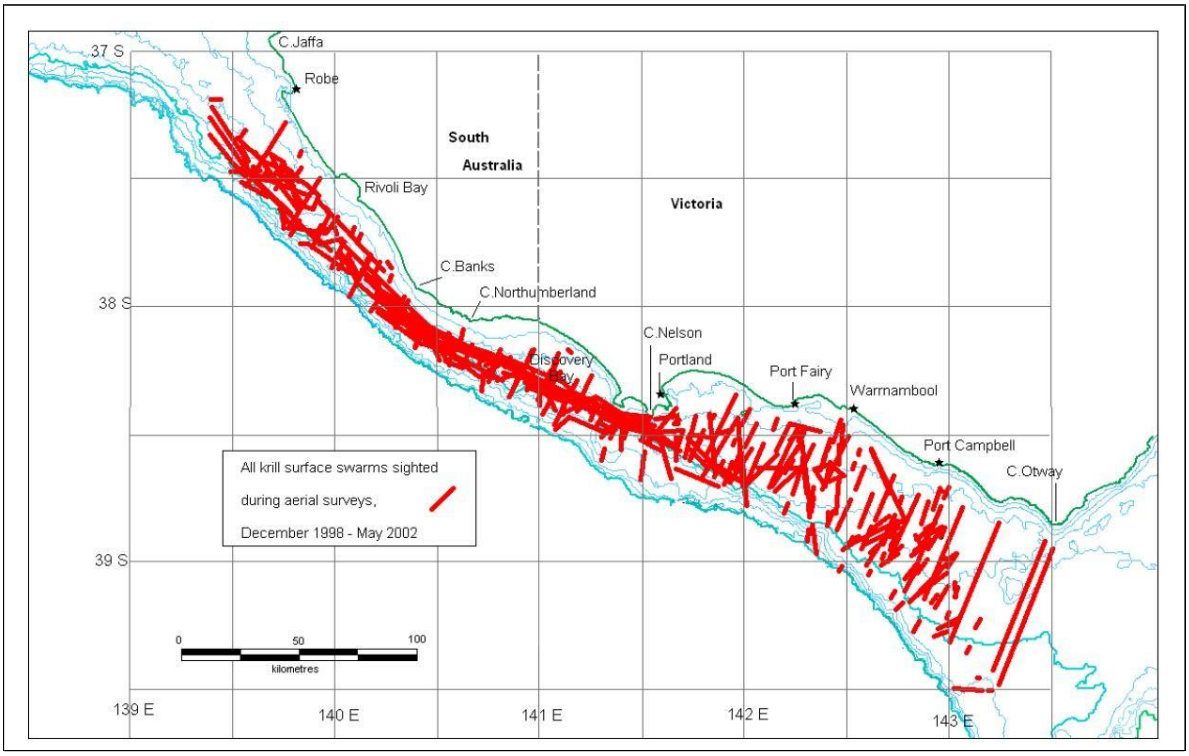


Figure 5.25 Distribution of krill surface swarms sighted from aerial surveys during 1998 – 2003

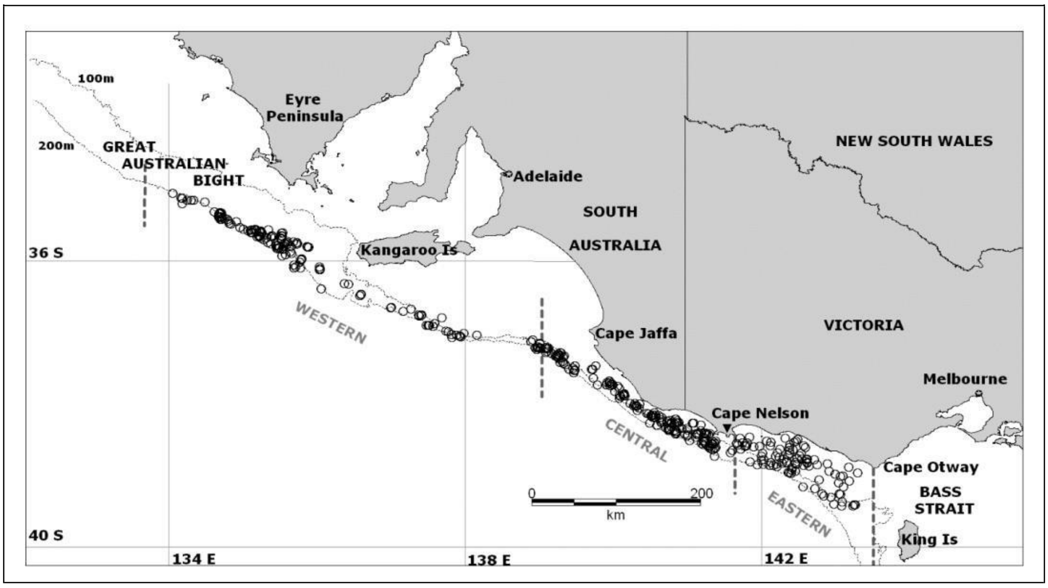


Source: Gill (2020).

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 PBW in the area extending from west of Kangaroo Island (~136oE) to Cape Otway (Vic) during the upwelling season (November-May). The total survey area was partitioned into western, central and eastern zones and differentiated physiographically by variations in shelf width, shelf orientation and sea surface temperature (SST). The central zone lies along the narrow shelf where the Bonney Upwelling surface plume is expressed (Gill, 2020). The Eastern zone occupies the broader shelf between Cape Nelson and Cape Otway, which is also subject to a largely subsurface upwelling except for nearshore surface plumes during strong upwelling events (Gill, 2020). The survey area partially overlaps the eastern zone. The following observations were made during the 2002-2007 surveys with respect to PBW:

- PBW are usually restricted to the western and central zones in November entering the eastern zone in December (Figure 5.26);
- PBW are widely spread through the central and eastern zones during January-April;
- In the eastern zone, encounter rates peak in February (9.8 whales/1,000 km); dropping slightly to 8.8 whales/1,000 km in March; then declining to approximately 4 whales/1,000 km in April and to a single sighting in May (0.4 whales/1,000 km). Encounter rates in November are zero and in December is 1 whale/1,000 km (Figure 5.20);
- The central zone received less survey coverage than the Eastern Zone (20,339 km vs 24,380 km), yet more PBW were sighted in the central zone, with the encounter rate in the central zone more than twice that in the eastern zone (11 whales/1,000 km vs 4.8 whales /1,000 km).
- The central zone is most consistently used by PBW (located 165 km northwest to the survey area at its closest point);
- Eighty percent (80%) of PBW are encountered at depths between 50 - 150 m and 93% of sightings occurred in water depths <200 m in the eastern and central zones with 10% of sightings within 5 km of the 200 m isobath;
- A mean PBW group size of 1.3±0.6 was observed per sighting record with cow-calf pairs observed in 2.5% of the sightings. This group size minimises the potential for prey competition (DAWE, 2020b);
- The overall pattern of seasonal distribution implied that PBW start foraging from the west early in the upwelling season (about November), spread eastward through the central and eastern zones until April, then possibly contract toward the central zone prior to departure for wintering grounds in April or May; and
- No PBW were sighted in the eastern zone in November of any year and peak months in this zone were February and March.

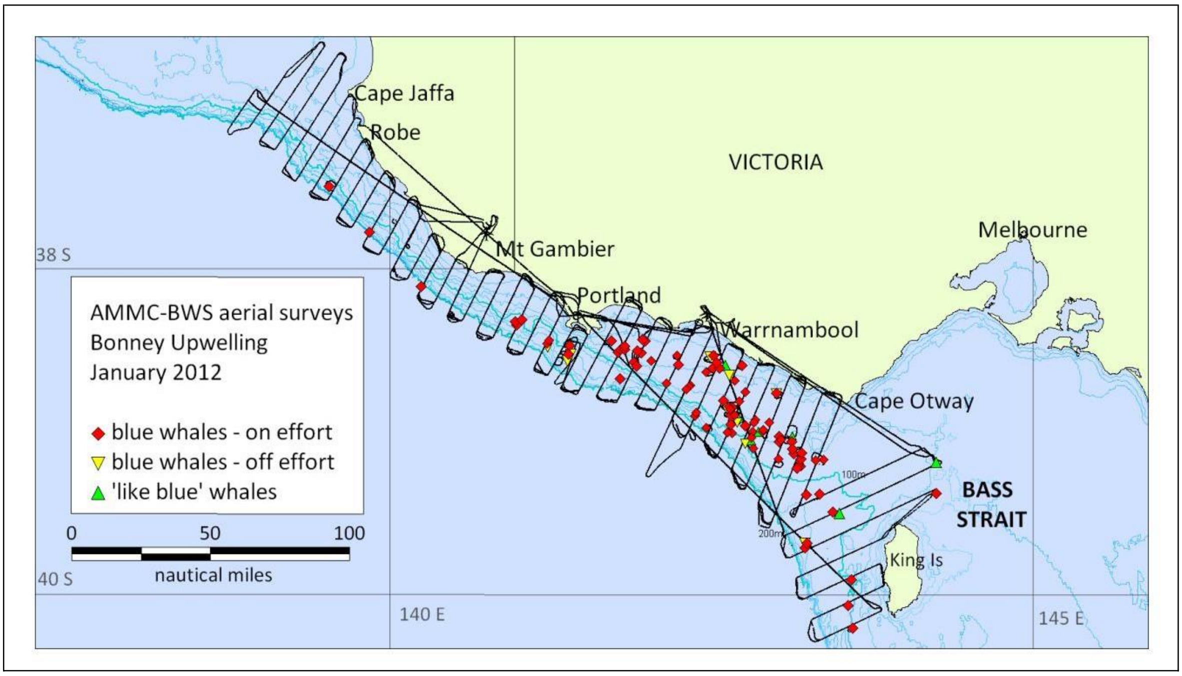
Figure 5.26 Distribution of blue whale sightings 2002 – 2007



Source: Gill et al (2011).

In January 2012, the BWS conducted six aerial surveys across the Bonney Upwelling/Otway Shelf feeding area to coincide with a vessel-based blue whale acoustic research program (Gill, 2020). All sightings from the surveys are shown in Figure 5.27. Unlike previously reported results, the surveys conducted in January 2012 recorded a near-absence of PBW in the central zone and a comparatively high abundance of whales in the eastern zone (Gill, 2020).

Figure 5.27 Blue whale sightings and tracks from January 2012



Source: Gill (2020).

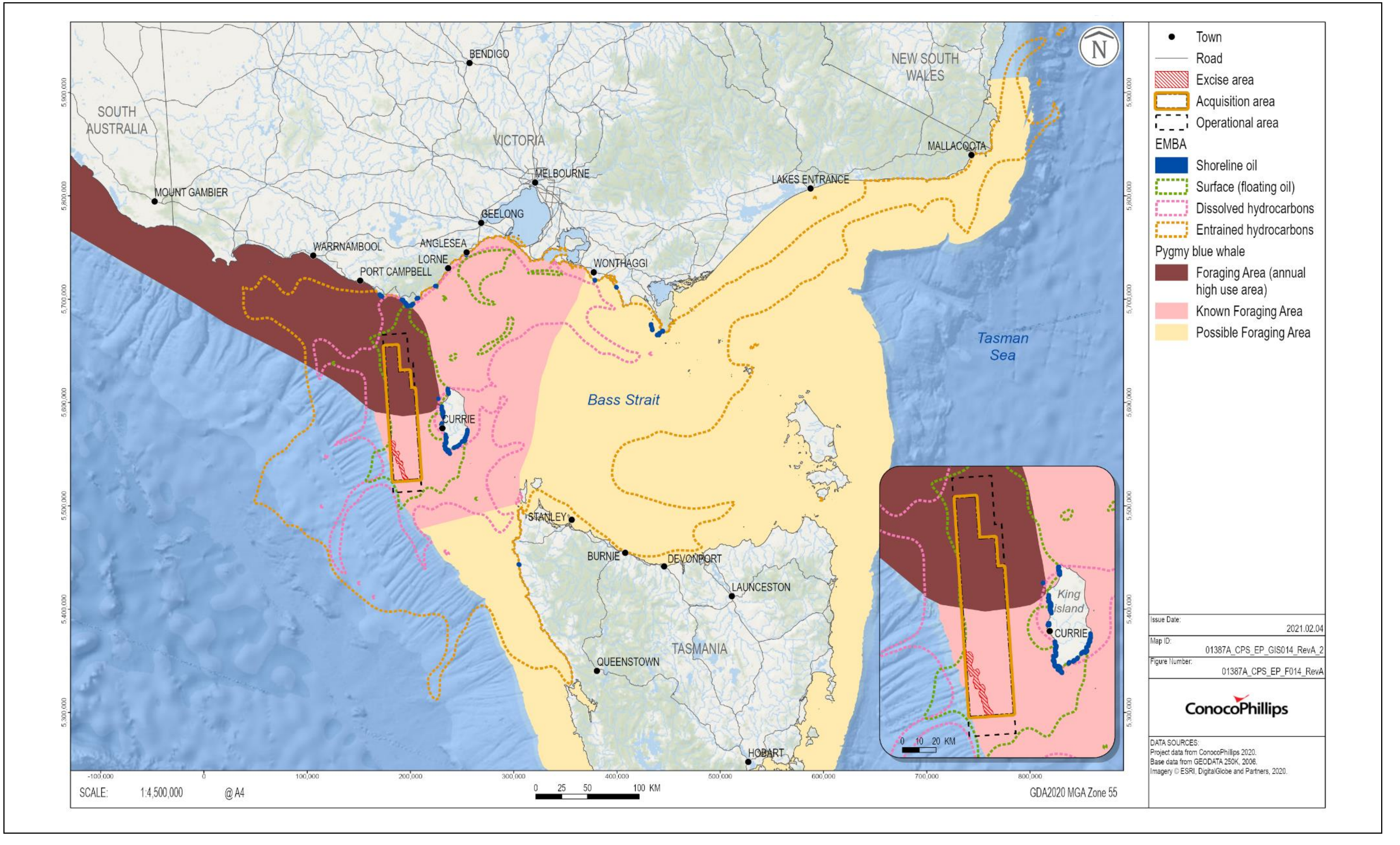
In an effort to avoid peak PBW presence in the Otway region, Origin Energy conducted MSS activities during November and December in 2012 (Gill, 2020). BWS flew monthly aerial surveys of the Astrolabe and

Bellerive prospects from June 2012 to investigate temporal changes in marine mammal presence. No PBW were sighted between June-October 2012, though whales and dolphins were observed during November (Gill, 2020). During late November 2013, the BWS conducted aerial surveys during an MSS located on the outer shelf between Warrnambool and Port Campbell. A total of 19 and 31 PBW were sighted on two survey days, all near the 200 m shelf break (Gill, 2020).

Summary

The Otway shelf is squarely within the productive, and to a certain extent predictable, Great Southern Australian Upwelling System. It has been shown to be an important, consistently used PBW foraging area over many years (Figure 5.28). The Otway shelf is also regarded as an area of high probability of encountering PBW during the November-May period, which defines the upwelling season and post-welling enrichment of the region. Sightings of PBW in the Otway region between June-October are rare. Therefore, it is considered unlikely that PBW will be present in the survey area in high numbers during the survey period (September to October).

Figure 5.28 PBW foraging areas intersected by the survey area and the EMBA



Fin whale (EPBC Act: Vulnerable, listed migratory)

A comparison of presence and absence for the fin whale between the database searches of the survey area and spill EMBA is presented in Table 5.34 below.

Table 5.34 Presence of fin whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	No records

The fin whale (*Balaenoptera physalus*) is a cosmopolitan migratory species that is listed as vulnerable 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 (DAWE, 2020b). 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 southwest South Pacific Ocean waters) (DAWE, 2020b).

Breeding occurs between May-July and the location of breeding areas is unknown (DAWE, 2020b). While Australian Antarctic waters are important feeding grounds for fin whales, the species also feeds in the Bonney upwelling during summer/autumn sometimes in the company of blue and sei whales (DAWE, 2020b). Areas of upwelling and interfaces with mixed and stratified waters may be an important feature of fin whale feeding habitat with the species feeding on planktonic crustacea, krill, some fish and cephalopods (DAWE, 2020b). Fin whales frequently lunge or skim feed at or near the surface and they are known to dive to 230 m to feed.

The NCVA does not identify any BIA for the fin whale within Australian waters (DAWE, 2020c).

Gill et al (2015) reported 8 individual fin whales in 7 sightings between November and May for the survey 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. Recorded encounter data per 1,000 km of survey distance for the months in which the fin whale was observed is listed below:

- November – 0.1 whales sighted;
- December – 0.14 whales sighted;
- January – 0.07 whales sighted; and
- February – 0.08 whales sighted.

It is unlikely, based on its habitat preferences, sightings and upwelling data, that this species will be encountered during the proposed survey period (September – October).

Southern right whale (EPBC Act: Endangered, listed migratory)

A comparison of presence and absence for the southern right whale between the database searches of the survey area and spill EMBA is presented in Table 5.35 below.

Table 5.35 Presence of southern right whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

The SRW (*Eubalaena australis*) is distributed in the southern hemisphere with a circumpolar distribution between latitudes of 16°S and at least 65°S. They are seasonally present on Australia's southern coastline, distributed in the southern hemisphere between 20oS and 60oS (with main feeding areas thought to occur between 40oS and 55oS) (DSEWPC, 2012c). The species are regularly present on the Australian coast between early-April to early November with isolated individuals seen outside these periods (DSEWPC, 2012c).

The SRW is pelagic in summer foraging in the open Southern Ocean (Bannister *et al*., 1996) between 32° and 65°S and migrates from the subantarctic to southern Australian coastal waters to calve and mate (Mustoe & Ross, 2004).

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 (Cape Otway to Cape Jaffa) from systematic aerial surveys between 2002 and 2013. These surveys were undertaken across all months with the highest seasonal effort from April to November. There were twelve sightings of SRW, most often between June and September, with 52 individuals identified in a mean group size 4.2 ± 4.2. Recorded encounter data per 1,000 km of survey distance for the period the SRW was observed is listed below:

- May - 0 whales sighted;
- June – 0.8 whales sighted;
- July – 3.1 whales sighted;
- August – 6.8 whales sighted;
- September – 8.8 whales sighted; and
- October – 0 whales sighted.

The peak period for SRW mating is from mid-July through August (DSEWPC, 2012c). Pregnant females generally arrive during late May/early June and depart with calves in September to October 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 (DSEWPC, 2012c).

In recent decades, sightings of SRW have been recorded around the coastline of Tasmania with most sightings occurring on the east coast, particularly in the south east region. The areas of most frequent use are consistent with the locations of the whaling stations and reflect the areas of sheltered bays and shallow water where the whales used to congregate and breed in large numbers (AMMC, 2012). Within Tasmanian waters, the seasonal occurrence of southern right whales are most observed between June and August, although they have been reported in all months (AMMC, 2009). Reports of these whales in Tasmania show an overall increase in recent years, notwithstanding significant inter-annual variation and increasing observations of whale aggregations remaining in the area for increasing periods, increasing observations of feeding and highly active and social behaviours. Cow-calf pairs are recorded in low numbers in Tasmania in most years (AMMC, 2012).

Tasmanian sighting data recorded between 1899 to 2018 identifies the east coast of Tasmania as having a higher sighting occurrence than the west coast (928 of 1,068 sighting records) and King Island (13 of 1,068 sighting records) (AMMC, 2018). Tasmanian sightings comprised of up to 7 individuals per sighting predominantly in south-eastern Tasmania, with 1 to 2 individuals per sighting usual (AMMC, 2018). Of the sightings around King Island, 12 were observed in the more sheltered coastal areas along the east coast of King Island (AMMC, 2018). A total of 19 southern right whales were observed within these 13 sightings (AMMC, 2018).

Until recently, SRW have been thought to be one population, however it is possible two populations exist, these are:

- South-east SRW population (Ceduna to Sydney including Tasmania); and
- South-western SRW population (located between Cape Leeuwin, WA and Ceduna) (DSEWPC, 2012c).

In terms of spatial recovery, the southwest 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 southeast population is not showing the same spatial recovery with very low regular habitat occupancy, particularly when considered in relation to historic ecology (DSEWPC, 2012c). Photo-identification studies for the southeast population (approximately 300 individuals) shows there is little population movement within the region or between the southeast and other regions (AMMC, 2009).

Calving areas

Key breeding areas within Australia are southern WA (Doubtful Island Bay, Israelite Bay, Twilight Cove, Flinders Bay and Albany), South Australia (Head of Bight, HOB) and Victoria (Warrnambool) (110 km northwest of the acquisition area) (DSEWPC, 2012c). Areas along the Victoria coastline such as Port Fairy and Portland also provide seasonal calving habitat (SEWPC, 2012). During calving, SRW generally remain within 2 km of the shoreline with calving occurring in waters less than 10 m deep (DAWE, 2020b) (refer Figure 5.29). At Logan’s Beach (Warrnambool), up to 6 cow/calf pairs (average 2.4) are resident per season (AMMC, 2009) and tend to be resident for most of the season, whereas at other southeast Victorian sites, they appear to be transiting through and are only seen for a short time (AMMC, 2009). The majority of first sightings in western Victoria occur in May (54%) and June (42%), while the majority of last sightings in western Victoria occur in September (50%) and October (38%) but there may be an increasing trend towards October with the last sightings occurring in 7 out of the last 10 years (SWIFFT, 2018).

Foraging

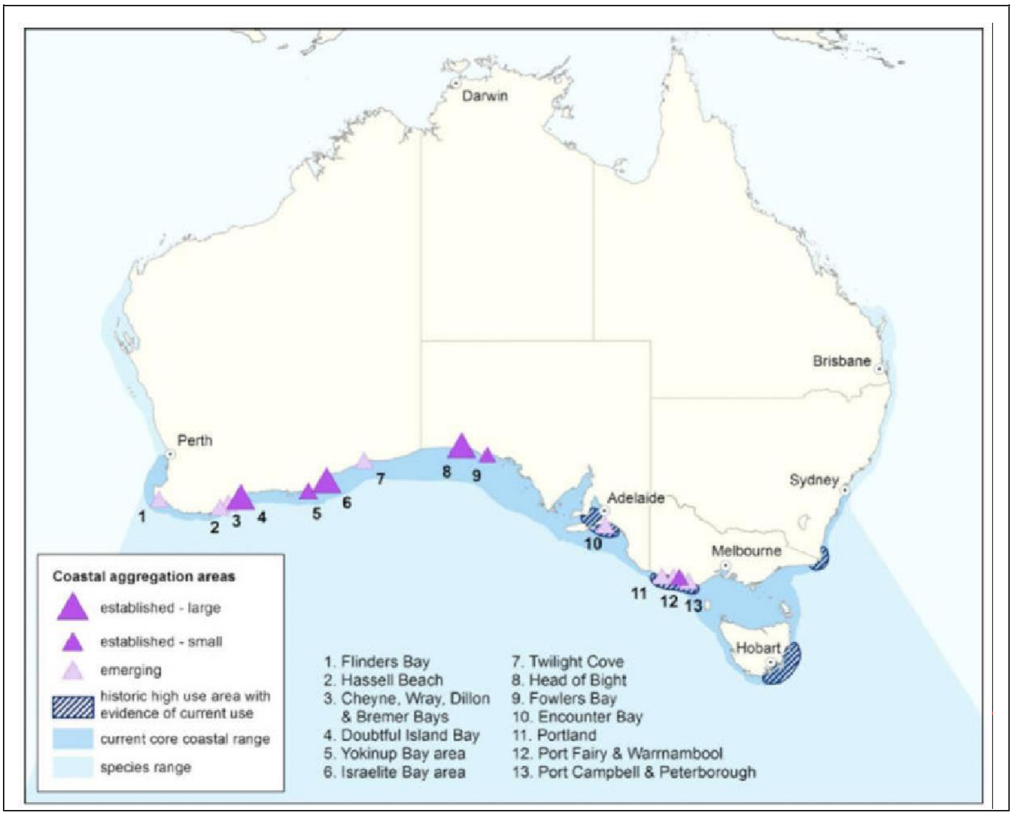
Foraging ecology for the species is poorly understood and observations of feeding are rare (DSEWPC, 2012). Species have been observed feeding in the region of the Sub-Tropical Front (41-44oS) in January and December. In that region copepods are mainly consumed, whereas at higher latitudes krill is the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

Migration

Individuals of the species are known to use widely separated coastal waters (200-1500 km apart) within a season, indicating substantial coast-wide movements (Kemper et al. 1997; 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. Such movements indicate the connectivity of coastal habitat is important for the species (DSEWPC, 2012c; Charlton et al., 2014).

Migration pathways between coastal Australian waters and offshore feeding grounds are not well defined (Gill et al. 2015; DSEWPC, 2012c). Exactly where whales approach and leave the coast from and to offshore areas is not well understood (DSEWPC, 201c2). A predominance of westward movements amongst long-rang photo-identification may indicate a seasonal westward movement in coastal habitat (DSEWPC, 2012c). More or less direct approaches and departures from the coast are also likely (DSEWPC, 2012c). SRW are thought to be solitary during migration or accompanied by a dependent calf (DSEWPC, 2012c).

Figure 5.29 Southern right whales aggregation areas

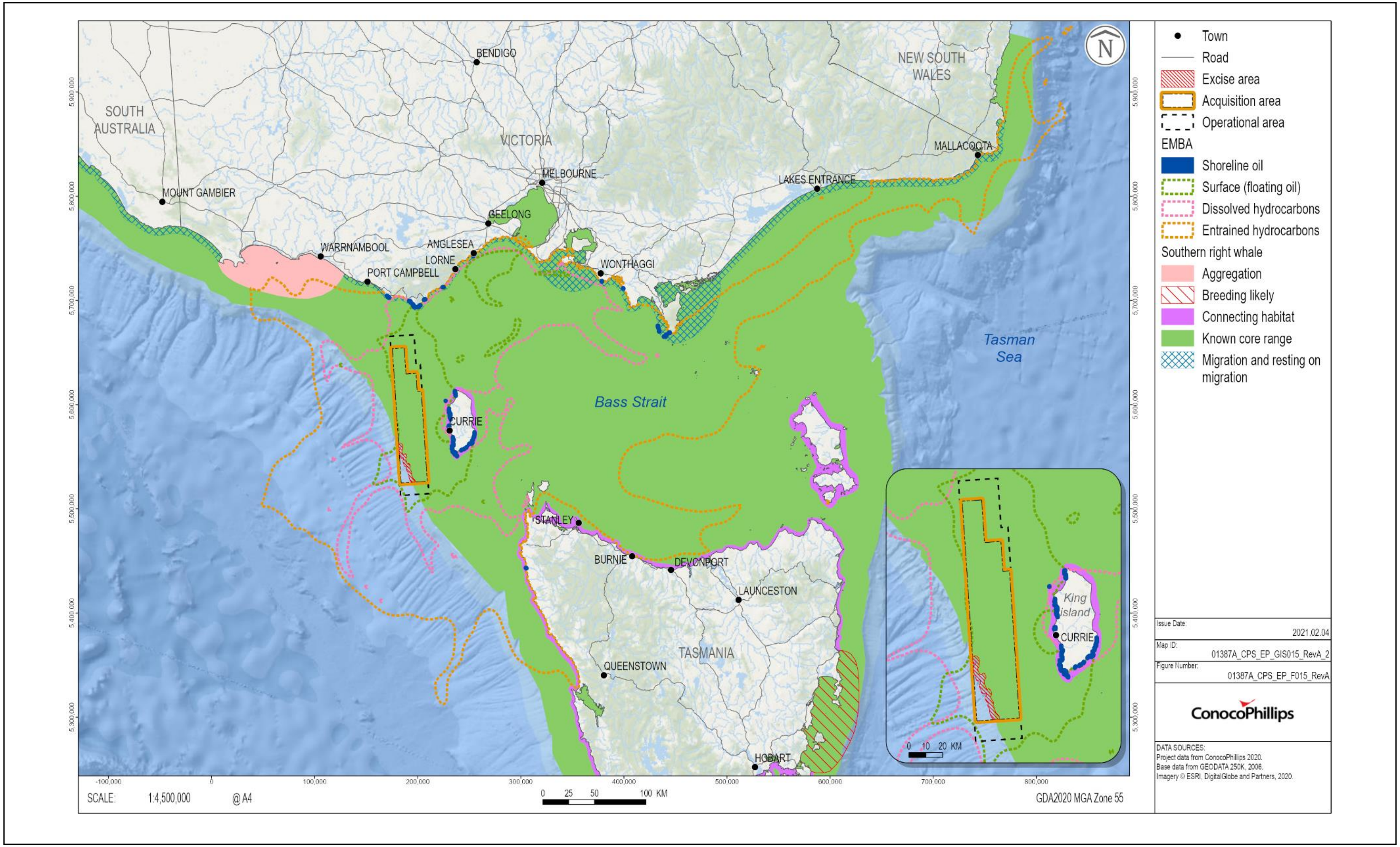


Source: DSEWPC (2012b)

Based on head callosity 'matches,' individual SRW movements have been recorded between the Antarctic and the West Australian/South Australian coast (15 animals), between 41-44°S and the WA/SA coast (2 animals), along the coast between HOB (SA) and WA (mainly westward movement - 18/30 animals) and between the Auckland Islands (New Zealand subantarctic) and HOB (3 animals). Two discovery mark returns show summer movement eastwards south of the GAB and Tasmania (Tormosov *et al*., 1998; cited in AMMC, 2012). American whaling logbook data ('Townsend's Charts' - see Bannister, 2001; cited in AMMC, 2012) show a general movement south from the coast from September, with south-easterly movement offshore in summer. In the 1840s, whalers were reported as believing that right whales moved northwards from the south early in the season, approaching Tasmania from about April and continuing on past Victoria and into the Bight. Southern right whales were also thought to approach the whole coast from the south, striking southward as a body from Cape Leeuwin and working southeast, 200-300 miles from land in October/November. Such a generalised, almost circular, anti-clockwise pattern for right whales south of Australia was suggested by Burnell (2001; cited in AMMC, 2012) from intra-year (95% westerly) and inter-year (75% easterly) movements recorded mainly from HOB (AMMC, 2012).

BIAs for the species are present at large and small established and emerging aggregation areas used for calving and nursing and coastal connecting habitat (coastal waters) (refer Figure 5.30). As identified in that figure, there is a seasonal aggregation area between Bridgewater Bay, Portland and Logan's Beach, Warrnambool for seasonal calving in shallow waters between May and November. It is also noted that less than 10% of the Australian southern right whale population is distributed east of Adelaide (DoEE, 2018b). BIAs are present to 3 km from the shoreline in the coastal waters surrounding King Island (low use coastal connecting habitat BIA) and the Victorian coastline (migration and resting on migration habitat BIA) which is likely used by the southern right whale between May to November (DAWE, 2020b).

Figure 5.30 Southern right whale BIA intersected by the survey area and the EMBA



Humpback whale (EPBC Act: Vulnerable, listed migratory)

A comparison of presence and absence for the humpback whale between the database searches of the survey area and spill EMBA is presented in Table 5.36 below.

Table 5.36 Presence of humpback whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

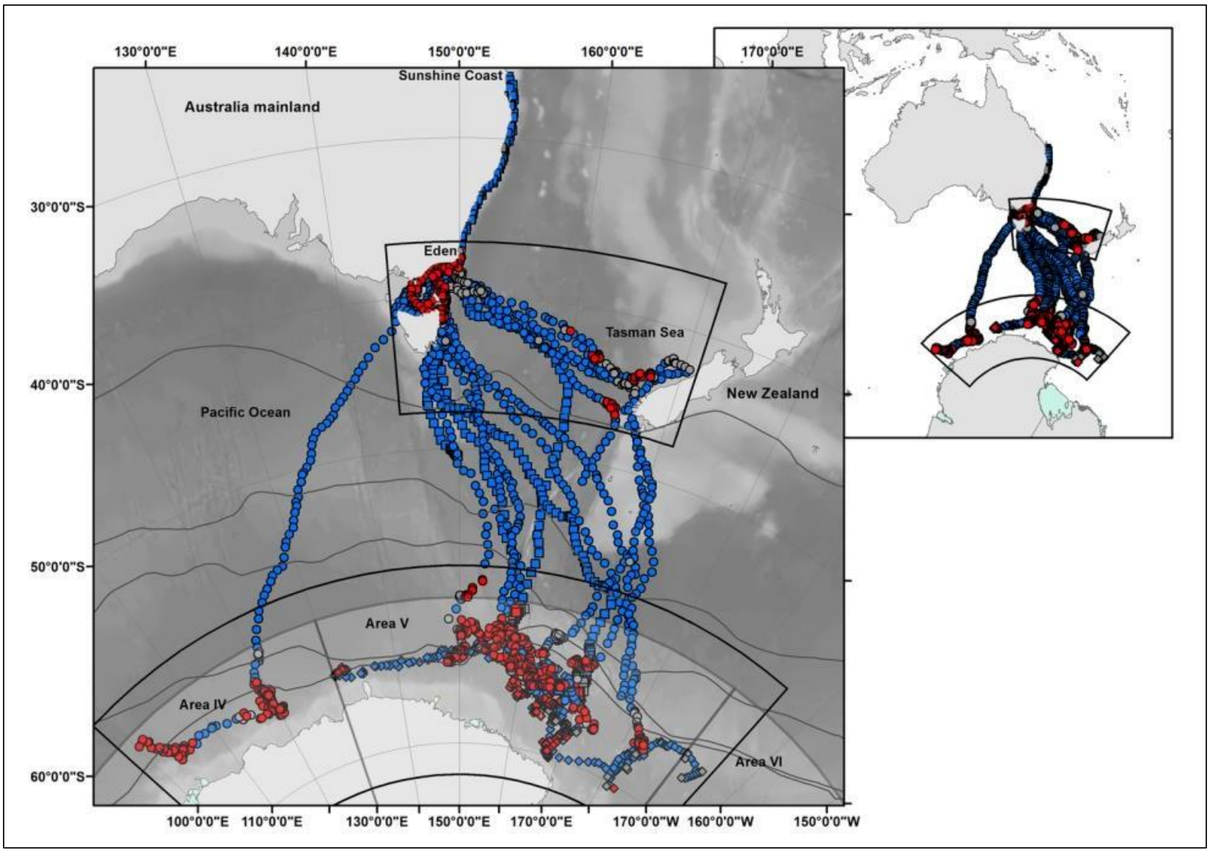
The humpback whale (*Megaptera novaeangliae*) is a moderately large baleen whale (15 to 18 m in length) and weighing up to 40 tonnes (DAWE, Australian Antarctic Division, 2016). They feed on krill primarily during the summer months in Antarctic waters south of about 55°S (peak season mid-January to February) (TSSC, 2015d). 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 (TSSC, 2015d). Two recognised populations exist in Australia, the western Australian population of humpbacks, which is a genetically distinct group from the eastern Australian group.

Feeding, resting or calving is not known to occur in Bass Strait (TSSC, 2015d) though migration through Bass Strait occurs (Figure 5.31). The nearest area that humpback whales are known to congregate and potentially forage is at the southern-most part of NSW near the eastern border of Victoria approximately 550 km northeast of the survey area at Twofold Bay, Eden off the New South Wales south coast.

Humpback whales are a migratory species found throughout Australian Antarctic waters and Commonwealth offshore waters (DAWE, 2020b) (Figure 5.32). The migratory pathways for this species are distinct along the eastern and western Australian coastlines with a lower presence in the Great Australian Bight (DEH, 2005a). Groups of young males typically lead the migration while pregnant cows and cow-calf pairs follow. The species commences a northerly migration from Antarctic waters and reaches southeast Australia in April to May. The species then migrates north to the Great Barrier Reef (14oS to 27oS) where breeding takes place, after which the southern migration commences (DAWE, 2020b) (Figure 5.33). Migratory humpbacks on their southern migration pathway are in southeast Australian waters during October to December each year (DEH, 2005a). The exact timing of the migration can vary depending on water temperature, sea ice and predation risk (DAWE, 2020b). In Victoria there are reports of humpback whales in all months except February (DAWE, 2020b).

In the austral summer of 2008/09, 2009/10 and 2010/11, the migrations of humpback whales were tracked using satellite tagging technology (Andrews-Goff et al., 2018). 21 of the whales migrated south along the coastline and across Bass Strait during the month of October. Throughout November, 12 whales migrated south via the east coast of Tasmania, while one whale migrated via the west coast of Tasmania and continued in a south westerly direction into the Pacific Ocean and then moved onto the Antarctic feeding grounds (Andrews-Goff et al., 2018). Seven whales travelled eastwards into the Tasman Sea crossing the 160 °E meridian whilst still in temperate waters. Therefore, it is unlikely that the western coast of Tasmania and western Bass Strait is frequently utilised for humpback whale migration. The results of the tagging and tracking study by Andrews-Goff et al (2018) and the divergent pathways of humpback whale migration routes are presented in Figure 5.31.

Figure 5.31 Migration pathways for 30 humpback whales satellite-tagged of the eastern coast of Australia



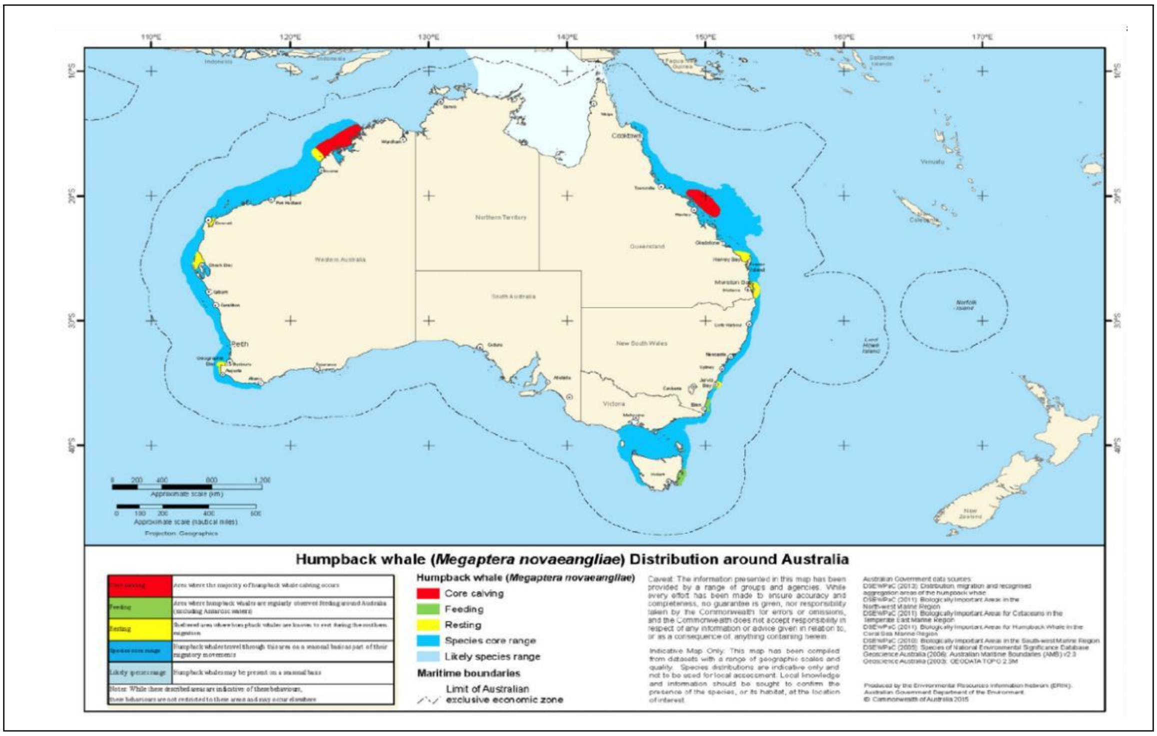
Source: Andrews-Goff et al (2018).

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, noting that the period of highest seasonal effort was between November to April in those years. 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. The mean depth of the species was observed to be 57 ± 31 m. Recorded encounter data per 1,000 km of survey distance for this period (Gill et al., 2015) is listed below:

- September – 0.35 whales sighted
- October – 0 whales sighted;
- November – 0.05 whales sighted;
- December – 0.07 whales sighted;
- January, February, March, April – 0 whales sighted;
- May – 0.11 whales sighted;
- June – 0.99 whales sighted;
- July – 1.0 whales sighted; and
- August – 0 whales sighted.

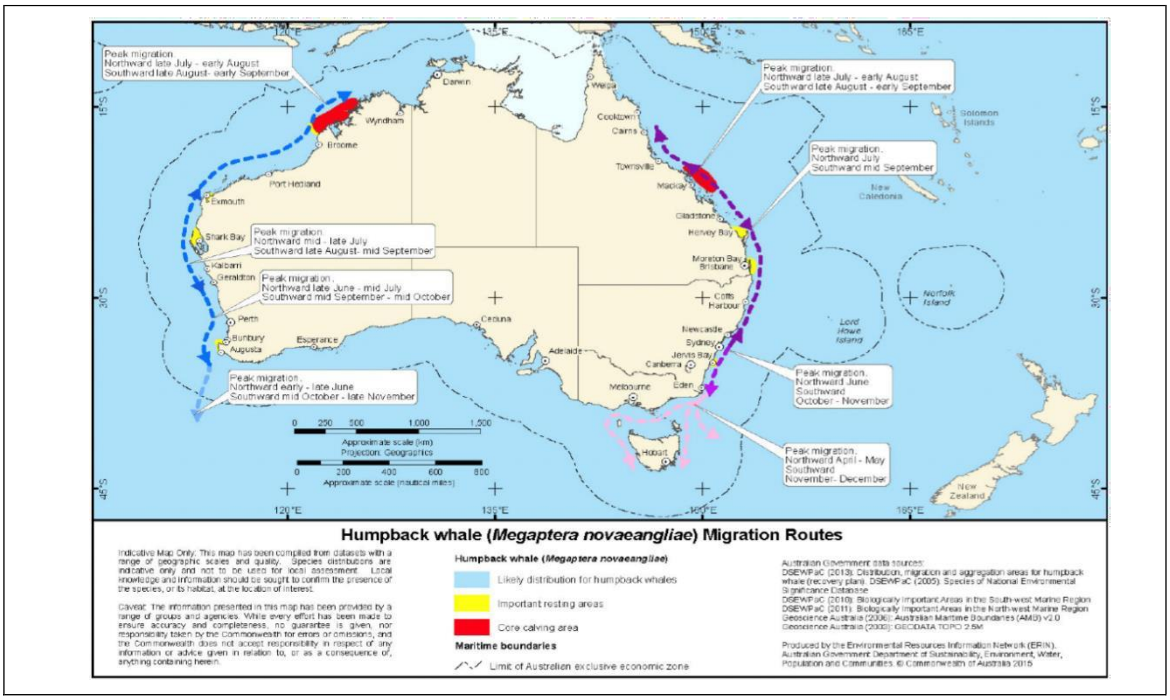
Observation data for humpback whale occurrence corresponds with the timing of migration to and from calving grounds off northern Australia (Gill *et al*., 2015), and evidence of autumn feeding is consistent with opportunistic feeding observed in migration routes off eastern Australia (cited in Gill *et al*., 2015).

Figure 5.32 Humpback whale distribution around Australia



Source: TSSC (2015d).

Figure 5.33 Humpback whale migration routes around Australia



Source: TSSC (2015d).

The survey area does not lie in a BIA (breeding, feeding, resting or migration pathway) for the humpback whale (DAWE, 2020c) (Figure 5.32). It is possible that this species may be encountered migrating south during the proposed survey, however the survey area is located further west than the humpback whale's normal (eastern) migration route. Based upon observation data, the timing of the survey is expected to avoid peak migration periods and the potential for encounter is considered unlikely.

Antarctic minke whale (EPBC Act: listed migratory)

A comparison of presence and absence for the Antarctic minke whale between the database searches of the survey area and spill EMBA is presented in Table 5.37 below.

Table 5.37 Presence of Antarctic minke whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	No records	No records

The Antarctic minke whale (*Balaenoptera bonaerensis*) has been recorded from all states but not in the Northern Territory (Bannister *et al*., 1996). Antarctic Minke Whales appear to occupy primarily offshore and pelagic habitats within cold temperate to Antarctic waters between 21° S and 65° S (Bannister et al., 1996) No population estimates are available for Antarctic Minke Whales in Australian waters. Extremely limited life history data exist for the Antarctic Minke Whale off Australia, though mature Antarctic minke whales feed primarily on the Antarctic Krill (*Euphausia superba*), although some smaller krill species (*E. spinifera* and *E. crystallorophias*) are also consumed (DAWE, 2020b). No daily patterns of movement have been described for Antarctic minke whales, but this species does undergo extensive migration between the summer Antarctic feeding grounds and winter sub-tropical to tropical breeding grounds (DAWE, 2020b). Given the lack of records, defined migration routes and BIAs identified in the survey area or EMBA, Antarctic minke whales are unlikely to be present in the survey area during the survey window (September to October).

Pygmy right whale (EPBC Act: listed migratory)

A comparison of presence and absence for the pygmy right whale between the database searches of the survey area and spill EMBA is presented in Table 5.38 below.

Table 5.38 Presence of pygmy right whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	No records

Pygmy right whales (*Caperea marginata*) are a little-studied baleen whale species found in temperate and sub-Antarctic waters in oceanic and inshore locations. The species, which has never been hunted commercially, is thought to have a circumpolar distribution in the Southern Hemisphere between about 30S and 55S. Distribution appears limited by the surface water temperature as they are almost always found in waters with temperatures ranging from 5° to 20°C (Baker, 1985). There are few confirmed sightings of pygmy right whales at sea (Reilly et al., 2008), with few records from the Otway region and no population estimates available for Australian waters (DAWE, 2020b). The largest reported group sighted (100+) occurred near Portland in June 2007 (Gill et al., 2008). Based upon the few sightings of the species in the Otway region and the absence of a BIA in Australian waters, it is considered unlikely that this species occurs within the survey area.

Sperm whale (EPBC Act: listed migratory)

A comparison of presence and absence for the sperm whale between the database searches of the survey area and spill EMBA is presented in Table 5.39 below.

Table 5.39 Presence of sperm whale according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	No records

The sperm whale (*Physeter macrocephalus*) has a worldwide distribution and has been recorded in all Australian state. The sperm whale is a pelagic species usually found in the deep water off the continental shelf with a water depth of 600 m or more and are uncommon in waters less than 300 m deep (DAWE, 2020b). The species is usually present in waters where sea surface temperatures are greater than 15°C (DAWE, 2020b). The major food for Sperm Whales comprises oceanic cephalopods, frequently taken at depth (Clarke, 1980). While sperm whales feed primarily on large and medium sized squids, the list of documented food items is fairly long and diverse. Female and young male sperm whales appear to be restricted to warmer waters (north of approximately 45° S in the Southern Hemisphere) while adult males travel to and from colder waters of Antarctica (Bannister *et al*. 1996). In Australian waters, sperm whales seem to be concentrated in a narrow area only a few miles wide at the shelf edge off Albany, Western Australia (outside the EMBA), moving westwards through the year (Bannister et al. 1996). In the open ocean, there is a generalised movement of sperm whales southwards in summer, and corresponding movement northwards in winter, particularly for males (DAWE,2020b).

Due to the species preference for deeper offshore waters and low number of sightings in the Otway region, sperm whales are unlikely to be present in the survey area.

Dolphins (EPBC Act: Listed marine species)

None of the eight dolphin species listed in Table 5.31 are listed as threatened under the EPBC Act. Many dolphins are cosmopolitan species that are generally restricted to continental shelf environments. A brief description of these dolphin species is provided below.

- The common dolphin (*Delphinus delphis*) is an abundant species, widely distributed from tropical to cool temperate waters, and generally further offshore than the bottlenose, although small groups may venture close to the coast and enter bays and inlets. They have been recorded in waters off all Australian states and territories. Stranding statistics indicate that common dolphins are active in Bass Strait at all times of the year, though less so in winter (DAWE, 2020b). Common dolphins are likely to be present in the survey area and spill EMBA.
- Risso's dolphin (*Grampus griseus*) is a widely distributed species found in deep waters of the continental slope and outer shelf from the tropics to temperate regions. This species prefers warm temperate to tropical waters with depths greater than 1,000 m, although they do sometimes extend their range into cooler latitudes in summer (Bannister et al., 1996). In Australia, the species has been recorded from all states except Tasmania and the Northern Territory. Fraser Island (off the southern Queensland coast) has the only suspected 'resident' population in Australia (Bannister et al., 1996). There are no known calving areas in Australian waters. The lack of resident populations in or near Bass Strait, and the lack of calving areas in Australia indicates there are no critical areas (and no BIA) for the species within the survey area or the EMBA and are not likely to be present.
- The dusky dolphin (*Lagenorhynchus obscures*) is primarily found from approximately 55°S to 26°S, though sometimes further north associated with cold currents. They are considered to be primarily an inshore species but can also be oceanic when cold currents are present (Gill *et al*., 2000; Ross, 2006). Only 13 reports of the dusky dolphin have been made in Australia since 1828, and key locations are yet to be identified (Bannister *et al*., 1996). They occur across southern Australia from WA to Tasmania, confirmed sightings near Kangaroo Island and off Tasmania. No key localities or critical habitats in Australian waters have been identified (Bannister *et al*., 1996). Given the lack of sightings in Australian

waters, it is unlikely that significant numbers of dusky dolphins would be present in the survey area or EMBA.

- The killer whale (Orcinus orca) (the largest member of the dolphin family) is thought to be the most cosmopolitan of all cetaceans and appear to be more common in cold, deep waters, though they have often been observed along the continental slope and shelf particularly near seal colonies (Bannister *et al*., 1996). The killer whale is widely distributed from polar to equatorial regions and has been recorded in all Australian waters with concentrations around Tasmania. The only recognised key locality in Australia is Macquarie Island and Heard Island in the Southern Ocean (Bannister *et al*., 1996). The habitat of killer whales includes oceanic, pelagic and neritic (relatively shallow waters over the continental shelf) regions, in both warm and cold waters (DAWE, 2020b). In Victoria, sightings peak in June/July, where they have been observed feeding on sharks, sunfish, and Australian fur seals (Mustoe, 2008). The breeding season is variable, and the species moves seasonally to areas of food supply (Bannister et al., 1996; Morrice et al., 2004). It is possible that killer whales may occur in the EMBA, however given the distance to the nearest seal colonies (see Section 5.5.7), the survey area is unlikely to represent an important habitat for this species.
- The Indian Ocean bottlenose dolphin (*Tursiops aduncus*) is distributed around the entire Australian mainland, but as the common name suggests, occur mainly in tropical and sub-tropical waters, usually coastal and shallow offshore areas. The species is thought to be common in discreet areas of eastern, northern and western Australia, though the total population size is not known (DAWE, 2020b). No critical habitats are known to occur within the survey area or EMBA. Indian Ocean bottlenose dolphins are likely to occur in the survey area and the EMBA.
- The bottlenose dolphin (*Tursiops truncatus*) has a worldwide distribution from tropical to temperate waters. While the species is primarily coastal, they are found in open oceans as well. There are two forms of bottlenose dolphin, a nearshore form and an offshore form. The nearshore form occurs in southern Australia (DAWE, 2020i). Most populations are relatively discrete and reside in particular areas, such as individual resident populations in Port Phillip Bay and Westernport Bay. There may be some migration and exchange between the populations, but it is likely that most are local residents. Bottlenose dolphins are likely to occur in the survey area and in the spill EMBA.

Listed in the VBA database results for the EMBA is the Burrunan dolphin (*Tursiops australis*), a species of bottlenose dolphin only recognised as a separate species in 2011. This species is listed as threatened under the FFG Act with only two resident populations known to occur, comprising about 50 individuals in the Gippsland Lakes and 100 individuals in Port Phillip Bay (Charlton-Robb *et al*., 2011). It is unclear whether migration occurs between these sites, though researchers from the Marine Mammal Foundation released information in mid-2017 indicating that there are genetic similarities between the dolphins in the Gippsland Lakes and around Tasmania's Freycinet Peninsula (ABC, 2017). The Marine Mammal Foundation believes a transient group of male dolphins swim between Gippsland and eastern Tasmania to breed with two different populations of female dolphins. The taxonomic validity of this new species has been questioned by the Committee for Taxonomy for the International Society for Marine Mammology (DRI, 2016). Burrunan dolphins, if present in the EMBA, are likely to just migrate through (rather than use these areas as permanent habitat). Burrunan dolphins are unlikely to be present in the survey area.

5.5.7. Pinnipeds

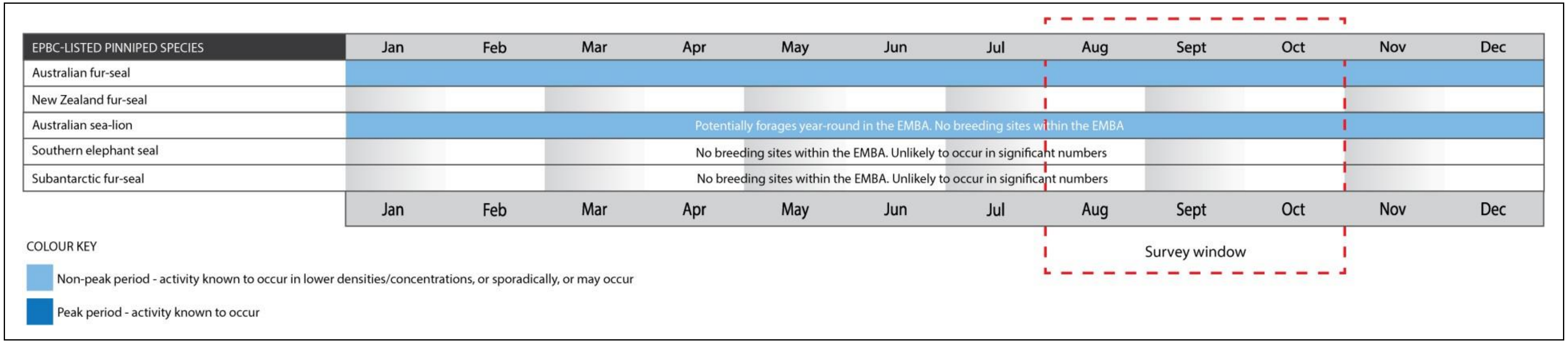
There are two pinniped species recorded under the EPBC Act PMST as potentially occurring within the survey area and spill EMBA (Table 5.40). An additional two threatened pinniped species were identified in the VBA and PMST searches for the EMBA but not the survey area (DAWE, 2020a).

A full list of pinniped species identified in the EMBA is presented in Appendix 12 and Appendix 13. Figure 5.34 illustrates the likely presence and absence of pinnipeds in the survey area and spill EMBA.

Table 5.40 EPBC-listed pinniped species that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
PMST								
Arctocephalus forsteri	New Zealand fur-seal	-	-	Yes	Y	Y	-	-
Arctocephalus pusillus	Australian fur-seal	-	-	Yes	Y	Y	-	-
Neophoca cinerea	Australian sea-lion	Vulnerable	-	Yes	N	Y	-	Recovery Plan
ALA								
Mirounga leonine	Southern elephant seal	Vulnerable	-	Yes	N	Y	-	Conservation Advice
VBA								
Arctophoca tropicalis	Subantarctic fur-seal	Endangered	-	Yes	N	Y	-	Conservation Advice

Figure 5.34 Annual activities and presence of pinnipeds in the survey area and EMBA



New Zealand fur-seal (EPBC Act: Listed marine)

A comparison of presence and absence for the New Zealand fur-seal between the database searches of the survey area and EMBA is presented in Table 5.41 below.

Table 5.41 Presence of New Zealand fur-seal according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

New Zealand fur-seals (*Arctocephalus forsteri*) (also known as long-nosed fur-seals) are mostly found in central South Australian waters (Kangaroo Island to South Eyre Peninsula, outside the EMBA); 77% of their population is found here (Shaughnessy, 1999).

There are 51 known breeding sites for New Zealand fur-seals in Australia, with most of these outside of Victoria (47 in SA and WA) (DEHWA, 2007) (Figure 5.35). The closest breeding colonies to the survey area are located at Cape Bridgewater (145 km northwest of the survey area) and Lady Julia Percy Island (130 km northwest of the survey area). Lower density breeding areas occur in Victoria occur at Kanowna Island, off Wilson's Promontory (located 238 km east of the survey area) and the Skerries (located approximately 551 km northeast of the survey area) (Kirkwood et al., 2009).

During the non-breeding season (November to January) the breeding sites are occupied by pups/young juveniles, whilst adult females alternate between the breeding sites and foraging at sea (Shaughnessy, 1999).

Haul-out sites in Bass Strait, as reported by Barton et al (2012) and OSRA mapping, are listed below:

- Beware Reef (483 km northeast of the survey area);
- Kanowna Island (238 km east of the survey area) - ~300 individuals;
- The Hogan Islands Group (297 km east of the survey area); and
- West Moncoeur Island (south of Wilson's Promontory, 255 km east of the survey area).

The species prefers the rocky parts of islands with jumbled terrain and boulders and prefers smoother igneous rocks to rough limestone. Breeding colonies in Bass Strait recorded by Shaughnessy (1999) and OSRA mapping are listed below:

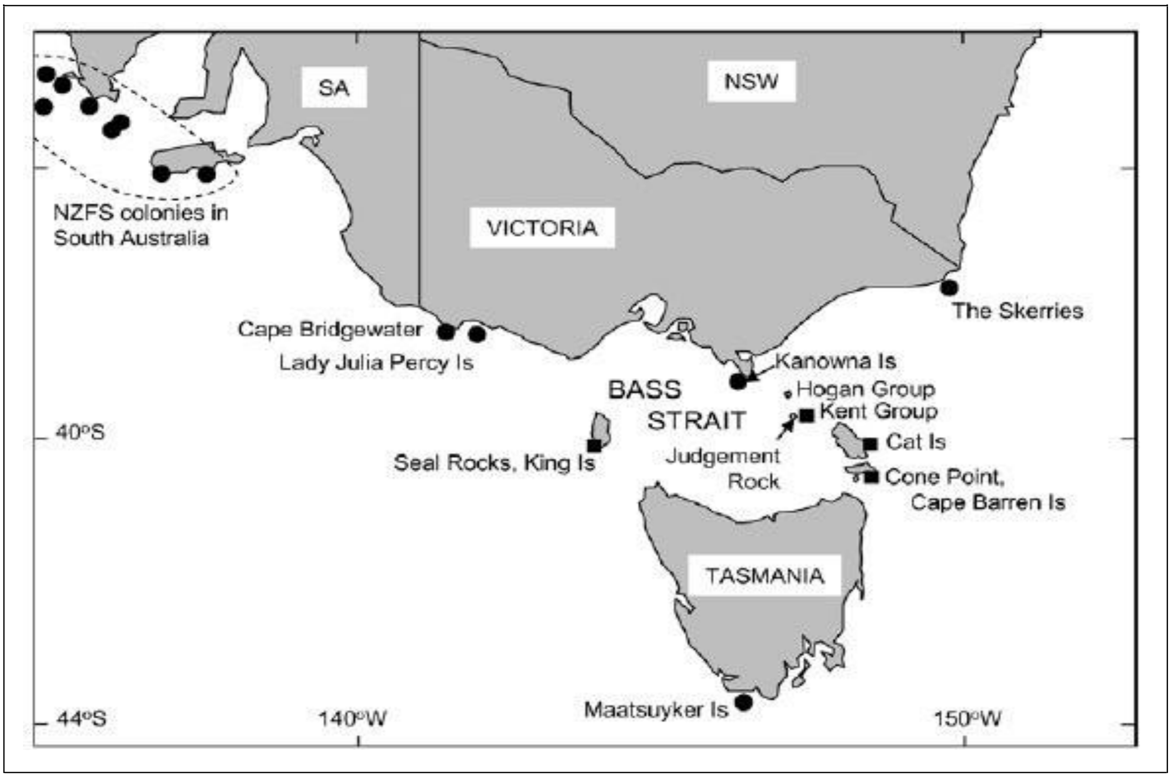
- Lady Julia Percy Island (130 km northwest of the survey area);
- Cape Bridgewater (145 km northwest of the survey area);
- Rag Island (1,000 fur seal & 235 pups in 2006, 275 km east of the survey area);
- Kanowna Island (10,700 adults and 2,700 pups, 238 km east of the survey area);
- Anser Group of Islands (all more than 240 km east of the survey area);
- The Skerries (551 km northeast of the survey area) – 300 individuals and 78 pups (in 2002); and
- Judgment Rock in the Kent Island Group (~2,500 pups per year, 307 km east of the survey area) (Kirkwood et al., 2009).

New Zealand fur-seals feed on small pelagic fish, squid and seabirds, including little penguins (Shaughnessy, 1999). Juvenile seals feed primarily in oceanic waters beyond the continental shelf, lactating females feed in mid-outer shelf waters (50-100 km from the colony) and adult males forage in deeper waters (Shaughnessy, 1999).

There is no BIA for the New Zealand fur-seal in Bass Strait. Given the general proximity of the survey area to breeding colonies and haul-out sites, it is unlikely that the species feeds within the survey area. However, there are no islands or rock outcrops within the survey area, so a resident population does not occur.

The ALA and VBA records the New Zealand fur-seal in the EMBA but not the survey area.

Figure 5.35 New Zealand fur-seal colonies in southeast Australia



Filled circles = current distribution. Filled squares = early 1800s distribution. Source: Kirkwood et al (2009).

Australian fur-seal (EPBC Act: Listed marine)

A comparison of presence and absence for the Australian fur seal between the database searches of the survey area and spill EMBA is presented in Table 5.42 below.

Table 5.42 Presence of Australian fur-seal according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

The Australian fur-seal (*Arctocephalus pusillus*) has a relatively restricted distribution around the islands of Bass Strait, parts of Tasmania and southern Victoria with no BIA in Bass Strait. The ALA and VBA records the Australian fur-seal in the EMBA but not the survey area.

There are 10 established breeding colonies of the Australian fur-seal that are restricted to islands in the Bass Strait; six occurring off the coast of Victoria and four off the coast of Tasmania (Shaughnessy, 1999) (Figure 5.36). The largest of the established colonies occur at Lady Julia Percy Island (outside the EMBA) (26% of the breeding population and 130 km northwest of the survey area) and at Seal Rocks (intersected by the EMBA) (25% of the breeding population and 154 km northeast of the survey area), in Victoria. There is another breeding colony located at Reid Rocks, which is located 50 km east of the survey area and is intersected by the EMBA.

Other breeding colonies in Bass Strait (that are intersected by the EMBA) include:

- Rag Island (1,000 fur seal & 270 pups in 2007, 275 km east of the survey area);

- Kanowna Island (15,000 adults and 3,000 pups, 238 km east of the survey area);
- Anser Group of Islands (all more than 240 km east of the survey area);
- The Skerries (551 km northeast of the survey area) – 11,500 individuals and 3,000 pups (in 2002); and
- Judgment Rock in the Kent Island Group (~2,500 pups per year, 307 km east of the survey area) (Kirkwood et al., 2009, Shaughnessy, 1999).

Historically, Australian fur-seal breeding colonies were more widespread, but several islands have not been occupied since their populations were removed by early commercial sealing (Shaughnessy, 1999).

Their preferred habitat, especially for breeding, is a rocky island with boulder or pebble beaches and gradually sloping rocky ledges. Australian fur-seals are present in the region all year. Pups begin to forage in June/July and are generally weaned by September/October (Shaughnessy, 1999).

Australian fur-seals are also regularly seen resting and foraging on and around the petroleum production platforms off the Gippsland coast. Barton et al (2012), Carlyon et al (2011) and OSRA (2017) list the haul-out sites known in Bass Strait:

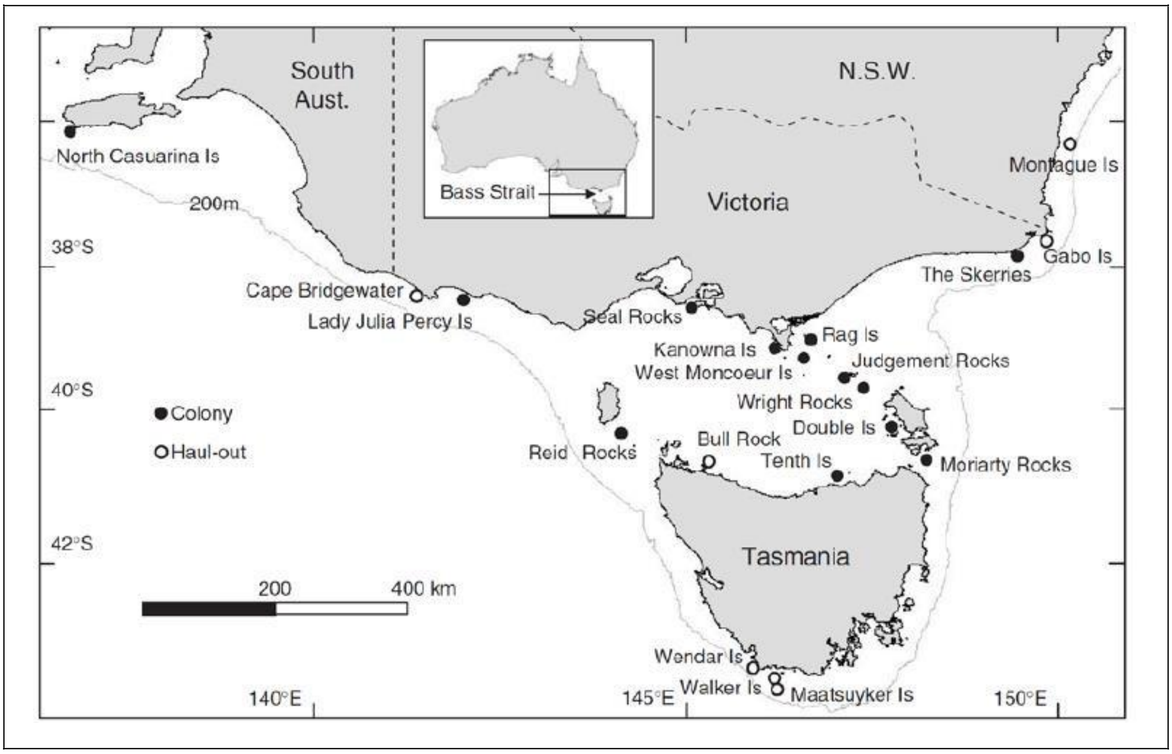
- Beware Reef (483 km northeast of the survey area) – a haul-out site where the seals are present most of year;
- Gabo Island (589 km northeast of the survey area) – 30-50 individuals; and
- The Hogan Island group (297 km east of the survey area) – ~300 animals.

During the summer months, Australian fur-seals travel between northern Bass Strait islands and southern Tasmania waters following the Tasmanian east coast, however, lactating female fur-seals and some territorial males are restricted to foraging ranges within Bass Strait waters. Lactating female Australian fur-seals forage primarily within the shallow continental shelf of Bass Strait and Otway on the benthos at depths of between 60 - 80 m and generally within 100 - 200 km of the breeding colony for up to five days at a time. The diet of Australian fur-seals is principally fish, including red-bait, leatherjackets and jack mackerel in winter and mostly cephalopods in summer (Shaughnessy, 1999).

Male Australian fur-seals are bound to colonies during the breeding season from late October to late December, and outside of this they time forage further afield (up to several hundred kilometres) and are away for long periods, even up to nine days (Kirkwood et al., 2009; Hume et al., 2004). Given the proximity of the survey area to the breeding colony at Reid Rocks (50 km east), it is likely that the southeast corner of the survey area is foraging habitat for Australian fur-seals.

The location of New Zealand and Australian fur-seal colonies in relation to the spill EMBA are presented in Figure 5.37.

Figure 5.36 Australian fur-seal colonies and haul-out sites where pups were born in 2007 in southeast Australia



Filled circles = breeding colonies. Empty circles = haul-out sites. Source: (Kirkwood et al., 2009).

Southern elephant seal (EPBC Act: Vulnerable, listed marine)

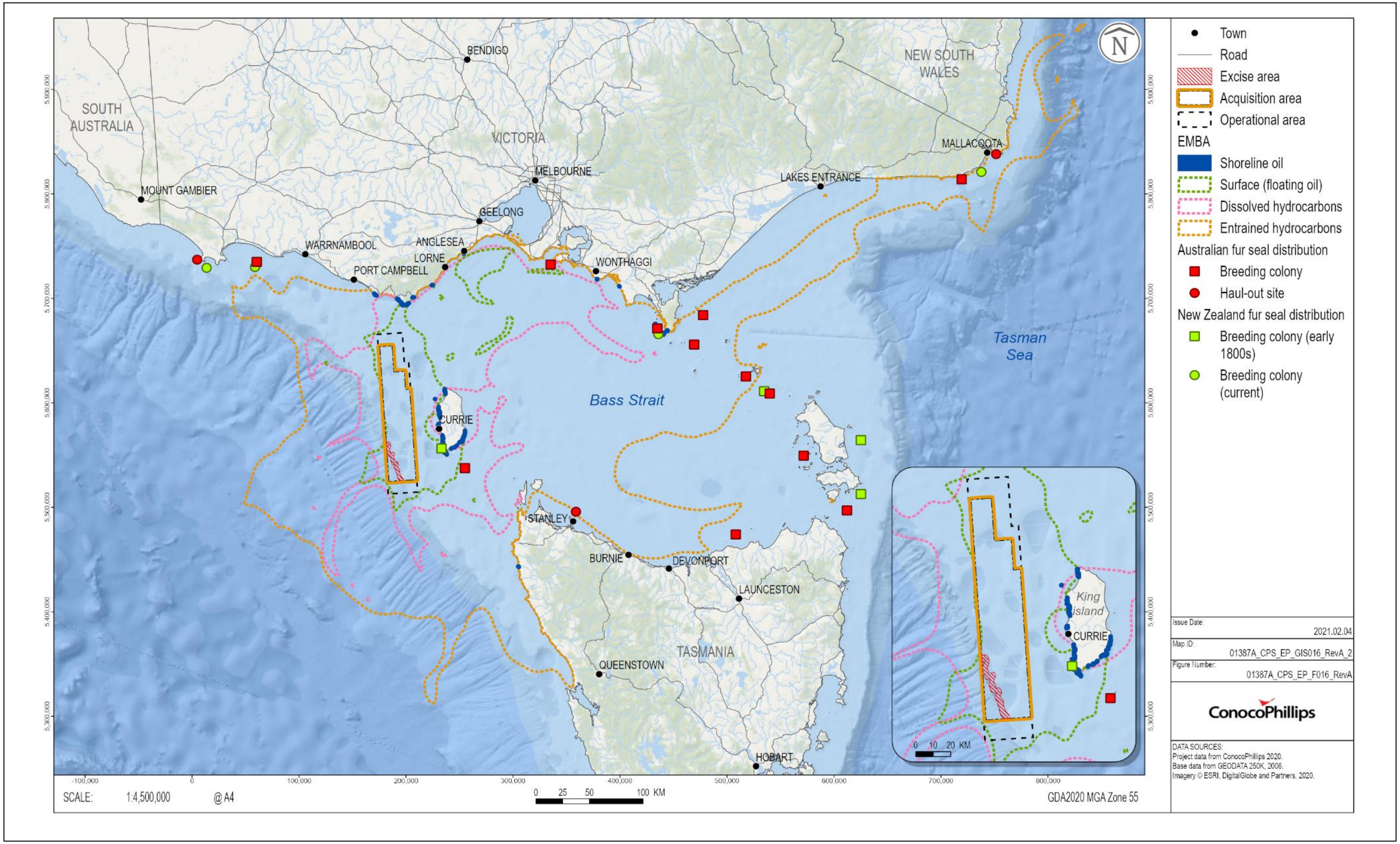
A comparison of presence and absence for the southern elephant seal between the database searches of the survey area and EMBA is presented in Table 5.43 below.

Table 5.43 Presence of Southern elephant seal according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	Recorded	Recorded

Elephant seals (*Mirounga leonine*) have a nearly circumpolar Southern Hemisphere distribution with most breeding colonies and haul-out areas occurring on subantarctic islands north of the seasonal pack ice zone (TSSC, 2016a). Within Australian jurisdiction, southern elephant seals breeds and hauls-out on Macquarie Island (1,900 km southeast) and Heard Island (5,500 km southwest). Historically, southern elephant seal populations occurred on islands of western Bass Strait before these were extirpated by European sealers (TSSC, 2016a). In 2005, the world population was estimated at between 664,000 and 740,000 animals occurring in the South Atlantic, South Indian and Pacific Oceans. Tracking studies have indicated the routes travelled by elephant seals, demonstrating their main feeding area is at the edge of the Antarctic continent. Currently, occasional pupping is seen on Maatsuyker Island (426 km south) in southern Tasmania where 12 individuals were recorded in 2015. Given the known distribution of southern elephant seals, this species is unlikely to occur in the survey area and unlikely to occur in significant numbers in the spill EMBA.

Figure 5.37 Australian and New Zealand fur-seal breeding colonies and haul-out sites intersected by the survey area and spill EMBA



Subantarctic fur-seal (EPBC Act: Endangered, listed marine)

A comparison of presence and absence for the subantarctic fur-seal between the database searches of the survey area and spill EMBA is presented in Table 5.44 below.

Table 5.44 Presence of Subantarctic fur-seal according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	No records	No records	Recorded

There are two records of the subantarctic fur-seal (*Arctocephalus tropicalis*) in the VBA database for the spill EMBA. The species has a wide southern hemisphere distribution and a dispersed breeding distribution on isolated subantarctic and subtemperate islands north of the Antarctic polar front. In the Australian region, the only established breeding colony occurs on Macquarie Island, located 1,940 km southeast of the survey area (TSSC, 2016b). Juvenile vagrants have been recorded to reach the southern shores of Tasmania and the mainland with 50 individuals recorded from NSW to WA since the 1970s. Given the locations of recordings of subantarctic fur-seals in the EMBA, it is highly unlikely that the species is present in the survey area or spill EMBA.

Australian sea-lion (EPBC Act: Vulnerable, listed marine)

A comparison of presence and absence for the Australian sea lion between the database searches of the survey area and spill EMBA is presented in Table 5.45 below.

Table 5.45 Presence of Australian sea-lion according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	Recorded	Recorded

There are three records of the Australian sea-lion (*Neophoca cincerea*) in the VBA database for the spill EMBA. The Australian sea-lion is endemic to southern Australia and its core range is located from Kangaroo Island (SA) (609 km northwest of the survey area) to the Houtman Abrolhos Islands (WA) (2,900 km northwest of the survey area) (TSSC, 2010). Australian sea-lions regularly visit haul-out sites and breeding colonies on remote sections of coastline and have been sighted at over 200 locations. The species may be present in the survey area and spill EMBA, though in low numbers as vagrant individuals given the low number of sightings and location of the survey area outside of its core range.

5.5.8. Reptiles

The EPBC Act PMST identified three species of marine reptile possibly occurring in the survey area (Table 5.47). An additional two species were identified in the PMST search for the EMBA.

The Southern Australian Sea Turtles (SAST) database, managed by the Centre for Integrative Ecology (CIE), was interrogated to compile turtles sightings relevant to the survey area and EMBA. There are no turtle recods for the survey area (CIE, 2020). Though there were no records for the species in the survey area, the loggerhead turtle was the most commonly recorded species on the southern Victorian coast (CIE, 2020).

Additionally, Wilson and Swan (2005) report that 31 species of sea snake and two species of sea kraits occur in Australian waters, though none of these occurs in waters of the southern coast of Australia, with the exception of the yellow-bellied sea snake (*Pelamis platurus*) that extends into waters off the Victorian coast. This species is the world's most widespread sea snake and feeds on fish at the sea surface (Wilson and Swan, 2005). Sea snakes are not expected to be encountered within the survey area or the spill EMBA.

Figure 5.38 illustrates the likely temporal presence and absence of marine reptiles in the survey area and spill EMBA.

Loggerhead turtle (EPBC Act: Endangered, listed migratory)

A comparison of presence and absence for the loggerhead turtle between the database searches of the survey area and EMBA is presented in Table 5.46 below.

Table 5.46 Presence of loggerhead turtle according to PMST, ALA & VBA database searches

	PMST	ALA	VBA	SAST
Survey area	Recorded	No records	No records	No records
EMBA	Recorded	Recorded	No records	Recorded

The loggerhead turtle (*Caretta caretta*) is globally distributed in sub-tropical waters (Limpus, 2008a), including those of eastern, northern and western Australia (DoEE, 2017a), and is rarely sighted off the Victorian coast. The main Australian breeding areas for loggerhead turtles are generally confined to southern Queensland and Western Australia (Cogger et al., 1993). Loggerhead turtles will migrate over distances in excess of 1,000 km but show a strong fidelity to their feeding and breeding areas (Limpus, 2008a).

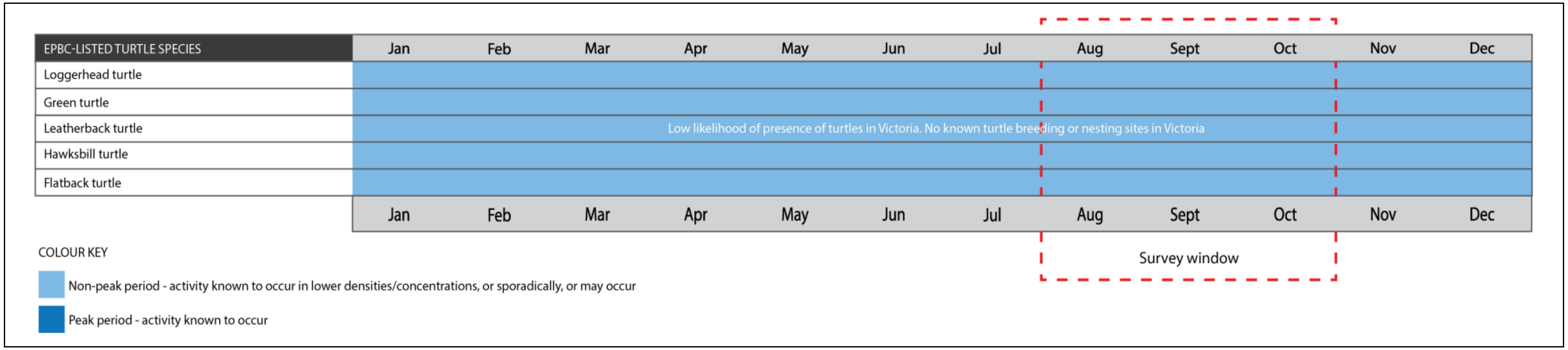
Loggerhead turtles are carnivorous, feeding primarily on benthic invertebrates such as molluscs and crabs in depths ranging from nearshore to 55 m in tidal and sub-tidal habitats, reefs, seagrass beds and bays (DoEE, 2017a). No known loggerhead foraging areas have been identified in Victoria waters although foraging areas have been infrequently identified in waters off SA (DoEE, 2017a).

The DAWE (2017a) maps the loggerhead turtle as having a known or likely range within Bass Strait, but given this species preference for sub-tropical waters, it is unlikely to be encountered in the survey area. The ALA records this species in the EMBA but not in the survey area, while the VBA contains no records for this species.

Table 5.47 EPBC-listed turtle species that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in			BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA	SAST		
PMST									
Caretta caretta	Loggerhead turtle	Endangered	Yes	Yes	Yes	Yes	Yes	-	Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017)
Chelonia mydas	Green turtle	Vulnerable	Yes	Yes	Yes	Yes	Yes	-	
Dermochelys coriacea	Leatherback turtle	Endangered	Yes	Yes	Yes	Yes	Yes	-	
Eretmochelys imbricate	Hawksbill turtle	Vulnerable	Yes	Yes	No	Yes	Yes	-	
Natator depressus	Flatback turtle	Vulnerable	Yes	Yes	No	Yes	No	-	
ALA									
No additional species									
VBA									
No additional species									
SAST									
No additional species									

Figure 5.38 Annual activities and presence of marine reptiles in the survey area and EMBA



Green turtle (EPBC Act: Vulnerable, listed migratory)

A comparison of presence and absence for the green turtle between the database searches of the survey area and spill EMBA is presented in Table 5.48 below. While there are suitable foraging sites, green turtles are unlikely to occur in the survey area.

Table 5.48 Presence of green turtle according to PMST, ALA & VBA database searches

	PMST	ALA	VBA	SAST
Survey area	Recorded	No records	No records	No records
EMBA	Recorded	Recorded	Recorded	Recorded

The green turtle (*Chelonia mydas*) is distributed in sub-tropical and tropical waters around the world (Limpus, 2008b; DoEE, 2017a). In Australia, they nest, forage and migrate across tropical northern Australia. Mature turtles settle in tidal and sub-tidal habitat such as reefs, bays and seagrass beds where they feed on seagrass and algae (Limpus, 2008b; DoEE, 2017a).

There are no known nesting or foraging grounds for green turtles in Victoria, and they occur only as rare vagrants (DoEE, 2017a). The DAWE (2020b) maps the green turtle as having a known or likely range within Bass Strait, with one sighting of the species recorded in the EMBA (CIE, 2020).

Leatherback turtle (EPBC Act; Endangered, listed migratory)

A comparison of presence and absence for the leatherback turtle between the database searches of the survey area and spill EMBA is presented in Table 5.49 below.

Table 5.49 Presence of leatherhead turtle according to PMST, ALA & VBA database searches

	PMST	ALA	VBA	SAST
Survey area	Recorded	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded	Recorded

The leatherback turtle (*Dermochelys coriacea*) is widely distributed throughout tropical, sub-tropical and temperate waters of Australia (DoEE, 2017a), including in oceanic waters and continental shelf waters along the coast of southern Australia (Limpus, 2009). More so than other marine turtles species, the leatherback turtle utilises cold water foraging areas, with the species most commonly reported foraging along the coastal waters of central eastern Australia (southern Queensland to central NSW), southeast Australia (Tasmania, Victoria and eastern SA), and southwestern WA (Limpus, 2009).

This species feeds on soft-bodied invertebrates, including jellyfish (Limpus, 2009). No major nesting has been recorded in Victoria or Tasmania, with isolated nesting recorded in the Northern Territory, Queensland and northern NSW (DoEE, 2017a). The DAWE (2020b) maps the leatherback turtles as having a known or likely range within Bass Strait, and a migration pathway in southern waters with 34 sightings of the species recorded in the EMBA (CIE, 2020).

The ALA database records this species in both the EMBA and the survey area. The waters of the survey area and EMBA do not represent critical habitat for the species, though it is possible it may occur in low numbers during upwelling.

Hawksbill turtle (EPBC Act: Vulnerable, listed migratory)

A comparison of presence and absence for the hawksbill turtle between the database searches of the survey area and spill EMBA is presented in Table 5.50 below.

Table 5.50 Presence of hawksbill turtle according to PMST, ALA & VBA database searches

	PMST	ALA	VBA	SAST
Survey area	No records	No records	No records	No records
EMBA	Recorded	Recorded	Recorded	Recorded

The hawksbill turtle (*Eretmochelys imbricate*) is widely distributed in the tropical and subtropical waters of Australia. Their eggs are laid on warm beaches with the most important nesting sites for the species located in northern Queensland, northeast Arnhem Land and Western Australia (DoEE, 2017a). Adult hawksbill turtles are primarily found in tropical reefs where they are usually seen resting in caves and ledges or otherwise feeding on sea sponges.

No major nesting sites have been recorded in Victoria or Tasmania, however the DoEE (2017a) maps the hawksbill turtle as having a known or likely range in eastern Bass Strait. There has been one sighting of the species recorded in the EMBA (CIE, 2020). The spill EMBA does not intersect any nesting beaches of the hawksbill turtle; it possibly occurs in the spill EMBA as a vagrant.

Flatback turtle (EPBC Act: Vulnerable, listed migratory)

A comparison of presence and absence for the flatback turtle between the database searches of the survey area and spill EMBA is presented in Table 5.51 below.

Table 5.51 Presence of flatback turtle according to PMST, ALA & VBA database searches

	PMST	ALA	VBA	SAST
Survey area	No records	No records	No records	No records
EMBA	Recorded	No records	No records	No records

In Australia, the flatback turtle (*Natador depressus*) is found only in the tropical waters of northern Australia, where it feeds on soft-bodied prey. Nesting occurs only in these tropical waters. The DAWE (2020b) maps the flatback turtle as having a known or likely range north of the Victorian/NSW border. The CIE database (2020) does not contain any records of this species on the southern coast of Australia. This species could be encountered in the far eastern extent of the EMBA but is unlikely to be present in the survey area.

5.5.9. Birds

Given the nature of the activity, the focus of this section is true seabirds (i.e., birds of the order *Procellariiformes*) and true shorebirds (i.e., birds of the order Charadriiformes). Seabirds are those whose normal habitat and food source is derived from the sea, whether that be coastal or offshore, while shorebirds spend more of their time (nesting, feeding and breeding) on the shoreline and do not swim.

Migratory and resident shorebirds would not be expected to be found within the marine waters of the survey area. Rather, shorebirds are more likely to be encountered along shorelines and coastal wetlands of the spill EMBA. The species descriptions provided in this chapter are focused on species that are listed as threatened under the EPBC Act.

The databases used to inform this section are noted below, with summaries of search findings:

- PMST – records 69 bird species (seabirds and shorebirds) under the EPBC Act as potentially occurring in the survey area and EMBA (Table 5.52, Appendix 10). The majority of these are listed as migratory and marine species. Figure 5.39 illustrates the likely temporal presence and absence of seabirds and shorebirds in the survey area and EMBA.
- VBA – records 57 seabirds and 53 shorebirds from the EMBA, summarised in Table 5.52 and the full list presented in Appendix 13.

- ALA – records 25 seabirds (shearwaters, albatross and petrels) in the survey area. For the EMBA, the ALA records 65 seabird species (predominantly shearwaters, albatross, penguins, petrels, gulls and prions), and 56 shorebird species (predominantly sandpipers, plovers, terns, curlews, oystercatchers and lapwings). The full list of records is presented in Appendix 12.
- Shorebird 2020 – records 28 species for the King Island search area adjacent to the survey area, and 79 species are recorded for the shorelines of the EMBA. Each of these species were either also recorded in the PMST database search for the survey area and EMBA or are not threatened species. The full list of records is presented in Appendix 14.

Many of the birds listed in Table 5.52 are listed in the following international conventions that aim to protect the species and/or their habitat:

- Republic of Korea Migratory Birds Agreement 2006 (ROKAMBA);
- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA);
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.
- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 (JAMBA); and
- Convention on Wetlands of International Important especially as Waterfowl Habitat 1971 ('Ramsar Convention', see also Section 5.5.9).

Table 5.52 EPBC-listed bird species that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
PMST								
Seabirds (29) - Albatross								
Diomedea antipodensis	Antipodean albatross	Vulnerable	Yes	Yes	Yes	Yes	Foraging	Generic Recovery Plan in place for all albatross in Australia
Diomedea antipodensis gibsoni	Gibson's albatross	Vulnerable	-	Yes	No	Yes	-	
Diomedea epomophora	Southern royal albatross	Vulnerable	Yes	Yes	Yes	Yes	-	
Diomedea exulans	Wandering albatross	Vulnerable	Yes	Yes	Yes	Yes	Foraging	
Diomedea sanfordi	Northern royal albatross	Endangered	Yes	Yes	Yes	Yes	-	
Phoebetria fusca	Sooty albatross	Vulnerable	Yes	Yes	Yes	Yes	-	
Thalassarche bulleri	Buller's albatross	Vulnerable	Yes	Yes	Yes	Yes	Foraging	
Thalassarche bulleri platei	Northern Buller's albatross	Vulnerable	-	Yes	Yes	Yes	-	
Thalassarche cauta	Shy albatross	Endangered	Yes	Yes	Yes	Yes	Foraging	
Thalassarche chrysostoma	Grey-headed albatross	Endangered	Yes	Yes	Yes	Yes	-	
Thalassarche eremita	Chatham albatross	Endangered	Yes	Yes	No	Yes	-	
Thalassarche impavida	Campbell albatross	Vulnerable	Yes	Yes	Yes	Yes	Foraging	
Thalassarche melanophris	Black-browed albatross	Vulnerable	Yes	Yes	Yes	Yes	Foraging	
Thalassarche salvini	Salvin's albatross	Vulnerable	Yes	Yes	Yes	Yes	-	

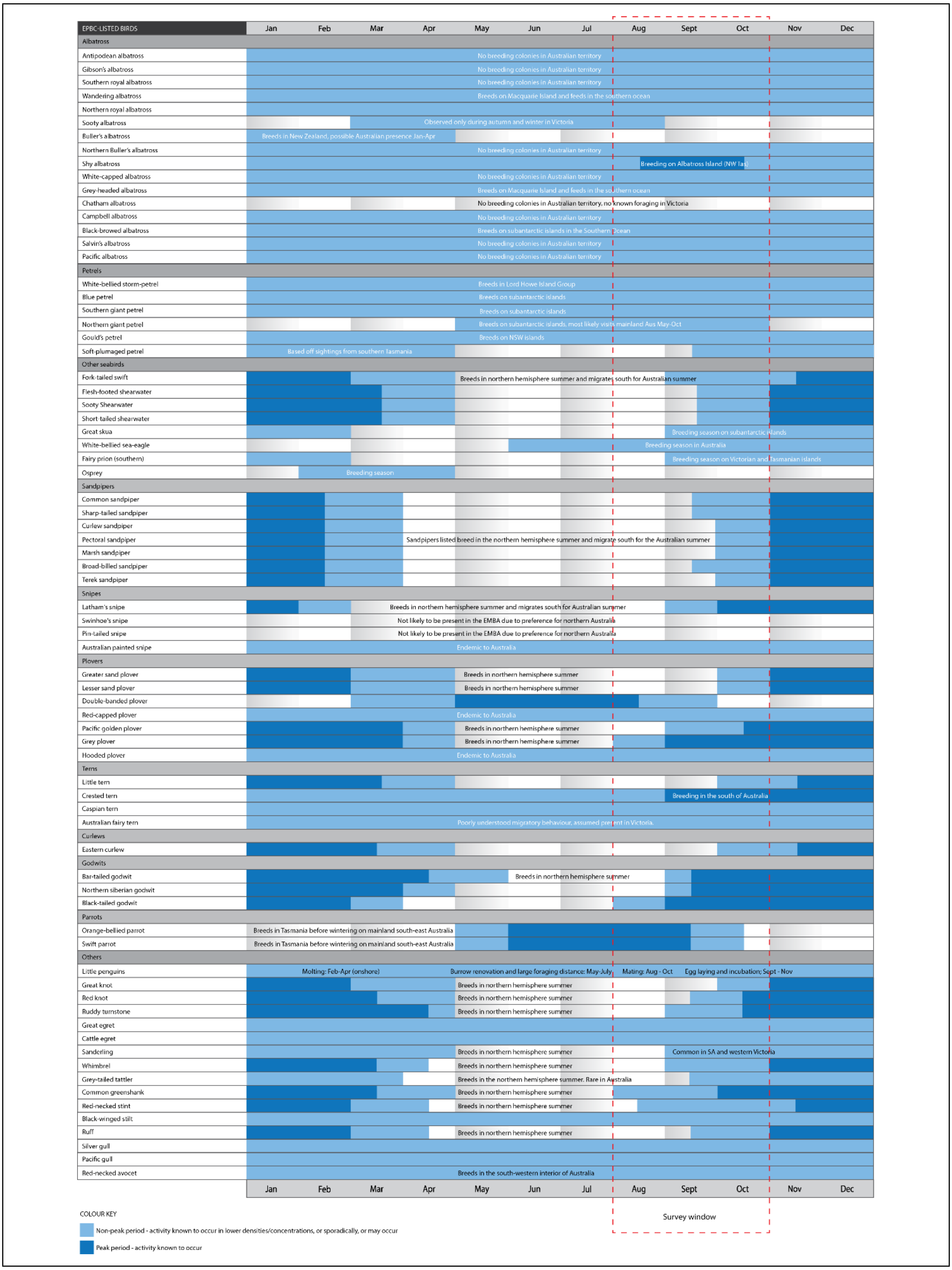
Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Thalassarche sp. nov.	Pacific albatross	Vulnerable	-	Yes	Yes	Yes	-	
Thalassarche steadi	White-capped albatross	Vulnerable	Yes	Yes	Yes	Yes	-	
Seabirds - petrels								
Fregetta grallaria grallaria	White-bellied storm-petrel	Vulnerable	-	-	Yes	Yes	-	-
Halobaena caerulea	Blue petrel	Vulnerable	-	Yes	Yes	Yes	-	-
Macronectes giganteus	Southern giant-petrel	Vulnerable	Yes	Yes	Yes	Yes	-	Generic Recovery Plan for giant petrels
Macronectes halli	Northern giant petrel	Vulnerable	-	Yes	Yes	Yes	-	
Pterodroma leucoptera-leucoptera	Gould's petrel	Endangered	-	-	Yes	Yes	-	Recovery Plan
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	-	Yes	Yes	Yes	Foraging	Conservation Advice
Other seabirds								
Ardenna carneipes	Flesh-footed shearwater	-	Yes	-	Yes	Yes	-	-
Ardenna grisea	Sooty shearwater	-	Yes	-	Yes	Yes	Foraging	-
Ardenna tenuirostris	Short-tailed shearwater	-	Yes	Yes	No	Yes	Foraging	-
Catharacta skua	Great skua	-	-	Yes	Yes	Yes	-	-
Haliaeetus leucogaster	White-bellied sea-eagle	-	-	Yes	No	Yes	-	-

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Pandion haliaetus	Osprey	-	Yes	Yes	Yes	Yes	-	-
Pachyptila turtur - subantarctica	Fairy prion (southern)	Vulnerable	-	Yes	Yes	Yes	-	Conservation Advice
Puffinus carneipes	Flesh-footed shearwater	-	-	Yes	Yes	Yes	-	-
Shorebirds (40)								
Actitis hypoleucos	Common sandpiper	-	Yes	Yes	Yes	Yes	-	-
Arenaria interpres	Ruddy turnstone	-	Yes	Yes	No	Yes	-	-
Apus pacificus	Fork-tailed swift	-	Yes	Yes	No	Yes	-	-
Calidris acuminata	Sharp-tailed Sandpiper	-	Yes	Yes	Yes	Yes	-	-
Calidris alba	Sanderling	-	Yes	Yes	No	Yes	-	-
Calidris canutus	Red knot	Endangered	Yes	Yes	Yes	Yes	-	Conservation Advice
Calidris ferruginea	Curlew sandpiper	Critically Endangered	Yes	Yes	Yes	Yes	-	Conservation Advice
Calidris tenuirostris	Great knot	Critically Endangered	Yes	Yes	No	Yes	-	Conservation Advice
Calidris melanotos	Pectoral sandpiper	-	Yes	Yes	Yes	Yes	-	-
Charadrius bicinctus	Double-banded plover	-	Yes	Yes	No	Yes	-	-
Charadrius leschenaultia	Greater sand plover	Vulnerable	Yes	Yes	No	Yes	-	Conservation Advice

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Charadrius mongolus	Lesser sand plover	Endangered	Yes	Yes	No	Yes	-	Conservation Advice
Gallinago hardwickii	Latham's snipe	-	Yes	Yes	No	Yes	-	-
Gallinago megala	Swinhoe's snipe	-	Yes	Yes	No	Yes	-	-
Gallinago stenura	Pin-tailed snipe	-	Yes	Yes	No	Yes	-	-
Hydroprogne caspia	Caspian tern	-	Yes	Yes	No	Yes	-	-
Larus dominicanus	Kelp gull	-	-	Yes	No	Yes	-	-
Larus novaehollandiae	Silver gull	-	-	Yes	No	Yes	-	-
Larus pacificus	Pacific gull	-	-	Yes	No	Yes	-	-
Lathamus discolor	Swift parrot	Critically Endangered	-	Yes	No	Y	-	-
Limicola falcinellus	Broad-billed sandpiper	-	Yes	Yes	No	Y	-	-
Limosa lapponica baueri	Bar-tailed godwit	Vulnerable	Yes	Yes	No	Y	-	-
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered	Yes	Yes	No	Y	-	Conservation Advice
Limosa limosa	Black-tailed godwit	-	Yes	Yes	No	Y	-	-
Neophema chrysogaster	Orange-bellied parrot	Critically Endangered	-	Yes	Y	Y	-	Recovery Plan
Numenius madagascariensis	Eastern curlew	Critically Endangered	Yes	Yes	Y	Y	-	Conservation Advice
Numenius minutus	Little curlew	-	Yes	Yes	No	Y	-	-
Numenius phaeopus	Whimbrel	-	Yes	Yes	No	Y	-	-
Philomachus pugnax	Ruff (reeve)	-	Yes	Yes	No	Y	-	-

Scientific name	Common name	EPBC Act Status			Recorded in		BIA within the EMBA?	Recovery plan in place?
		Listed threatened species	Listed migratory species	Listed marine species	Survey area	EMBA		
Pluvialis fulva	Pacific golden plover	-	Yes	Yes	No	Y	-	-
Pluvialis squatarola	Grey plover	-	Yes	Yes	No	Y	-	-
Rostratula australis	Australian painted snipe	Endangered	-	Yes	No	Y	-	Conservation Advice
Sternula albifrons	Little tern	-	Yes	Yes	No	Y	-	-
Sternula nereis nereis	Australian fairy tern	Vulnerable	-	-	Y	Y	-	Conservation Advice
Thalasseus bergii	Crested tern	-	Yes	Yes	No		-	-
Thinornis rubricollis rubricollis	Hooded plover (eastern)	Vulnerable	-	Yes	Y	Y	-	Conservation Advice
Tringa brevipes	Grey-tailed tattler	-	Yes	Yes	No	Y	-	-
Tringa nebularia	Common greenshank	-	Yes	Yes	No	Y	-	-
Tringa stagnatilis	Marsh sandpiper	-	Yes	Yes	No	Y	-	-
Xenus cinereus	Terek sandpiper	-	Yes	Yes	No	Y	-	-
ALA								
No additional species								
VBA								
No additional species								
Shorebirds 2020								
No additional species								

Figure 5.39 Annual presence and absence of seabirds in the survey area and spill EMBA

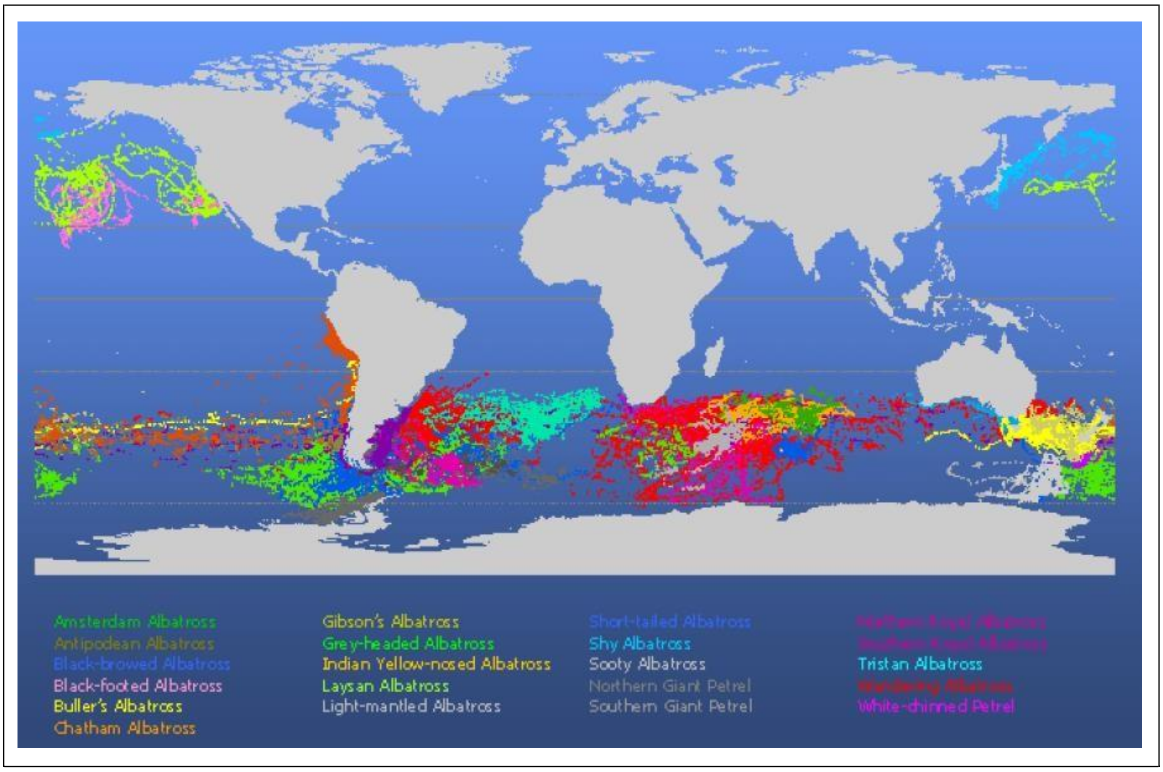


Seabirds

Albatrosses and petrels (EPBC Act: Endangered & vulnerable, listed migratory, listed marine)

Table 5.52 lists albatross and petrel species which may be present in the survey area and EMBA. Albatrosses and giant-petrels are among the most oceanic of all seabirds, and seldom come to land unless breeding (DSEWPC, 2011a). Many species, such as antipodean albatross, are extremely dispersive, spending most of their time over the pelagic waters of the oceans while others like adult shy albatrosses, tend to remain sedentary, regularly foraging over coastal waters throughout their adult lives (DSEWPC, 2011a). 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 25o where many species spend the majority of their foraging time (DSEWPC, 2011a). Figure 5.40 presents the results of tracking studies undertaken on albatross species and demonstrates the extremely dispersive behaviours of the various species.

Figure 5.40 Albatross and petrel tracking database



Source: DSEWPC (2011c).

The albatross species listed in Table 5.52 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, grey-headed albatross and shy albatross breed in Australian jurisdictions (DSEWPC, 2011a).

The remaining 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 Island (TAS) [shy albatross] (90 km east) (intersected by the EMBA); and Macquarie Island [black-browed albatross, grey-headed albatross & wandering albatross] (1940 km southeast) (outside the EMBA) (ACAP, 2012; DSEWPC, 2011a).

The petrel species listed in Table 5.52 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 40OS and 60OS. Petrel species feed on small fish, cephalopods (octopus, squid & cuttlefish) and crustaceans along the edge of the continental shelf and open waters (DEWHA, 2007). No breeding colonies or nesting areas for listed petrel species are located within or adjacent to the proposed survey area. The closest breeding islands to the survey area, but outside the EMBA, are Maatsukyer Island (TAS) [soft plumaged petrel] (420 km southeast) and Macquarie Island [blue petrel, northern & southern giant petrels] (1,940 km southeast) (ACAP, 2012; DSEWPC, 2011c).

The survey area spatially overlaps the following BIAs for albatross and petrel species:

- Albatross (foraging BIAs) - wandering albatross; antipodean albatross; Tasmanian shy albatross; Buller's albatross; Campbell albatross; black-browed albatross and Indian yellow-nosed albatross.
- Petrels (foraging BIAs) - common diving petrel and white-faced storm petrel.

Albatross and petrels are likely to overfly and forage within the survey area during the survey period as well as in the EMBA.

Fairy prion (southern) (EPBC Act: Vulnerable, listed marine)

The southern fairy prion (Pachyptila turtur subantarctica) is mainly found offshore. The species diet is comprised mostly of crustaceans (especially krill), but occasionally includes some fish and squid. It feeds mainly by surface-seizing and dipping, but can also catch prey by surface-plunging or pattering (Birdlife Australia, 2020). In Australia, it is known to breed only on Macquarie Island (2,030 km southeast of the Project area), and on the nearby Bishop and Clerk islands (Birdlife Australia, 2020). No BIA for this species lies within the survey area or EMBA (DAWE, 2020c). Encounter with this species is possible during survey activities.

A comparison of presence and absence for the fairy prion (southern) between the database searches of the survey area and spill EMBA is presented in Table 5.53 below.

Table 5.53 Presence of fairy prion according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	Recorded	No records
EMBA	Recorded	Recorded	Recorded

Shorebirds and coastal species Plovers

There are six EPBC Act-listed plovers (double-banded, greater sand, lesser sand, Pacific golden, grey and hooded) that may occur within the EMBA and survey area. Plovers are medium sized wading birds that have wide-ranging coastal habitats comprising estuaries, bays, mangroves, damp grasslands, sandy beaches, sand dunes, mudflats and lagoons (Flegg, 2002), with roosting also taking place on sand bars and spits. Plovers feed on a range of molluscs, worms, crustaceans and insects. Plovers (with the exception of the hooded and red-capped lovers) breed in Asia and the Artic region and are more likely to be present in Australia during summer, depending on the species.

The hooded plover (EPBC Act: Vulnerable) breeds in Australia and builds its nests in sandy oceanic beaches. The location of these nests presents the greatest threat to this species' population, as nests, eggs and chicks are vulnerable to predation and trampling (Birdlife Australia, 2020). A comparison of presence and absence for the hooded plover between the database searches of the survey area and spill EMBA is presented in Table 5.54 below.

Table 5.54 Presence of hooded plover according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	Recorded
EMBA	Recorded	Recorded	Recorded

The greater sand plover (EPBC Act: Vulnerable) and lesser sand plover (EPBC Act: Endangered) are migratory shorebirds that breed in the northern hemisphere summer. The species arrive in Australia as non-breeding migrants in spring before departing in autumn (Birdlife Australia, 2020). They roost during high tide on sandy beaches, spits and rocky shores and forage on wet ground at low tide, usually away from the edge of the water. Their diet includes insects, crustaceans, polychaete worms and molluscs. A comparison of presence and absence for each species between the database searches of survey area and spill EMBA is presented in Table 5.55 below.

Table 5.55 Presence of greater sand plover and less sand plover according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	Recorded	Recorded

Terns

There are four EPBC Act-listed tern species (Caspian, little, fairy and crested) that may occur within the EMBA. Terns are slender, lightly built birds with long, forked tails, narrow wings, long bills, and relatively short legs. Many of the tern species present along the southern Australian coastline are widespread and occupy beach, wetland and grassland habitats. Terns rarely swim; they hunt for prey in flight, dipping to the water surface or plunge-diving for prey (Flegg, 2002) usually within sight of land for fish, squid, jellyfish and sometimes crustaceans (DEHWA, 2007).

The Australian fairy tern (EPBC Act: Vulnerable) population is estimated to be 5000 mature individuals that utilise offshore, estuarine, lacustrine, wetland, beach and spit habitats (DSEWPC, 2011b). The species nests above the high-water mark in clear view of the water and on sites where the substrate is sandy and the vegetation low and sparse (DSEWPC, 2011b). Australian fairy terns are threatened by predation from introduced mammals, disturbance by humans, dogs and vehicles (DSEWPC, 2011b).

A comparison of presence and absence for the Australian fairy tern between the database searches of the survey area and spill EMBA is presented in Table 5.56 below.

Table 5.56 Presence of Australian fairy tern according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

Sandpipers

There are seven EPBC Act-listed sandpiper species (common, sharp-tailed, pectoral, broad-billed, marsh and terek) that may occur within the survey area and spill EMBA. Sandpipers are small wader species found in coastal and inland wetlands, particularly in muddy estuaries, feeding on small marine invertebrates (Birdlife

Australia, 2020). Sandpipers breed in Europe and Asia and migrate to Australia during the southern summer (Birdlife Australia, 2020).

The curlew sandpiper (EPBC Act: Critically endangered) is a common visitor during the Australian summer, congregating in large flocks, sometimes comprising thousands of birds, at sheltered intertidal mudflats and also at the muddy margins of terrestrial wetlands (Birdlife Australia, 2020). They often mix with other species of shorebirds, pecking at invertebrates on the surface of the mud or making shallow probes below its surface, sometimes wading in belly-deep water while probing. Feeding becomes more intense as migration time approaches, with birds fuelling up for their long flight back to their breeding grounds in Siberia. Up to 1,800 curlew sandpiper are known to congregate to feed at the Gippsland Lakes (outside the EMBA).

A comparison of presence and absence for the curlew sandpiper between the database searches of the survey area and spill EMBA is presented in Table 5.57 below.

Table 5.57 Presence of curlew sandpiper according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	Recorded
EMBA	Recorded	Recorded	Recorded

Snipes

There are four EPBC-Act listed snipe species (Latham's, Swinhoe's, pin-tailed and Australian painted) that may occur within the survey area and EMBA. These snipe species (other than the Australian painted snipe, which is endemic to Australia) are present during the southern hemisphere summer (breeding in Asia and Russia in the northern hemisphere summer).

The Australian painted snipe (*Rostratula australis*) (EPBC Act: Endangered) is a medium-sized wader that roosts among dense vegetation around the edge of wetlands, especially temporary ones which have muddy margins and small, low-lying islands where it feeds on seeds and invertebrates (Birdlife Australia, 2020). The species is known to occur at Mallacoota Inlet. The nest of the species is usually a scrape in the ground lined with twigs and stalks of grass. It is threatened by the loss and degradation of wetlands, through drainage and diversion of water for agriculture and reservoirs (Birdlife Australia, 2020).

A comparison of presence and absence for the Australian painted snipe between the database searches of the survey area and spill EMBA is presented in Table 5.58 below.

Table 5.58 Presence of Australian painted snipe according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	Recorded	No records

Godwits

There are three EPBC Act-listed godwit species (bar-tailed, northern Siberian and black-tailed) that may occur within the survey area and EMBA. Godwits are large waders that are found around all coastal regions of Australia during the southern hemisphere summer (breeding in Europe during the northern hemisphere summer), though the largest numbers remain in northern Australia.

The bar-tailed godwit (EPBC Act: Vulnerable) and the northern Siberian bar-tailed godwit (EPBC Act: Critically endangered) arrive in Australia each year in August from breeding grounds in the northern hemisphere. They are commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit where they forage on intertidal mudflats or sandflats, in soft mud or shallow water and occasionally in shallow estuaries where they feed on annelids, crustaceans, arachnids, fish eggs and spawn and tadpoles of frogs, and occasionally seeds. (Birdlife Australia, 2020).

A comparison of presence and absence for each species between the database searches of the survey area and spill EMBA is presented in Table 5.59 and Table 5.60 below.

Table 5.59 Presence of bar-tailed godwit according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	No records	Recorded

Table 5.60 Presence of Siberian bar-tailed godwit according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No Records	No Records	No Records
EMBA	Recorded	No Records	Recorded

Knots

The red knot (EPBC Act: Endangered) and great knot (EPBC Act: Critically endangered) are EPBC Act-listed species that may occur within the survey area and EMBA during summer. Both the red knot and great knot have a coastal distribution around the entire Australian coastline when it is present during the southern hemisphere summer (breeding in eastern Siberia in the northern hemisphere summer). The red knot is a medium-sized wader that prefers sandy beach, tidal mudflats and estuary habitats, where they feed on bivalve molluscs, snails, worms and crustaceans (Birdlife Australia, 2020). The great knot inhabits intertidal mudflats and sandflats in sheltered coasts, including bays harbours and estuaries. They forage on the moist mud, and they often roost on beaches or in nearby low vegetation, such as mangroves or dune vegetation. Lake Reeve (outside the EMBA) has supported the largest concentration (5,000) of red knot recorded in Victoria.

A comparison of presence and absence for each species between the database searches of the survey area and spill EMBA is presented in Table 5.61 and Table 5.62 below.

Table 5.61 Presence of red knot according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

Table 5.62 Presence of great knot according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	Recorded	Recorded

Eastern curlew (EPBC Act: Critically endangered)

A comparison of presence and absence for the eastern curlew between the database searches of the survey area and spill EMBA is presented in Table 5.63 below.

Table 5.63 Presence of eastern curlew according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No Records	No Records
EMBA	Recorded	Recorded	Recorded

The eastern curlew (*Numenius madagascariensis*) is the largest wader that visits Australia, with a very long down-curved bill. The species is found on intertidal mudflats and sandflats, often with beds of seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons (Birdlife Australia, 2020). The eastern curlew is widespread in coastal regions in the northeast and south of Australia, including Tasmania, and scattered in other coastal areas and is rarely seen inland. It breeds in Russia and north-eastern China. The eastern curlew eats mainly small crabs and molluscs.

Orange-bellied parrot (EPBC Act: Critically Endangered)

A comparison of presence and absence for the orange-bellied parrot between the database searches of the survey area and spill EMBA is presented in Table 5.64 below.

Table 5.64 Presence of Orange-bellied parrot according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	Recorded	No records	No records
EMBA	Recorded	Recorded	Recorded

The orange-bellied parrot (*Neophema chrysogaster*) breeds in Tasmania during summer, migrates north across Bass Strait in autumn and over-winters on the mainland. Birds depart the mainland for Tasmania from September to November (Green, 1969). The southward migration is rapid (Stephenson, 1991), so there are few migration records. The northward migration across western Bass Strait is more prolonged (Higgins, 1999).

The parrot's breeding habitat is restricted to southwest Tasmania, where breeding occurs from November to mid-January mainly within 30 km of the coast (Brown and Wilson, 1980). The species forage on the ground or in low vegetation (Brown and Wilson, 1980; 1984, Loyn et al., 1986). During winter, on mainland Australia, orange-bellied parrots are found mostly within 3 km of the coast (DELWP, 2016).

In Victoria, they mostly occur in sheltered coastal habitats, such as bays, lagoons and estuaries, or, rarely, saltworks. They are also found in low samphire herbland dominated by beaded glasswort (Sarcocornia quinqueflora), sea heath (Frankenia pauciflora) or sea-blite (Suaeda australis), and in taller shrubland dominated by shrubby glasswort (Sclerostegia arbuscula) (DELWP, 2016). Given its habitat preferences, this species does not occur within the survey area and is unlikely to occur within the EMBA other than overflying it.

Swift parrot (EPBC Act: Critically Endangered)

A comparison of presence and absence for the swift parrot between the database searches of the survey area and spill EMBA is presented in Table 5.65 below.

Table 5.65 Presence of swift parrot according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	No records	No records
EMBA	Recorded	Recorded	Recorded

The swift parrot (*Lathamus discolour*) is a small parrot that has rapid, agile flight. During summer, it breeds in colonies in blue gum forest of south-east Tasmania. Infrequent breeding also occurs in northwest Tasmania. The entire population migrates to the mainland for winter. On the mainland it disperses widely and forages on flowers and psyllid lerps in eucalypts. The birds mostly occur on inland slopes, but occasionally occur on the coast (TSSC, 2016c). The ALA and VBA have no records of knots in the survey area, but records for this species exist for the EMBA in both databases. Given its habitat preferences, this species does not occur within the survey area and is unlikely to occur within the EMBA other than overflying it.

Little penguin (EPBC Act: listed marine)

A comparison of presence and absence for the little penguin between the database searches of the survey area and spill EMBA is presented in Table 5.66 below.

Table 5.66 Presence of little penguin according to PMST, ALA & VBA database searches

	PMST	ALA	VBA
Survey area	No records	Recorded	No records
EMBA	No records	Recorded	Recorded

A little penguin BIA (breeding and foraging) is intersected by the spill EMBA, as shown in Figure 5.41. Little penguins are known to breed throughout southern Australia from Western Australia to New South Wales, including Bass Strait and Tasmania. Most little penguins stay at sea throughout autumn and winter, although some will return frequently to their burrows all year round. Little penguins breed from August to October, nesting from late September to about late October with incubation through to mid-November while chick raising occurs over the subsequent summer months (Arnould and Berlincourt, 2013; CSIRO, 2000; Gormley and Dann, 2009). Table 5.67 summarises little penguin daily and seasonal behaviour.

Little penguins have an annual breeding cycle that results in their behaviour and activity changing considerably throughout the year. Little penguins are known to travel considerable distance during the non-breeding season and display much shorter foraging behaviour during the chick raising phase of their cycle. During the breeding period, the penguins forage close to the colonies to attend to their chicks daily. By winter the chicks have fledged and the adults have moulted and can undertake foraging trips of extended duration in order to regain the weight lost during the autumn moulting period (CSIRO, 2000; Gormley and Dann, 2009). For the duration of the survey period (September to October), little penguins are likely to conduct shorter foraging trips and stay closer to their nests in comparison to the winter period.

Little penguins tracked from Phillip Island during the winter were shown to travel hundreds of kilometres and stay away from the colony for periods lasting a couple of weeks. Port Phillip Bay (intersected by the EMBA) was heavily utilised, suggesting that this area is an important feeding ground for the little penguin (Arnould and Berlincourt, 2013).

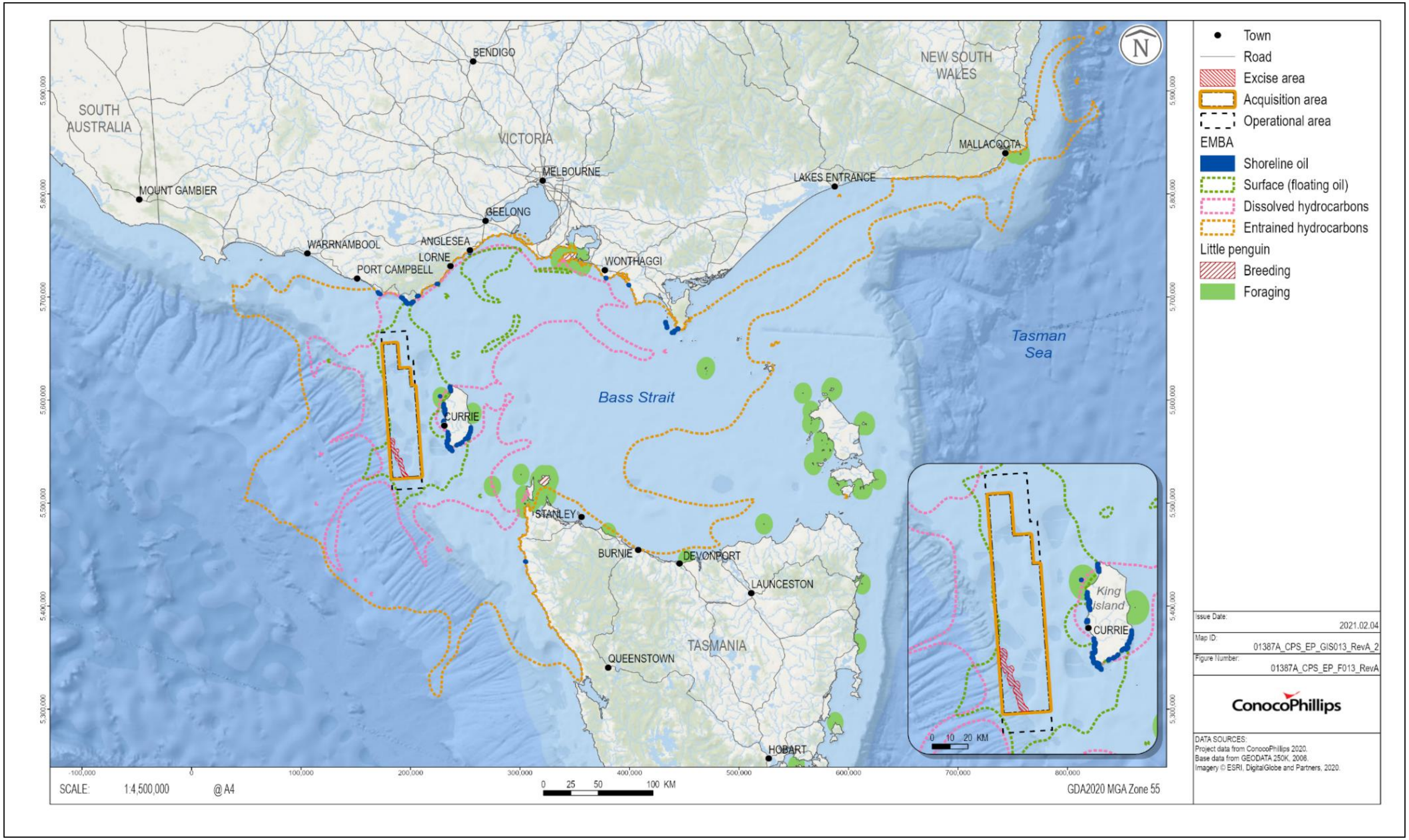
There are many little penguin colonies along the Victorian coast and their size varies considerably from six to 35,000 birds at Pyramid Rock and Gabo Island respectively (both intersected by the EMBA). One of

Australia's largest little penguin colonies of approximately 26,000 breeding individuals exist on the Summerland Peninsula, Phillip Island (intersected by the EMBA). There are also smaller colonies on rocky islands off Wilsons Promontory and King Island (both intersected by the EMBA) (Arnould and Berlincourt, 2013).

Table 5.67 Summary of little penguin seasonal behaviour

Behaviour	Description
Residency at nesting sites	All year
Daily cycle to and from shore: Leaving Arriving	1 - 2 hr before sunrise Majority (60%) arrive in the first 50 min of sunset, the rest within 2 hours
Feeding	Mainly small fish such as pilchards, anchovies and squid
Diving depth	Usually less than 10 m but can dive to 70 m
Underwater time	Usually 4 - 45 seconds
Travel distance each day	15 – 50 km
Mating period	August - October
Egg laying	September - October (on Phillip Island)
Incubation period	35 days
Age when chicks go to sea	8 - 10 weeks after hatching
Moulting	Feb - April for about 17 days - birds remain onshore
Renovation of burrows and courtship	May – August, depending on food supply

Figure 5.41 Little penguin BIA intersected by the EMBA



5.5.10. Marine pests

It is widely recognised that marine pests can become invasive and cause significant impacts on economic, ecological, social and cultural values of marine environments. Impacts can include the introduction of new diseases, altering ecosystem processes and reducing biodiversity, causing major economic loss and disrupting human activities (Brusati and Grosholz, 2007).

In the South-east Marine Region, 115 marine pest species have been introduced and an additional 84 have been identified as possible introductions, or 'cryptogenic' species (NOO, 2002). Several introduced species have become pests either by displacing native species, dominating habitats or causing algal blooms.

Transport mechanisms of marine pests in the marine environment have largely been associated with commerce and exploration. These include:

- Wooden-hulled vessel boring;
- Biofouling;
- Dry and semidry ballast;
- Steel-hulled vessel biofouling and the transport of planktonic organisms and fragments in ballast water
- Intentional transfer of aquaculture and mariculture organisms;
- Transfer of live, frozen and dried food products and aquarium trade;
- Use of biological material for packing (e.g., Ribera Siguan 2002, 2003; Miller et al. 2004); and
- Explicit transport of species for scientific research.

Marine pests known to occur in Bass Strait, according to Parks Victoria (2020), include:

- Pacific oyster (*Crassostrea gigas*) – small number of this oyster species are reported to occur in Western Port Bay and at Tidal River in the Wilsons Promontory National Park.
- Northern pacific seastar (*Asterias amurensis*) – prefer soft sediment habitat, but also use artificial structures and rocky reefs, living in water depths usually less than 25 m (but up to 200 m water depths). It is thought to have been introduced through ballast water from Japan.
- New Zealand screw shell (*Maoricolpus roseus*) – lies on or partially buried in sand, mud or gravel in waters up to 130 m deep. It can densely blanket the sea floor with live and dead shells and compete with native scallops and other shellfish for food. This species is known to be present in the Port Phillip and the Western Port region.
- European shore crab (*Carcinus maenas*) – prefers intertidal areas, bays, estuaries, mudflats and subtidal seagrass beds, but occurs in waters up to 60 m deep. It is widespread across Victorian intertidal reef and common in Western Port.
- Dead man's fingers (*Codium fragile ssp*.) – Widespread in Port Phillip and known to inhabit San Remo and Newhaven in Western Port. It grows rapidly to shade out native vegetation and can regenerate from a broken fragment enabling easy transfer from one area to another. Attaches to subtidal rocky reed and other hard surfaces.
- Asian date mussel (*Musculista senhousia*) – prefers soft sediments in waters up to 20 m deep, forming mats and altering food availability for marine fauna.

The Marine Pests Interactive Map (DAFF, 2020) indicates that the major ports likely to be used to support the survey (e.g., Geelong, Melbourne and Portland) are known to harbour the following species:

- Northern pacific seastar – as above.
- European shore crab – as above.
- European fan worms (Sabella spallanzannii) – attaches to hard surfaces, artificial structures and soft sediments, preferring sheltered waters up to 30 m deep. It reached Port Phillip Bay in the mid 1980s and is a nuisance fouler (Parks Victoria, 2020).

- Japanese kelp (Undaria pinnatifida) – occupies cold temperate oceanic waters up to 20 m deep, growing on rock, reef, stones and artificial structures. It rapidly forms dense forests and overgrows native species. It first established in Port Phillip Bay in the 1980s (Parks Victoria, 2020).
- Asian date mussel (Musculista senhousia) – prefers soft sediments in waters up to 20 m deep, forming mats and altering food availability for marine fauna.

5.6. Cultural Heritage

5.6.1. Aboriginal heritage

Victoria

Gunaikurnai people are the traditional owners of Gippsland. There are currently approximately 3,000 Gunaikurnai people and the territory includes the coastal and inland areas to the southern slopes of the Victorian Alps. Gunaikurnai people are made up of five major clans (GLaWAC, 2020). The Victorian Aboriginal Heritage Register contains details of Aboriginal cultural heritage places and objects along the coastline.

However, the register is not publicly accessible in order to protect culturally sensitive information.

The Gippsland, northern Tasmanian and Bass Strait islands coastlines are of Aboriginal cultural heritage significance. Coastal fishing is an important part of Aboriginal culture with fishing methods including hand gathering, lines, rods and reels, nets, traps and spears (DoE, 2015a). It has been estimated that between 5,000 and 10,000 indigenous Australians occupied Tasmania prior to European settlement. Indigenous peoples in the area fished and collected shellfish, and seals and mutton birds were also important sources of food (DoE, 2015a).

Crustaceans (e.g., SRL, crab) and shellfish formed an important part of the diet of Aboriginal people living along the coast. There are numerous areas containing Aboriginal shell middens (i.e., the remains of shellfish eaten by Aboriginal people) along the sand dunes of the Gippsland coast. Coastal shell middens are found as layers of shell exposed in the side of dunes, banks or cliff tops or as scatters of shell exposed on eroded surfaces. These areas may also contain charcoal and hearth stones from fires, and items such as bone and stone artefacts, and are often located within sheltered positions in the dunes, coastal scrub and woodlands. Other archaeological sites present along the Gippsland coast include scar trees and assorted artefact scatters (Basslink, 2001).

Tasmania

Aboriginal people have inhabited Tasmania for at least 35,000 years. At the end of the last ice age the sea level rose, and Tasmania became isolated from the mainland of Australia. They survived in the changing landscape partly due to their ability to harvest aquatic resources, such as seals and shellfish. Following conflict between the European colonists and the Tasmanian Aboriginal peoples, leading to the relocation of people to missions on Bruny Island, Flinders Island and other sites, and finally to Oyster Cove, their numbers diminished drastically. The Aboriginal Heritage Register lists over 13,000 sites; however, there is no searchable database to identify any sites in the EMBA.

There are known sites that occur on the west coast of Tasmania associated with the West Tasmanian Aboriginal Cultural Landscape (as described in Section 5.1.3).

King Island

Archaeological evidence suggests that the island was inhabited by Aboriginal people during the Pleistocene when King Island was connected to Tasmania, however by the time of earliest European occupation in the early 18th Century, no Aboriginal people inhabitants were observed (Huys, 2012). Stone artefacts have been recorded on the island along southwestern coastal cliffs, at the Petrified Forest and elsewhere on the island in different dune formations.

Aboriginal heritage sites on King Island typically contain low density stone artefact scatters with isolated midden finds. These sites are mostly located in close proximity to freshwater sources, particularly freshwater lagoons found in numerous locations on the island (Sim, 1991). On King Island there is less visibility of Aboriginal heritage in coastal areas as the west and southwest coast has been inundated by dune formation with middens (shellfish and bones) only exposed through dune blowouts (Sim, 1991).

Locations on King Island where Aboriginal middens have been observed include Cataraqui Monument (a quarry site 500 m from the Cataraqui Point headland), Quarantine Bay (shellfish midden located 15 m above sea level and 350 m inland), Seal Bay at Middle Point (warrener shell midden located 30 m inland and 5 m above sea level) and New Year Island (Sim, 1991). Sea caves (Cliff Cave, Iron Monarch and Blister Cave) examined for Aboriginal heritage indicate caves were not used in pre-historic times, except one possible artefact at the entrance to Iron Monarch. Human remains dating to 14,270 BC have been found in the Cliff Cave at a depth of 2.9 m and on New Year Island resulting from a dune blowout in the 1970s (Sim, 1991).

5.6.2. Native Title

Victoria

In 2010, the Federal Court recognised that the Gunaikurnai holds native title over much of Gippsland. On the same day the state entered into an agreement with the Gunaikurnai under the Traditional Owner Settlement Act 2010. The agreement area extends from west Gippsland near Warragul and Inverloch east to the Snowy River and north to the Great Dividing Range. It also includes 200 m of sea country offshore. The determination of native title under the Native Title Act 1993 (Cth) covers the same area (GLaWAC, 2020).

The agreement and the native title determination only affect undeveloped Crown land within the Gippsland region.

The Gunaikurnai and Victorian Government Joint Management Plan was approved by the Minister for Energy, Environment and Climate Change in July 2018. The plan guides the partnership between the Gunaikurnai people and the Victorian Government in the joint management of the ten parks and reserves for which the Gunaikurnai have gained Aboriginal Title as a result of their 2010 Recognition and Settlement Agreement with the Victorian Government.

An additional native title claim area is intersected by the EMBA that includes Cape Otway and the waters 100 m seaward from the mean low-water mark of the coastline. In 2012, the Eastern Maar traditional owner group lodged a native title determination application in the Federal Court of Australia which was registered on 20 March 2013. The Eastern Maar Aboriginal Corporation manages these native titles rights for Eastern Maar Peoples. The Eastern Maar traditional owner group and the State of Victoria have agreed to negotiate a Recognition and Settlement Agreement under the Traditional Owner Settlement Act 2010.

Tasmania

There are no registered native title claims in Tasmania.

5.6.3. Maritime archaeological heritage

Shipwrecks

Shipwrecks over 75 years old are protected within Commonwealth waters under the Underwater Cultural Heritage Act 2018 (Cth), in Victorian waters under the Victorian Heritage Act 1995 (Vic), and in Tasmanian waters under the Historic Cultural Heritage Act 1995 (Tas).

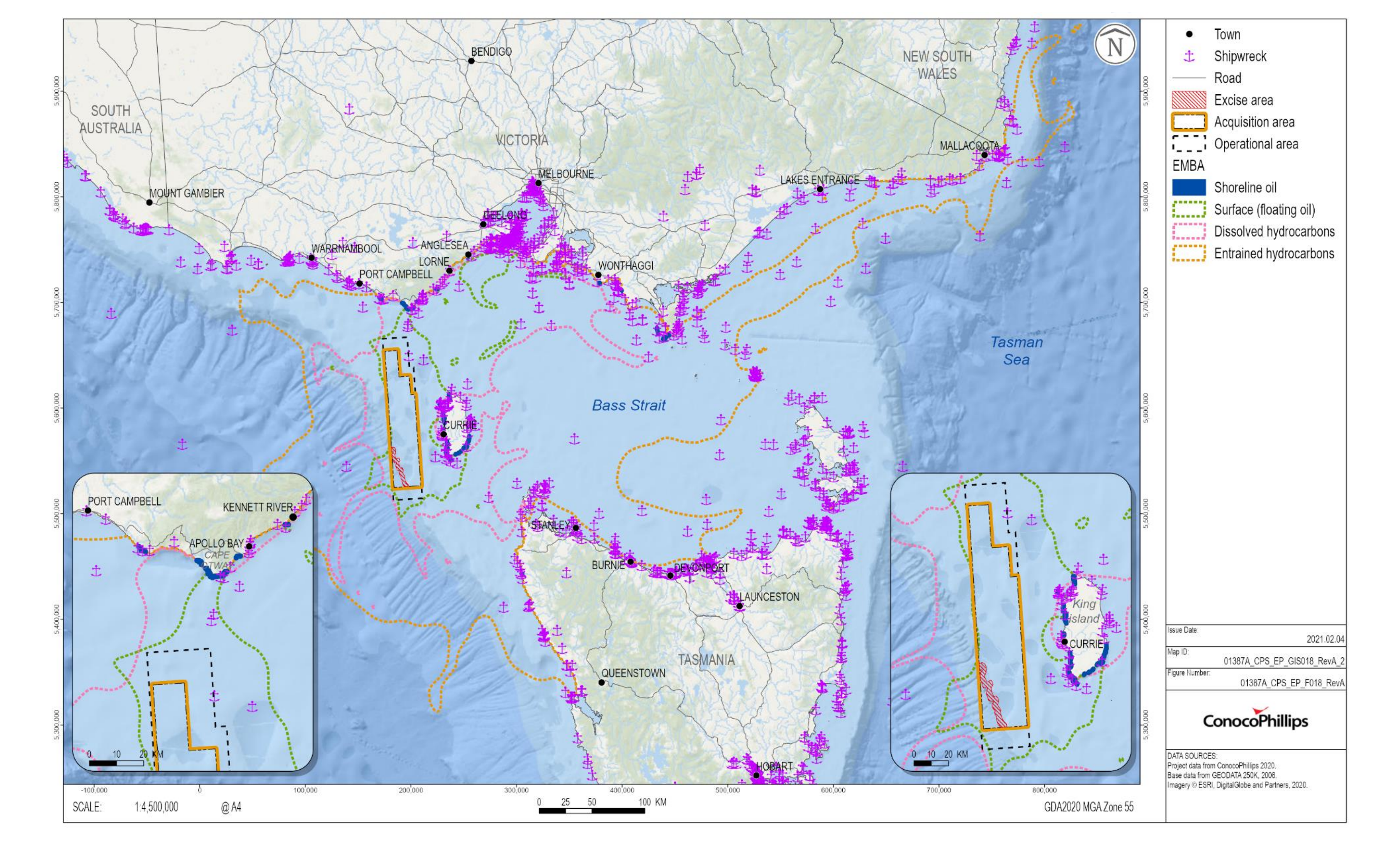
In special circumstances when a shipwreck is considered highly significant or vulnerable a 'Protected Zone' may be declared around the site, requiring a permit from the management authority to enter. There are currently no 'Protected Zones' in Tasmania.

King Island is located in the centre of the western entrance to Bass Strait and is exposed to the “roaring forties” winds, with strong waves, rocky reefs and cliffs also presenting hazards There are over 60 known shipwrecks along the coastline of King Island, with 40 lying along its western coastline (DAWE, 2020h). The. The wrecks represent recreational (i.e., diving) opportunities for tourists. Significant shipwrecks along the coast of King Island which forms part of the King Island Maritime Trail (Shipwrecks and Safe Havens) include the following (refer Figure 5.42):

- Blencathra (1875);
- British Admiral (1874);
- Carnarvon Bay (1910);
- Cataraqui (1845);
- Loch Leven (1871);
- Netherby (1866);
- Neva (1935);
- Sea Elephant Bay (1802); and
- Shannon (1906).

The Australian National Shipwreck Database does not record any historic shipwrecks or shipwreck protection zones within the survey area (DAWE, 2020h).

Figure 5.42 Shipwrecks intersected by the survey area and the EMBA



5.7. Socio-Economic Environment

5.7.1. Coastal Settlements

Statistics presented in this section regarding populations, employment types and so forth are sourced from 2016 census data (ABS, 2020).

Victoria

Victorian coastal settlements that lie within the spill EMBA and are subject to potential impact include (from west to east):

- Cape Otway, Marengo, Apollo Bay, Wye River, Lorne, Anglesea, Torquay, Point Lonsdale, Portsea, Sorrento, Flinders, Summerland, Cowes, Cape Patterson, Inverloch, and Mallacoota.

The larger coastal settlements within the EMBA are described below based on ABS data from the 2016 census.

Colac-Otway

- Torquay has a population of 13,258 people and a median age of 39. Of those in the labour force, 55.2% work full-time with 35.5% working part-time. The agriculture, forestry and fishing industries employ 0% of the workforce. The primary and secondary education industries employ 5.9% of the workforce. Professionals, managers and technicians and trade workers make up 56.4% of occupations.

Port Phillip Bay

- Mornington Peninsula (Shire) has a population of 154,999 people and a median age of 46. Of those in the labour force, 53.5% work full-time with 36.3% working part-time. The agriculture, forestry and fishing industries employ 0% of the work. Hospitals, primary education and supermarket and grocery stores employ 9.4% of the workforce. Professionals, technicians and trade workers and managers make up 50.6 of occupations.
- Queenscliff has a population of 1,315 people and a median age of 59. Of those in the labour force, 45.6% work full-time with 45.6% working part-time. The accommodation, cafes and restaurants and primary education industries employ 16.8% of the workforce. Professionals, managers and clerical and administrative workers make up 59% of occupations.

Bass Coast

- Wonthaggi has a population of 4,965 people and a median age of 52, occupying 2,400 dwellings. The greatest proportion of the population are employed as technicians, trade workers and labourers.
- Cape Paterson has a population of 891 people and a median age of 52. There are 1,077 private dwellings and the median weekly household income is $897. Professionals and technicians and trades workers were the two most common occupations at 22.4% and 17.6%, respectively.
- Inverloch, with a population of 5,437, had 47.6% of its 4,290 dwellings permanently unoccupied. The area is a popular tourist destination, particularly for swimming, kitesurfing and windsurfing in the calm waters of Anderson Inlet. Fishing and surfing are also popular.

King Island

The closest coastal settlement to the survey area is King Island, which is located to the northwest of Tasmania. King Island is located approximately 80 to 90 km from the Victoria and Tasmania coastlines and is predominantly rural, with three small townships. About half of the population (of 1,585 people) live in the township of Currie, located on the west coast, with two smaller townships at Grassy and Naracoopa located on the east coast.

The island is renowned for excellence in the production of food products. Beef and dairy farms cover the island, which employs 29.7% of the workforce. The island has a small fishing industry, mostly focused on SRL and giant crab, which employs 4.1% of the workforce. In its submission to ConocoPhillips during the public exhibition of the EP, the King Island Council states that there are 18 SRL fishing vessels based at the island, all of which are locally owned and operated. King Island Dairy and JBS Australia are the two major employers on the island.

The kelp industry is a major part of the island's economy, generating $2.5M annually, which is supported by up to 80 individuals who have a fishing license (marine plant) to collect cast bull kelp on the island. Tourism is a growth industry for the island (KIRDO, 2014), with golf courses being a key drawcard.

5.7.2. Offshore Energy Exploration and Production

There is no oil and gas infrastructure within the survey area. Subsea infrastructure of Bass Strait that lies within the spill EMBA is illustrated in Figure 5.43.

The Otway Gas Field Development, operated by Beach Energy, is located 70 km south of Port Campbell and 25 km west of the nearest survey operational boundary. This consists of a the remotely operated Thylacine platform, offshore and onshore pipelines and a gas processing plant located 6.4 km northeast of Port Campbell. Over its operating life, the development is expected to supply 950 billion cubic feet (bcf) of raw gas, 885 PJ of sales gas, 12.2 million barrels of condensate and 1.7 million tonnes of LPG to the market. The fields are estimated to contain sufficient natural gas to provide more than 10% of current annual demand in south-eastern Australia over a period of 10 years. First gas sales commenced September 2007.

In 2016, Origin (now Beach Energy) also completed its Halladale and Blackwatch gas field development. The Halladale production well is located 13 km north of the Netherby production well. It was directionally drilled from an adjacent onshore location, with a pipeline laid between the onshore drill site and the Iona Gas Plant (DEDJTR, 2016b).

The Minerva Gas Development is operated by Cooper Energy (previously BHP Billiton) and commenced production in April 2005. This consists of two subsea wells in shallow waters (60 m deep and 10 km from the coast) that are tied back to an onshore gas plant (4.5 km inland) via a single pipeline. The gas plant has the capacity to produce 150 TJ gas and 600 barrels of condensate per day.

The Casino-Henry-Netherby Field Development, operated by Cooper Energy (previously Santos), is located 17-25 km offshore from Port Campbell in water depth ranging from 65-71 m. The offshore development consists of 4 subsea wells which transport gas via a 250mm gas pipeline to the Iona Gas Plant(Cooper Energy, 2020).

The entrained MDO spill EMBA intersects the Star of the South Wind Farm project area (287 km east-northeast of the acquisition area), which is the first proposed offshore wind farm in Australia. The project involves installation of offshore wind turbines and offshore substations, submarine cables from the wind farm to the Gippsland coast and a transmission network of cables and substations connecting to the La Trobe Valley. The project is currently in its feasibility phase with preliminary site investigations such as metocean, geophysical, geotechnical and environmental studies underway.

Offshore seismic exploration has been undertaken over many decades in the Otway basin in order to locate potential hydrocarbon reservoirs. Figure 2.2 illustrates previous seismic surveys have that been undertaken within and adjacent to the survey area.

5.7.3. Other Infrastructure

The Victorian Desalination Plant, located at Wonthaggi, is located 198 km northeast of the acquisition area. Operation of the plant commenced in December 2012. The seawater intake and outlet structures are connected to the onshore plant via a 1.2 km and 1.5 km underground tunnel, respectively. The two intake structures are 8 m high, 13 m in diameter, situated 50 m apart and located in a water depth of 20 m. They draw in water at very low speeds (the suction effect is not strong enough to draw fish in).

The Indigo telecommunications cable runs east-west across the northern part of the survey area (Figure 5.43). This cable facilitates international and trans-Australian connectivity with a two fibre pair 'Open Cable' design that utilises spectrum sharing technology and spans approximately 9,000 km, connecting Singapore to Perth and Perth to Sydney.

The two discrete systems are known as Indigo West (Singapore to Perth) and Indigo Central (Perth to Sydney). The northern part of the acquisition area overlaps 21 km of the cable.

There are two Telstra telecommunications cables located 168 km and 205 km east of the survey area (see Figure 5.43).

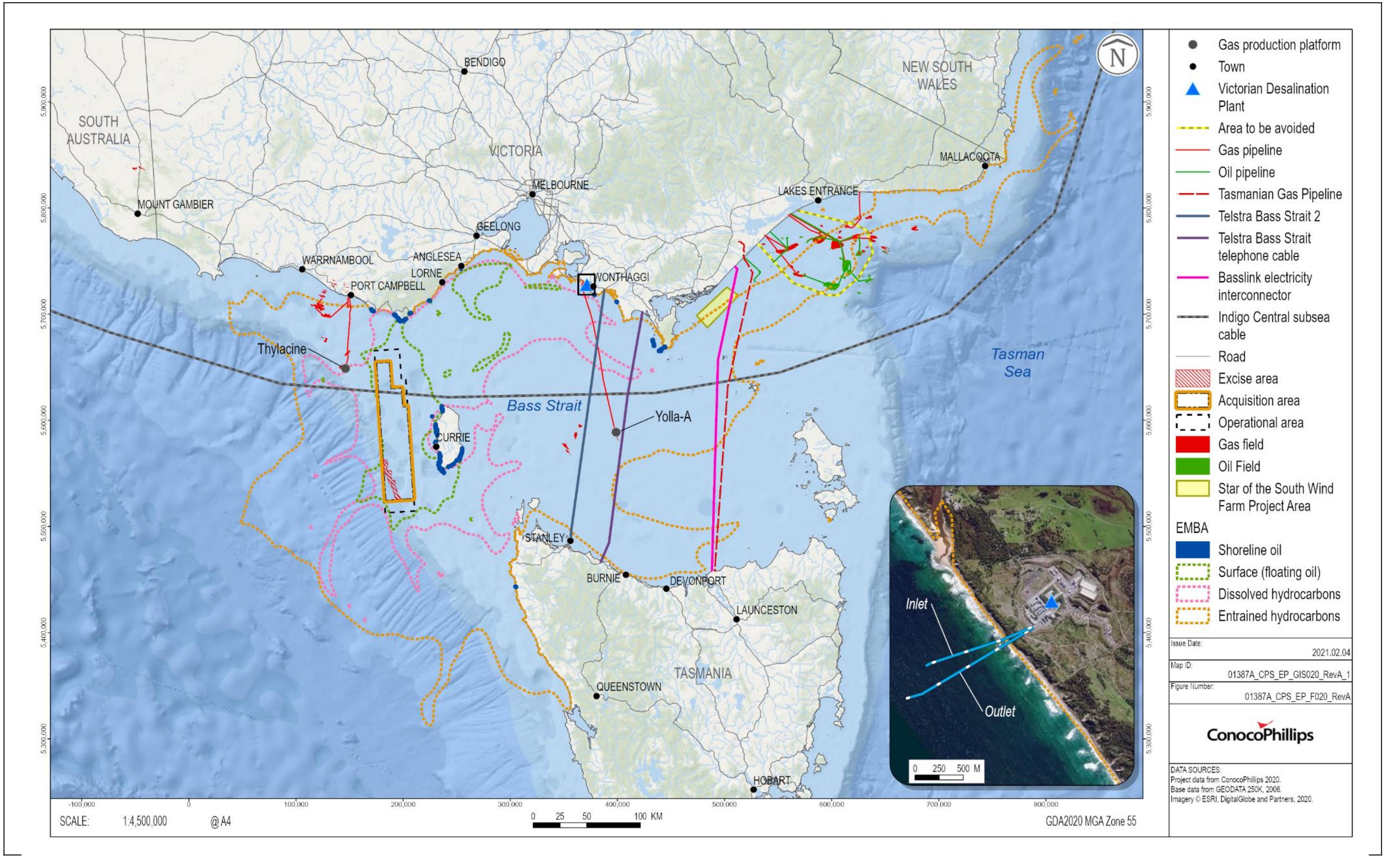
5.7.4. Tourism

King Island's economy supports 708 jobs (Nicol et al., 2013). The Island's main industries include agriculture and fishing, which employed 164 people and manufacturing 130 in 2011 (Nicol et al., 2013). Of the 708 people employed in King Island, it is estimated that tourism supports 34 jobs (4.9% of King Island employment) (Nicol et al., 2013). The following tourism statistics are available for King Island (King island Council, 2016):

- Total visitors to the island during 2015/16 was approximately 13,500 with 64% of this population staying 3 nights or less (short-break holiday);
- Purpose of visit: Business (33%), holiday (49%) and visiting relatives (16%);
- Origin of visitors: Victoria (39%), Tasmania (29%) and NSW (16%) with international visitors (3%);
- High season for tourism on the island is mid-October to mid-April;
- Activities undertaken on the island during visits included recreational walks (29%); visiting arts and crafts shops (21%); food related festivals/tourism (16%); bird watching particularly penguins (9%); golf (8%); game bird hunting (6%); surfing (3%) and diving/snorkelling (2%); and
- Places most visited were Lavinia Beach/Penny's Lagoon and the Calcified Forest/Seal Rocks Reserve.

The tourism sector is estimated to generate $5 million in annual economic output from a total output of $190.6 million (Nicol et al., 2013). The King Island tourism sector is estimated to contribute just over 0.2% of the Tasmanian tourism output (Nicol et al., 2013).

Figure 5.43 Bass Strait offshore infrastructure intersected by the survey area and the EMBA



5.7.5. Commercial Fisheries

The survey area lies within three fishing management jurisdictions – Commonwealth, Victoria and Tasmania.

Commonwealth-managed fisheries

Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA) under the Fisheries Management Act 1991 (Cth). AFMA jurisdiction covers the area of ocean from 3 nm from the coast out to the 200 nm limit (the Australian Fishing Zone (AFZ)). Commonwealth commercial fisheries with jurisdictions to fish within the EMBA are the:

- Bass Strait Central Zone Scallop Fishery (BSCZSF);
- Eastern Tuna and Billfish Fishery;
- Eastern Skipjack Tuna Fishery;
- Southern Bluefin Tuna Fishery;
- Small Pelagic Fishery (eastern sub-area);
- Southern Squid Jig Fishery (SSJF); and
- Southern and Eastern Scalefish and Shark Fishery (SESSF), incorporating:
- Gillnet and Shark Hook sector.
- Commonwealth Trawl sector.
- Scalefish Hook sector.

Table 5.68 provides a summary of the jurisdiction and recent fishing activities relevant to the survey area. Though certain fisheries possess jurisdiction to fish within the survey area and the EMBA, analysis of publicly available and requested catch data indicates that not all fisheries have recently actively fished within the survey area and/or the spill EMBA.

Table 5.69 summarises the key information for each of the fisheries identified with jurisdiction to fish within the survey area and spill EMBA, including fishing catch and value data for the last five years.

Table 5.68 Presence of fisheries jurisdiction and fishing activity within the survey area and the EMBA

Fishery	Jurisdiction to fish in the survey area	Evidence of recent fishing in the survey area	Evidence of recent fishing in the EMBA
BSCZSF	Yes	No	Yes
Eastern Tuna and Billfish Fishery	Yes	No	Yes
Southern Bluefin Tuna Fishery	Yes	No	Yes
Small Pelagic Fishery	Yes	No	Yes
SSJF	Yes	Yes	Yes
SESSF - Gillnet and Shark Hook sector	Yes	Yes	Yes
SESSF - Commonwealth Trawl sector	Yes	Yes	Yes
SESSF - Scalefish Hook sector	Yes	Yes	Yes

Sources: Patterson et al (2020, 2019, 2018; 2017; 2016), SETFIA and Fishwell Consulting (2020).

Table 5.69 Commonwealth-managed fisheries in the EMBA

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
SESSF							
Shark Gillnet (Figure 5.50) and Shark Hook (Figure 5.51) Sector	Gummy shark (*Mustelus antarcticus*) is the key target species, with bycatch of elephant fish (*Callorhinchus milii*), sawshark (*Pristiophorus cirratus, P. nudipinnis*), and school shark (*Galeorhinus galeus*).	Waters from the NSW/Victorian border westward to the SA/WA border, including the waters around Tasmania, from the low water mark to the extent of the AFZ. Most fishing occurs in waters adjacent to the coastline in Bass Strait. Major landing ports include Adelaide, Port Lincoln, Robe, Devonport, Hobart, Lakes Entrance, San Remo, and Port Welshpool.	**Survey area?** **Yes.** There is overlap between the survey area and low fishing intensity. The acquisition area intersects 0.21% of the total fishery area. The survey area intersects 0.31% of the total fishery area. **EMBA?** **Yes.** Based on 2019-20 fishing intensity	12-month season begins 1st May.	Demersal gillnet and a variety of line methods. Landing ports in Victoria are Lakes Entrance, San Remo and Port Welshpool. 2019-20 – 74 permits and 71 active vessels. 2018-19 – 74 permits and 78 active vessels. 2017-18 – 74 permits and 76 active vessels. 2016-17 – 74 permits and 62 active vessels. 2015-16 – 74 permits and 61 active vessels.	In 2015-16, the SESS Fishery was the largest Commonwealth fishery in terms of volume produced. 2019-20 – 2,201 tonnes with no value assigned. 2018-19 – 2,126 tonnes worth $23.6 million. 2017-18 – 2,216 tonnes worth $19.1 million. 2016-17 – 2,118 tonnes worth $18.3 million. 2015-16 – 2,233 tonnes worth $18.4 million.	Fishing catch and effort was reported from the survey area in 2019 in an area of low fishing intensity. Effort is highest during September to April when most of the catch is taken. Over 2008-2017, a total of 18 different GHAT vessels have fished in the Sequoia MSS area. Shark gillnet Sector Over the last 10 years, an average annual catch of 6.3 tonnes valued at $39,000 has been taken from the survey area. This represents 1% of the catch taken for the whole fishery (SETFIA & Fishwell Consulting, 2020). Shark hook sector Over the last 10 years, an annual average catch of 5.2 tonnes worth $37,000 has

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
			data, the spill EMBA overlaps areas of low, medium and high intensity fishing. The spill EMBA intersects 8.6% of the fishery.				been taken from the survey area. This represents 1% of the catch taken for the whole fishery (SETFIA & Fishwell Consulting, 2020).
Commonwealth Trawl Sector (CTS) (Figure 5.52 & Figure 5.54)	Key species targeted are eastern school whiting (*Sillago flindersi*), flathead (*Platycephalus richardsoni*) and gummy shark (*Mustelus antarcticus*).	Covers the area of the AFZ extending southward from Barrenjoey Point (north of Sydney) around the NSW, Victorian and Tasmanian coastlines to Cape Jervis in South Australia.	**Survey area?** **Yes.** Based on 2019-20 fishing intensity data, the survey area overlaps areas of low and medium fishing intensity. The acquisition area intersects 0.26% of the total fishery area. The survey area intersects 0.37%	12-month season begins 1st May. Highest catches from September to April.	Multi gear fishery, but predominantly demersal otter trawl and Danish-seine methods. Primary landing ports in NSW, and Lakes Entrance and Portland in Victoria. For 2018-2019, there were 57 trawl fishing rights with 51 active trawl and Danish-seine vessels.	• 2019-20 – 13,148 tonnes with no value assigned. • 2018-19 – 8,454 tonnes worth $49.47 million. • 2017-18 – 8,631 tonnes worth $41.86 million. • 2016-17 – 8,691 tonnes, worth $46.42 million. • 2015-16 – 9,025 tonnes, worth $41.5 million.	Fishing catch and low and medium fishing intensity was reported from the survey area in 2019-20 season. Effort in the areas is highest during October to March over the past 10 years with a peak of 100 shots during October. Effort was lowest during July with 32 shots recorded in 2007. Since 2008, between 6 and 9 CTS

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
			of the total fishery area. **EMBA? Yes.** Based on 2019-20, fishing intensity data, the spill EMBA overlaps areas of low, medium, and high fishing intensity. The spill EMBA intersects 10.47% of the total fishery area.				vessels (including one Danish seine) have recorded fishing in the Sequoia MSS area. Over the last 10 years, an annual average catch of 79 tonnes worth $322,000 has been taken from the survey area. This represents 1% of the catch of the whole fishery (SETFIA & Fishwell Consulting, 2020).
Scalefish Hook Sector (SHS) (Figure 5.53)	Key species targeted are gummy shark (*Mustelus antarcticus*), elephantfish (*Callorhinchus milii*) and draughtboard shark	Includes all waters off South Australia, Victoria and Tasmania from 3 nm to the extent of the AFZ.	**Survey area? Yes.** Based on 2019-20 fishing intensity data, the survey area overlaps areas of reported catch. The acquisition	12-month season begins 1st May. Effort highest from January to July.	Multi gear fishery, using different gear types in different areas or depth ranges. Predominantly demersal longline fishing methods, some of which are automated, and	Logbook catches have been gradually declining since 2006 and are now <2,000 t/year. Catch data is combined with that for the CTS. Areas of relative low, medium and high fishing intensity occur	Fishing catch and effort was reported from the activity area in 2019-20 but not areas of relatively low, medium or high fishing intensity. Over the last 10 years, an annual average catch of 5.2 tonnes worth

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
	(*Cephaloscyllium laticeps*).		area intersects 0.13% of the total fishery area. The survey area intersects 0.18% of the total fishery area. **EMBA? Yes.** Based on 2019-20 fishing intensity data, the spill EMBA overlaps areas of reported catch. The spill EMBA intersects 5.06% of the total fishery area.		demersal gillnets. For 2017-18, there were 37 fishing rights 29 active vessels. Primary landing ports in NSW, and Lakes Entrance and Portland in Victoria.	east of St. Helens (outside the EMBA).	$37,000 has been taken from the survey area. This represents <1% of the catch taken for the whole fishery (SETFIA and Fishwell Consulting, 2020).
Southern Squid Jig Fishery (Figure 5.49)	Arrow squid (*Nototodarus gouldi*)	The fishery extends from the SA/WA border east to southern Queensland. AFMA does not control squid fishing in	**Survey area? Yes.** There is overlap between the survey area and reported catch. The acquisition	12-month season begins 1st January and ends 31 Decembe	Squid jigging is the fishing method used, mainly at night time and in water depths of 60 to 120 m. High-powered	The species' short life span, fast growth and sensitivity to environmental conditions result in strongly fluctuating stock sizes.	Fishing catch and effort was reported from the survey area in 2019. The survey area overlaps an area of reported catch, however, there is no low, medium or high intensity

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
		Victorian or Tasmanian state waters. Most fishing takes place off Portland (March to June) at night between depths of 60 and 120 m.	area intersects 0.12% of the total fishery. The survey area intersects 0.17% of the total fishery. **EMBA?** **Yes.** The spill EMBA intersects 4.8% of the total fishery, but in an area of reported catch only.	r.	lamps are used to attract squid. In 2019 there were 8 active vessels. Hobart, Portland and Queenscliff are the primary landing ports.	• 2019 – 722 tonnes worth $2.89 million. • 2018 – 1,649 tonnes worth $5.26 million. • 2017 – 828 tonnes worth $2.24 million. • 2016 – 981 tonnes worth $2.57 million. 2015 – 824 tonnes worth $2.33 million.	catch reported from the survey area. As such, the amount of catch taken from the survey area and its value is expected to be comparatively low when compared to areas of higher fishing intensity.
Bass Strait Central Zone Scallop Fishery (Figure 5.44)	Commercial scallop (*Pecten fumatus*)	Central Bass Strait area that lies within 20 nm of the Victorian and Tasmanian coasts. Fishery does not operate in state waters.	**Survey area?** **No.** There is no overlap between the activity area and fishing effort. The acquisition	19th July to 31st December.	Towed scallop dredges that target dense aggregations ('beds') of scallops. 48 fishing permits are in place. 12 vessels were active in the fishery in 2019, a decrease from 26	• 2019 – 2,931 tonnes with $6.3 million. • 2018 – 3,253 tonnes worth $6.7 million. • 2017 – 2,929 tonnes worth $6.7 million.	No fishing catch or effort was reported from the survey area in 2019.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
		Fishing effort is concentrated east of King Island. Primary landing ports are Devonport, Stanley, Apollo Bay, Melbourne, Queenscliff and San Remo.	area intersects 1.91% of the total fishery. The survey area intersects 2.63% of the total fishery. **EMBA? Yes.** There is overlap between the EMBA and the King Island scallop fishing grounds. The spill EMBA intersects 47% of the total fishery.		active vessels in 2009, reflecting the 'boom or bust' nature of the fishery.	• 2016 – 2,885 tonnes worth $4.6 million. • 2015 – 2,260 tonnes worth $2.8 million. Scallop spawning occurs from winter to spring (June to November), with timing dependent on environmental conditions such as wind and water temperature. Majority of catch occurs during September – December east of King Island.	

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
Southern Bluefin Tuna (Figure 5.47)	Southern bluefin tuna (*Thunnus maccoyii*)	The fishery extends throughout all waters of the AFZ. AFMA manages Southern Bluefin Tuna stocks in Victorian state waters under agreements set up within the OCS (DEH, 2004). The nearest fishing effort is concentrated along the NSW south coast around the 200 m depth contour and southeast off Kangaroo Island, SA.	**Survey area? No.** There is no overlap between the survey area and fishing effort. **EMBA? Yes.** The spill EMBA intersects an area of reported catch only (long-line).	12-month season begins 1st December.	Purse seine catch in the Great Australian Bight for transfer to aquaculture farms off Port Lincoln in South Australia. Port Lincoln is the primary landing port. On the east coast, pelagic longline fishing is the key fishing method. • 2018-19 – 27 • active vessels. 2017-18 – 38 • active vessels. 2016-17 – 22 active vessels. 2015-16 - 25 active vessels.	No recent fishing effort in Bass Strait. The latest data for the east coast pelagic longline catches are: • 2018-19 – 6,074 tonnes worth $43.41 million. • 2017-18 – 6,159 tonnes worth $39.73 million. • 2016-17 – 5,334 tonnes worth $38.57 million. • 2015-16 – 5,636 tonnes worth $37.29 million. • 2014-15 – 5,519 tonnes worth $37.29 million.	No fishing catch or effort was reported from the survey area in 2019.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
Small Pelagic Fishery (eastern and western sub-area) (Figure 5.48)	Australian sardine (*Sardinops sagax*), jack mackerel (*Trachurus declivis*), blue mackerel (*Scomber australasicus*), redbait (*Emmelichthys nitidus*)	Operates in Commonwealth waters extending from southern Queensland around southern Western Australia.	**Survey area? No.** There is no overlap between the survey area and fishing effort. **EMBA? Yes.** The spill EMBA intersects an area with reported catch.	12-month season begins 1st May.	Purse seine and mid-water trawl, with the latter being the main method. Thirty (31) entities held licences in 2019-20 using four active vessels. The main landing ports are Iluka and Ulladulla in NSW.	A Total Allowable Commercial Catch (TACC) in recent years has not been reached. Some catch and effort values are confidential due to the small number of fishers. • 2019-20 – 16,093 tonnes. • 2018-19 – 9,424 tonnes. • 2017-18 – 5,713 tonnes. • 2016-17 – 8,038 tonnes. • 2015-16 – 10,394 tonnes.	No fishing catch or effort was reported from the survey area in 2019.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
Eastern Tuna and Billfish Fishery (Figure 5.45)	Albacore tuna (*Thunnus alulunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*), broadbill swordfish (*Xiphias gladius*), striped marlin (*Tetrapturus audux*)	Fishery extends from Cape York in Queensland to the South Australian/Victorian border. Fishing occurs in both the AFZ and adjacent high seas.	**Survey area? No.** There is no overlap between the survey area and fishing effort. **EMBA? Yes.** The spill EMBA intersects an area of low fishing intensity.	12-month season begins 1st March.	Pelagic longline is the key fishing method, with small quantities taken using minor line methods (such as handline, troll, rod and reel). Active vessel numbers were 37 in 2019 (down from about 150 in 2002). No Victorian or Tasmanian ports are used to land catches.	Catch data and economic value available for the last five years: • 2019 – 4,341 tonnes worth $32.1 million. • 2018 – 4,046 tonnes worth $38.4 million. • 2017 – 4,624 tonnes worth $35.7 million. • 2016 – 5,139 tonnes worth $47.1 million. • 2015 – 5,408 tonnes worth $33 million. Spawning occurs through most of the year in water temperatures greater than 26°C (Wild Fisheries Research Program, 2012).	No fishing catch or effort was reported from the survey area in 2019.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area- specific)
Eastern Skipjack Tuna Fishery (Figure5.46)	Skipjack tuna (Katsuwonus pelamis)	Extends from the border of Victoria and South Australia to Cape York, Queensland.	**Survey area? No.** The fishery is not currently active. **EMBA? No.** The fishery is not currently active.	Not currently active.	Purse seine fishing gear is used in this fishery. There are 17 permits in the eastern zone, though no vessels currently work the fishery. Port Lincoln was the main landing port until its tuna cannery closed down.	Not currently active. The last fishing effort in the fishery occurred in 2008-09.	Not currently active. The last fishing effort in the fishery occurred in 2008-09.

Sources: Patterson et al (2020, 2019, 2018; 2017; 2016), AFMA (2020), SETFIA and Fishwell Consulting 2020.

Figure 5.44 Jurisdiction and fishing intensity in the BSCZSF 2019

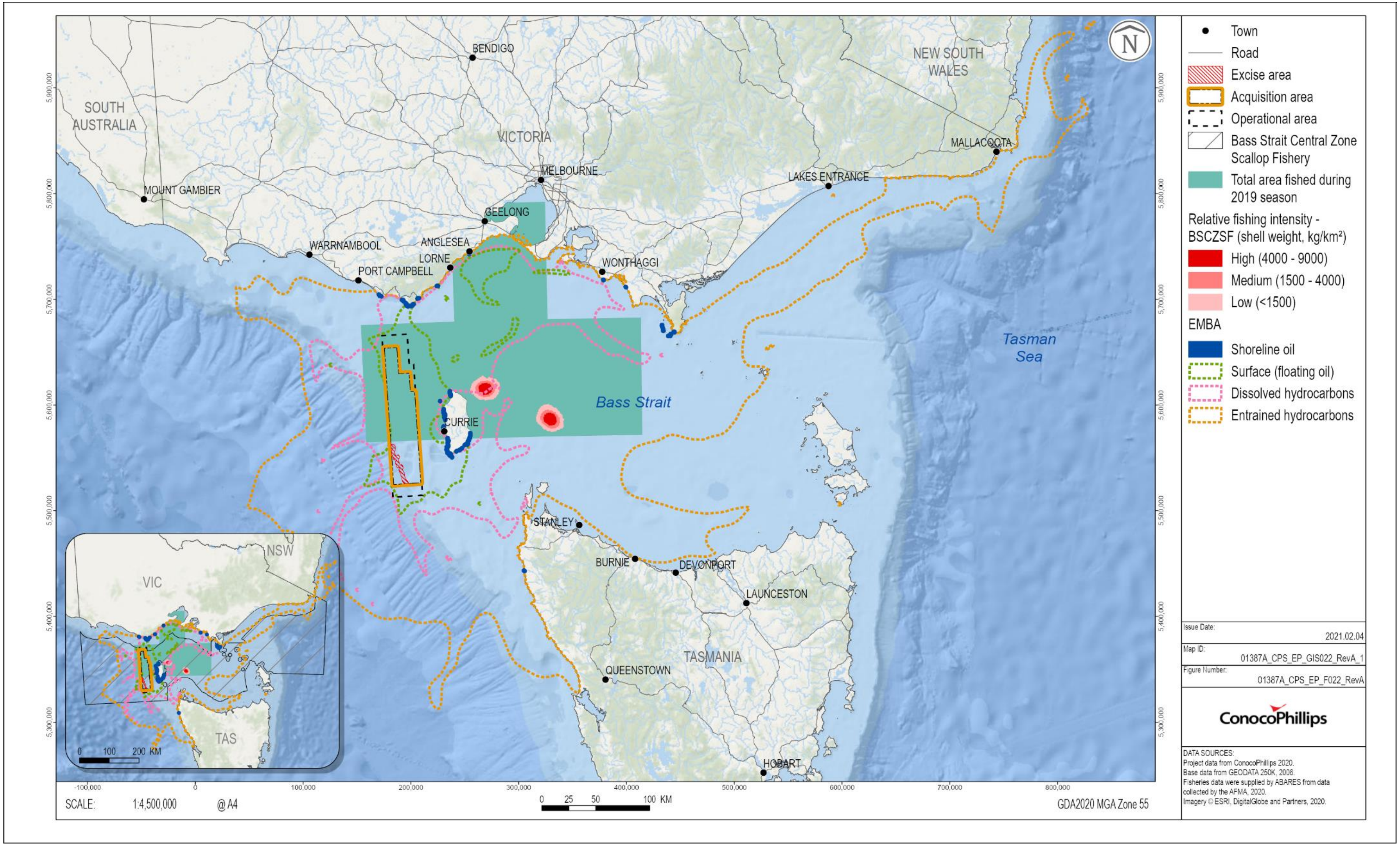


Figure 5.45 Jurisdiction and fishing intensity in the Eastern Tuna and Billfish Fishery

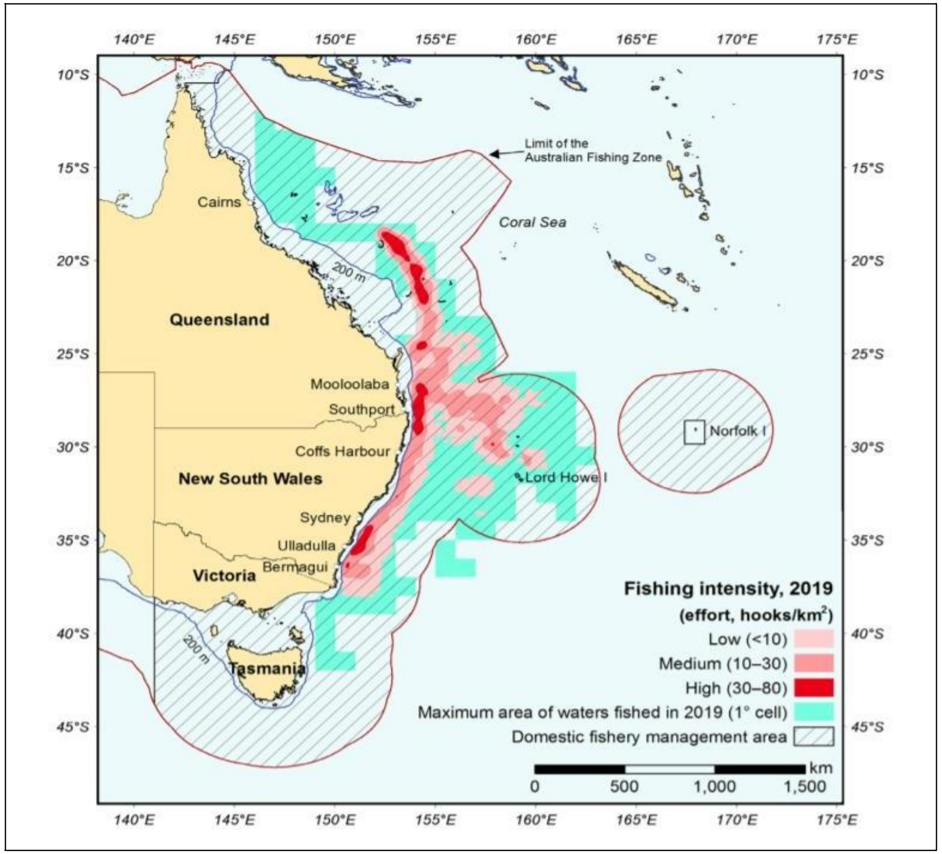


Figure 5.46 Jurisdiction and fishing intensity in the Eastern Skipjack Tuna Fishery

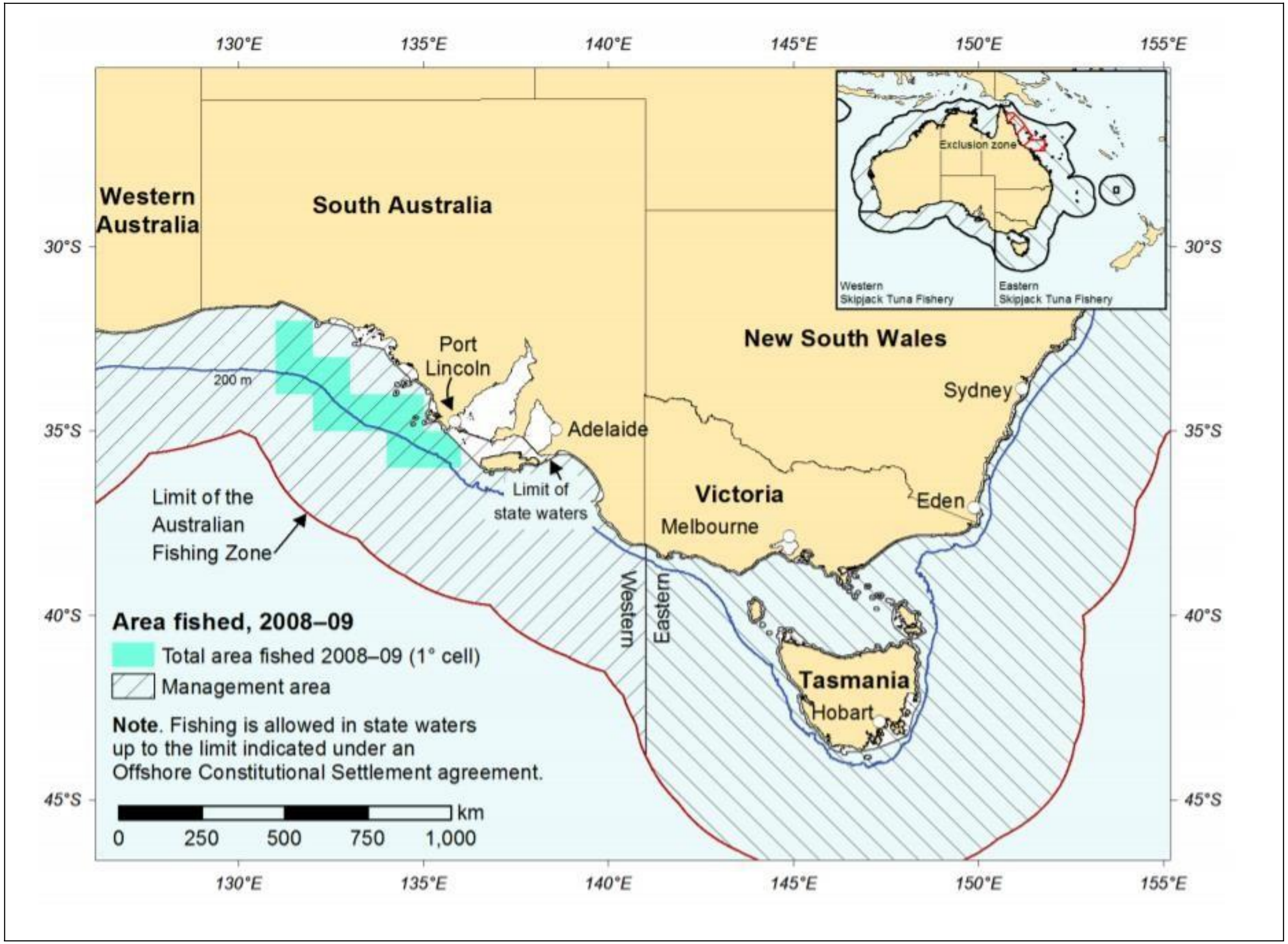


Figure 5.47 Jurisdiction and fishing intensity in the Southern Bluefin Tuna Fishery

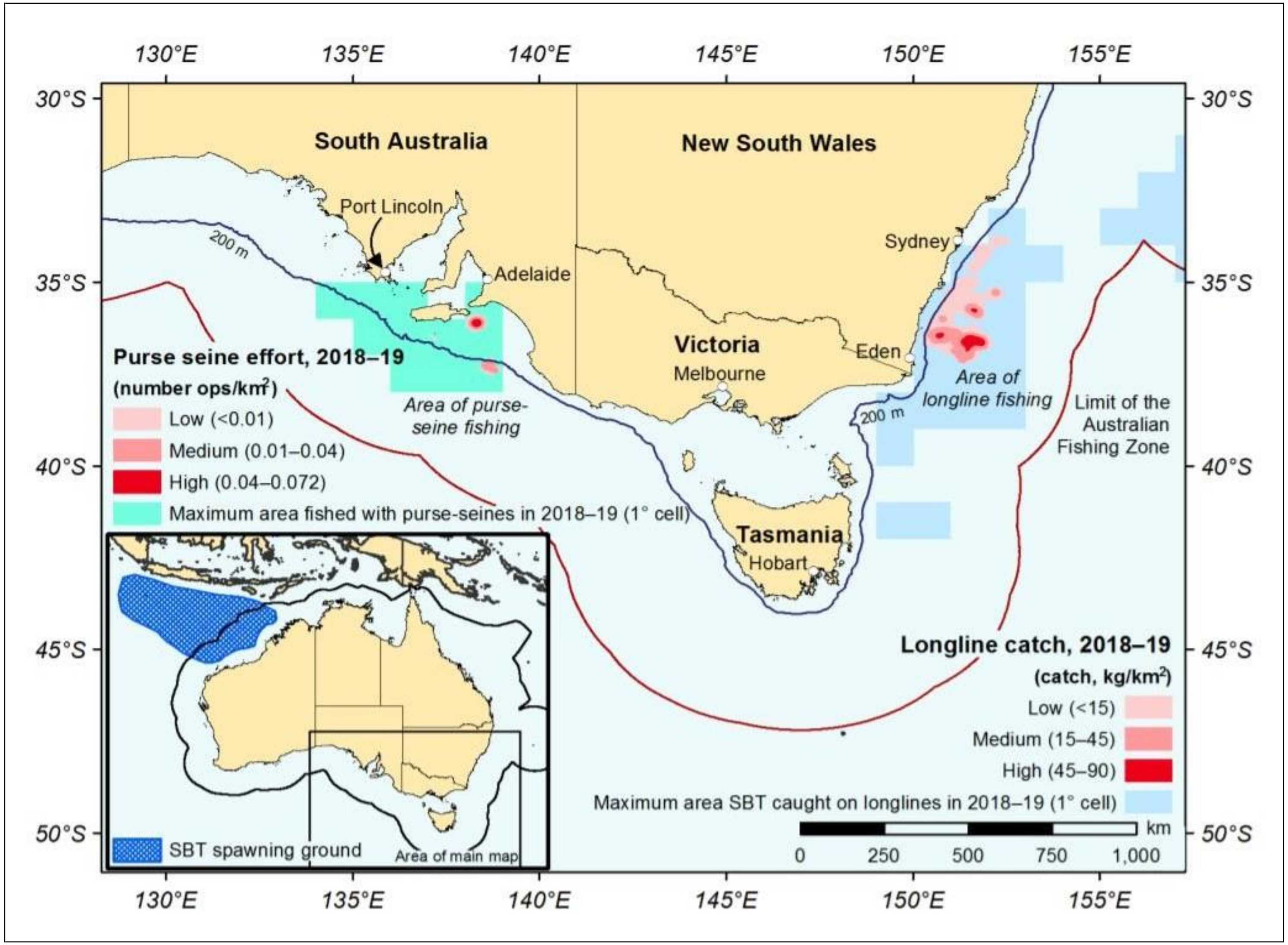


Figure 5.48 Jurisdiction and fishing intensity in the Small Pelagic Fishery

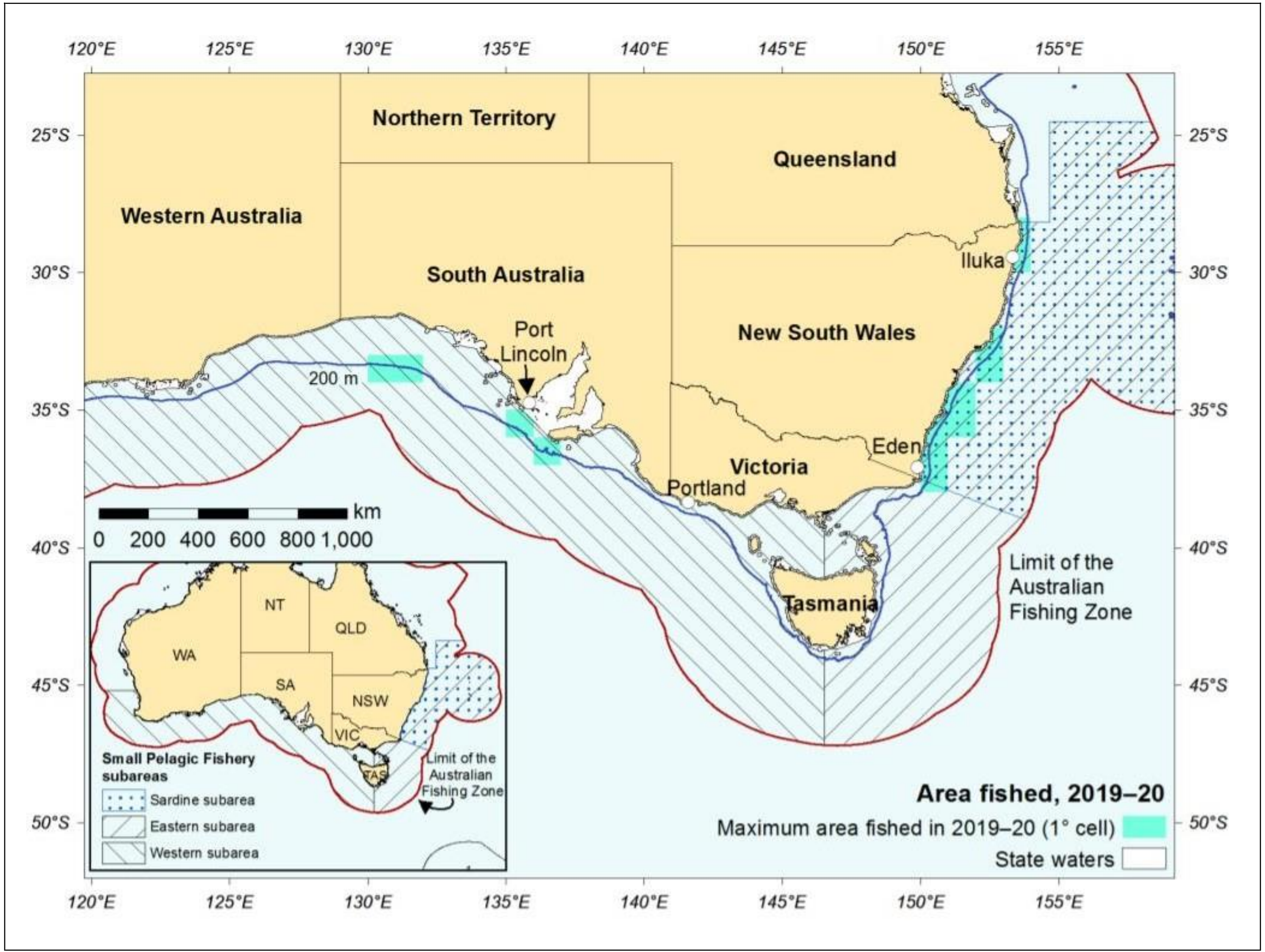


Figure 5.49 Jurisdiction and fishing intensity in the Southern Squid Jig Fishery

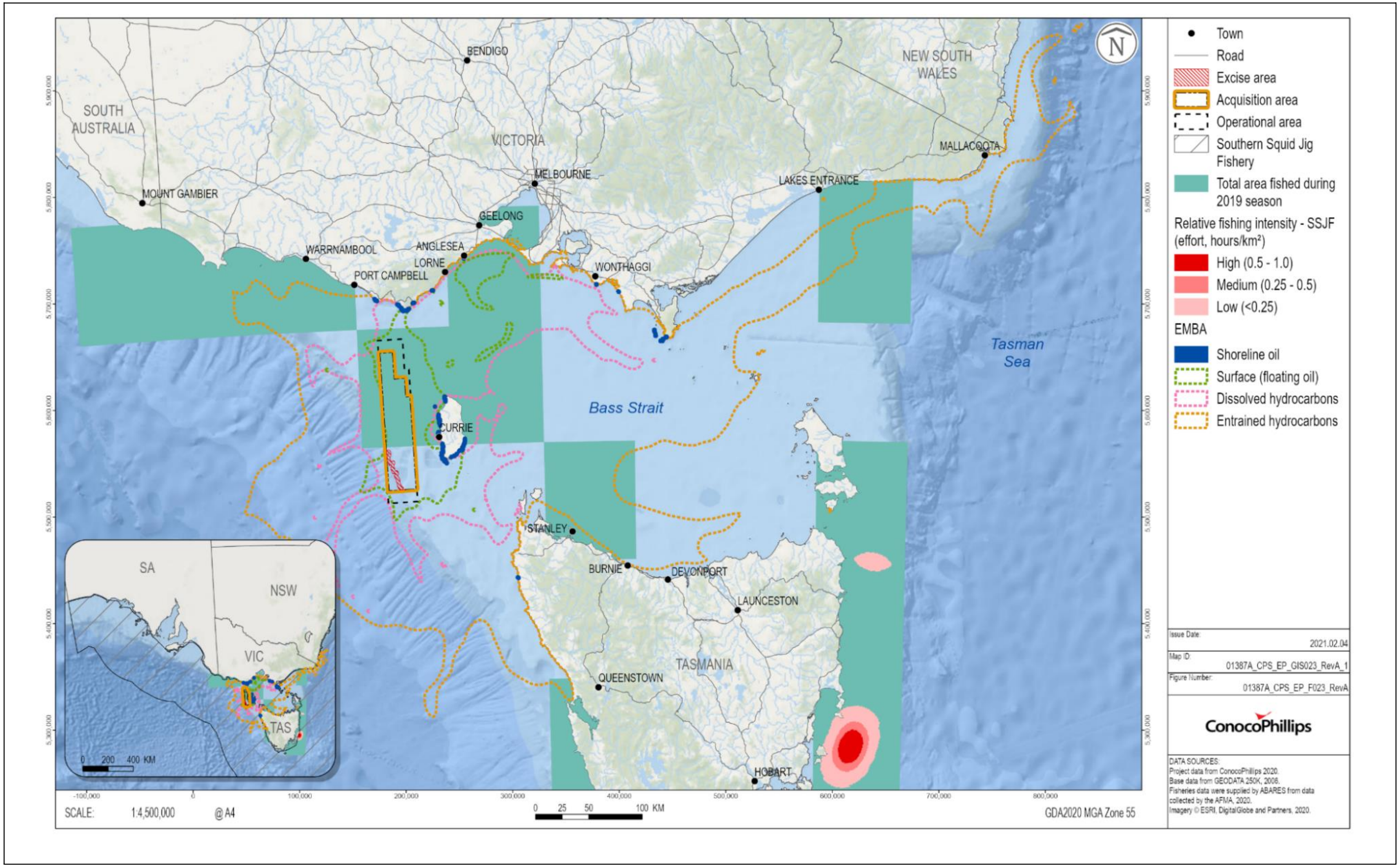


Figure 5.50 Jurisdiction and fishing intensity in the SESSF – Shark Gillnet Sector

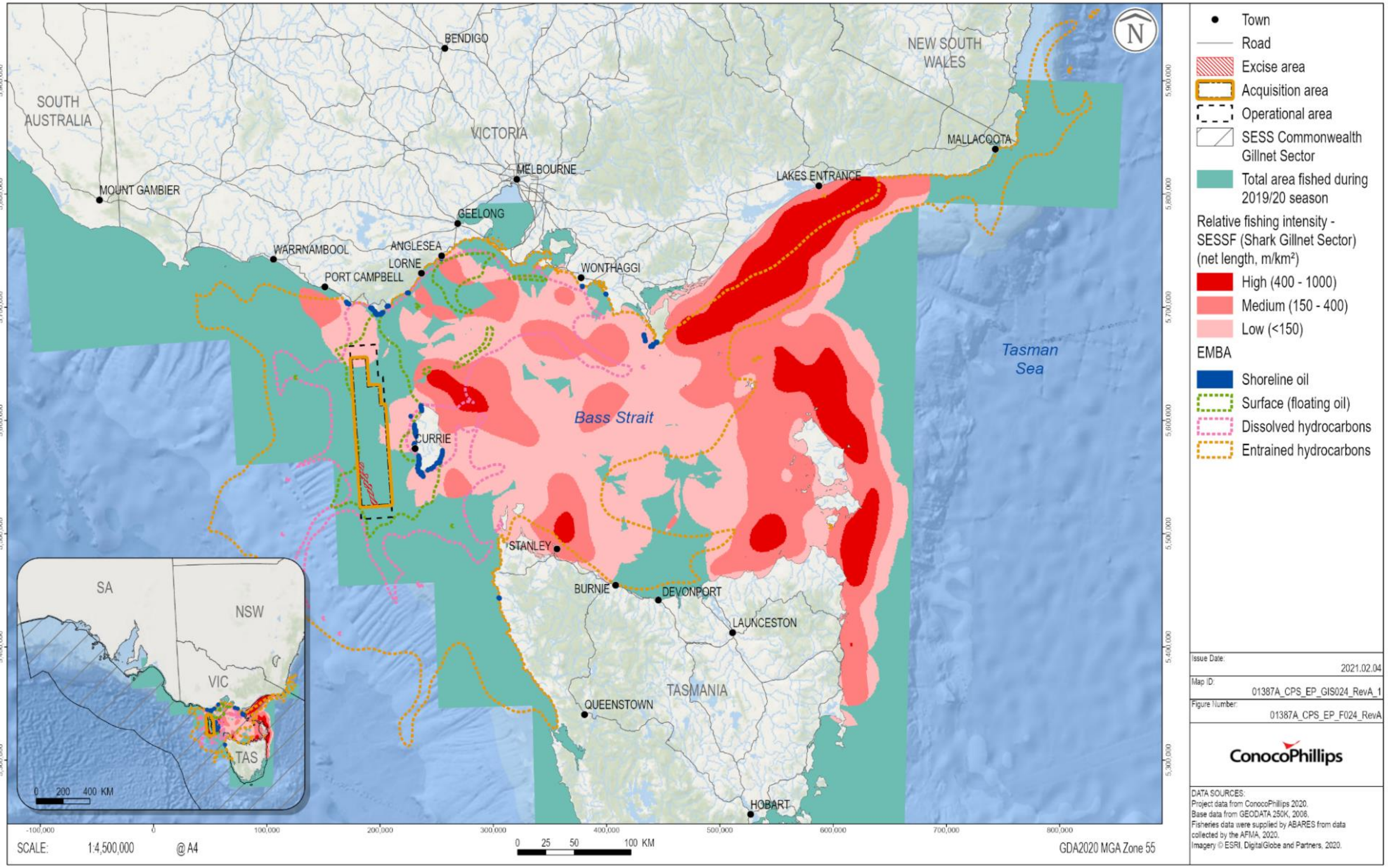


Figure 5.51 Jurisdiction and fishing intensity in the SESSF – Shark Hook Sector

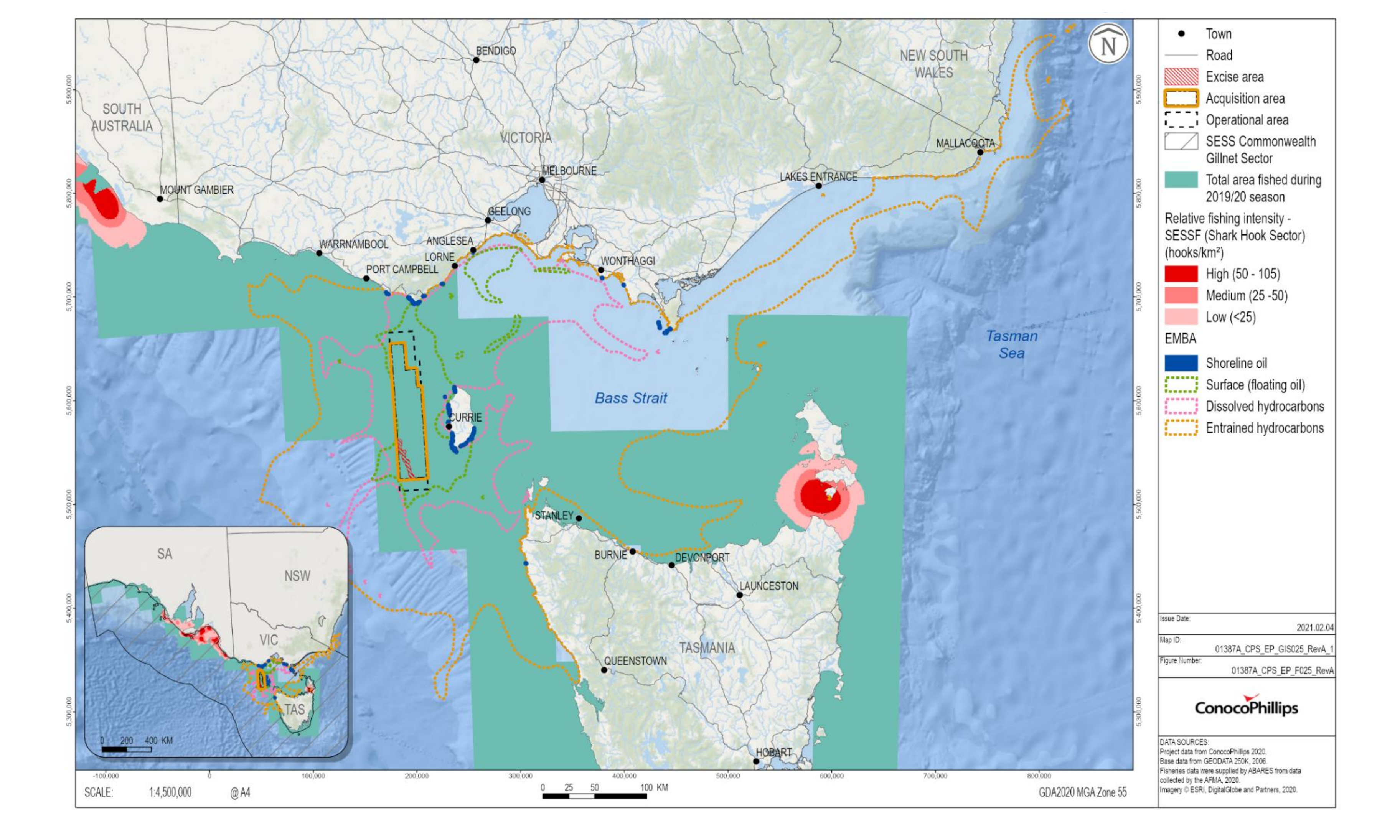


Figure 5.52 Jurisdiction and fishing intensity in the SESSF – Commonwealth Trawl Sector

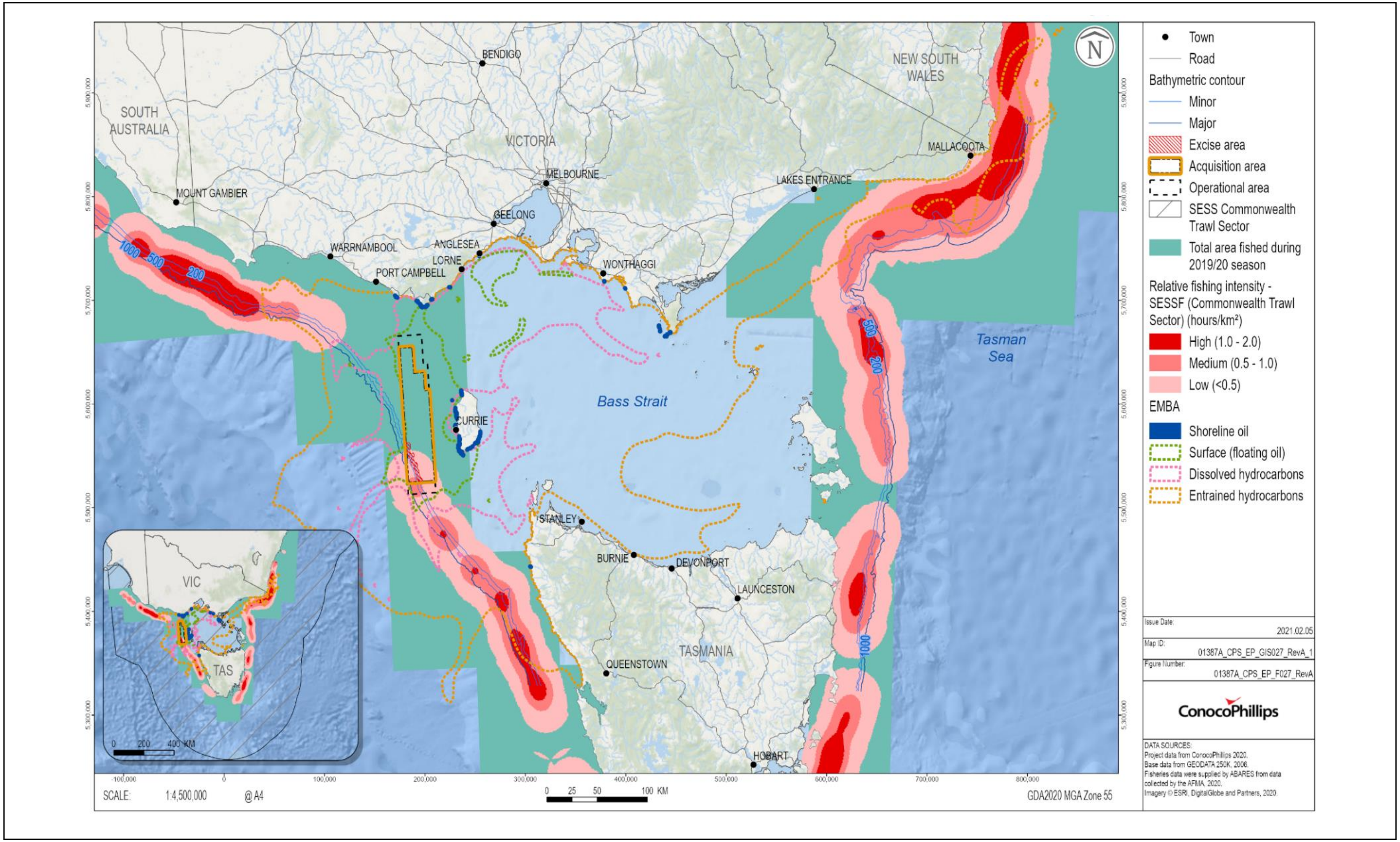


Figure 5.53 Jurisdiction and fishing intensity in the SESSF – Scalefish Hook Sector

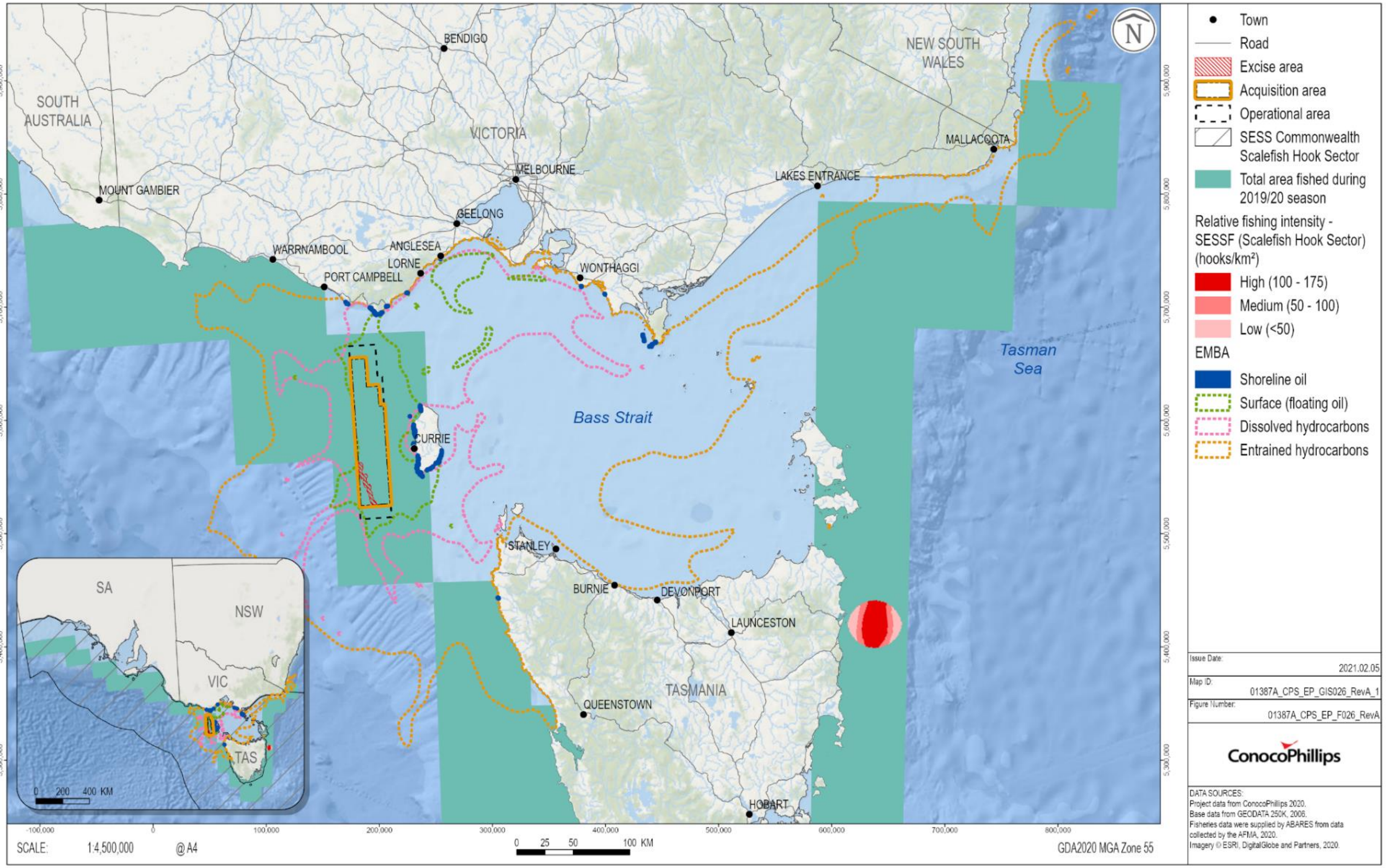
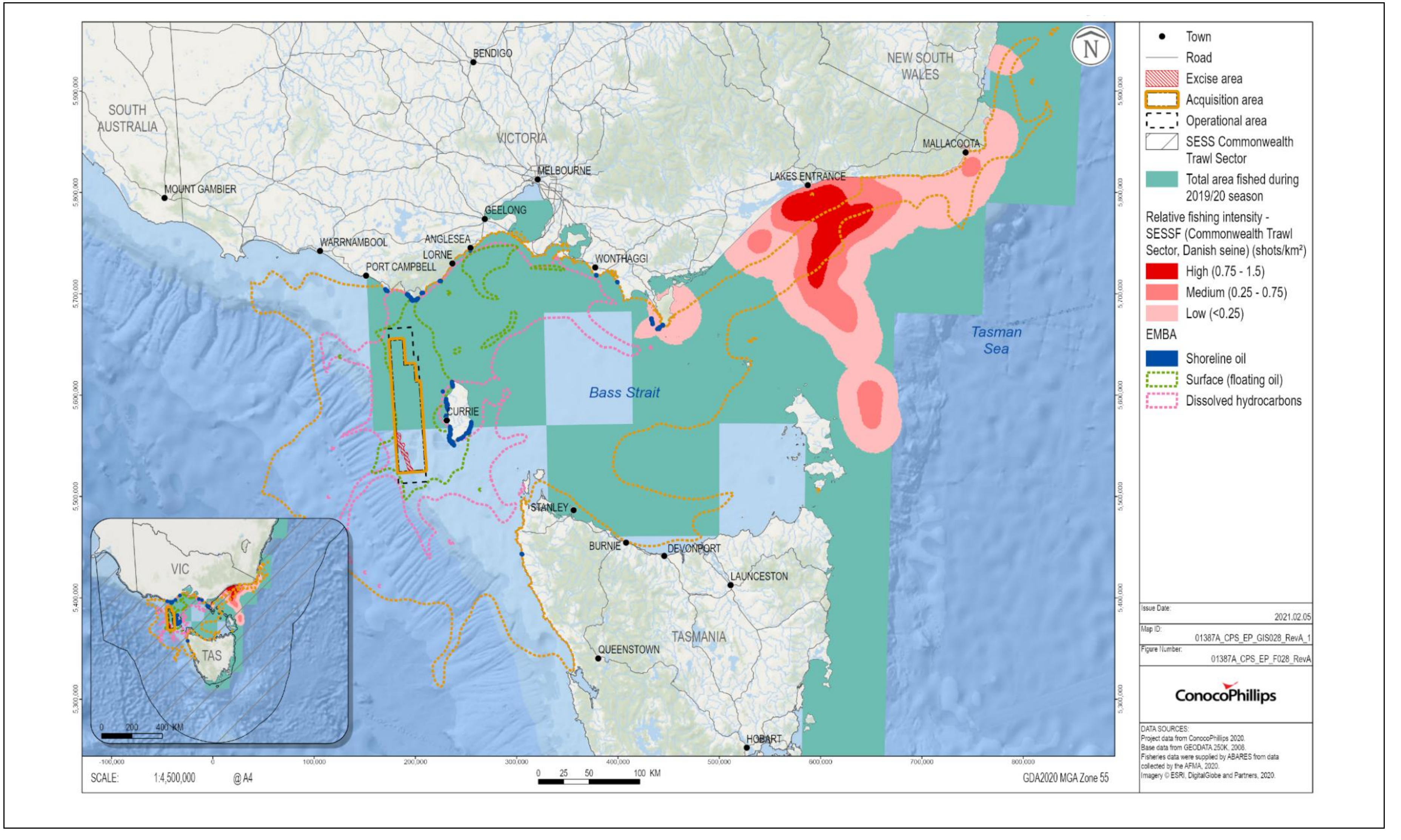


Figure 5.54 Jurisdiction and fishing intensity in the SESSF – Commonwealth Trawl Sector (Danish seine operations)



Victorian-managed Fisheries

Victorian-managed commercial fisheries with access licences that authorise harvest in the survey area and spill EMBA include the following:

- Scallop;
- Abalone;
- SRL;
- Wrasse;
- Ocean Access (General);
- Pipis (the entire Victorian coastline);
- Ocean Purse Seine;
- Inshore trawl; and
- Giant crab.

There are two Victorian-managed fisheries that operate within the survey area – the SRL and giant crab fisheries. The Victorian Fisheries Authority (VFA) catch and effort grid cell network is based on divisions of 10’ latitude (approximately 10 nm) and 12.1’ longitude (approximately 12.1 nm) (Figure 5.55).

Table 5.70 summarises the key information for each of these fisheries and indicates that all the above-listed fisheries are actively fishing in the spill EMBA.

Figure 5.55 VFA fishing catch and effort grid cells overlapped by the survey area and the EMBA

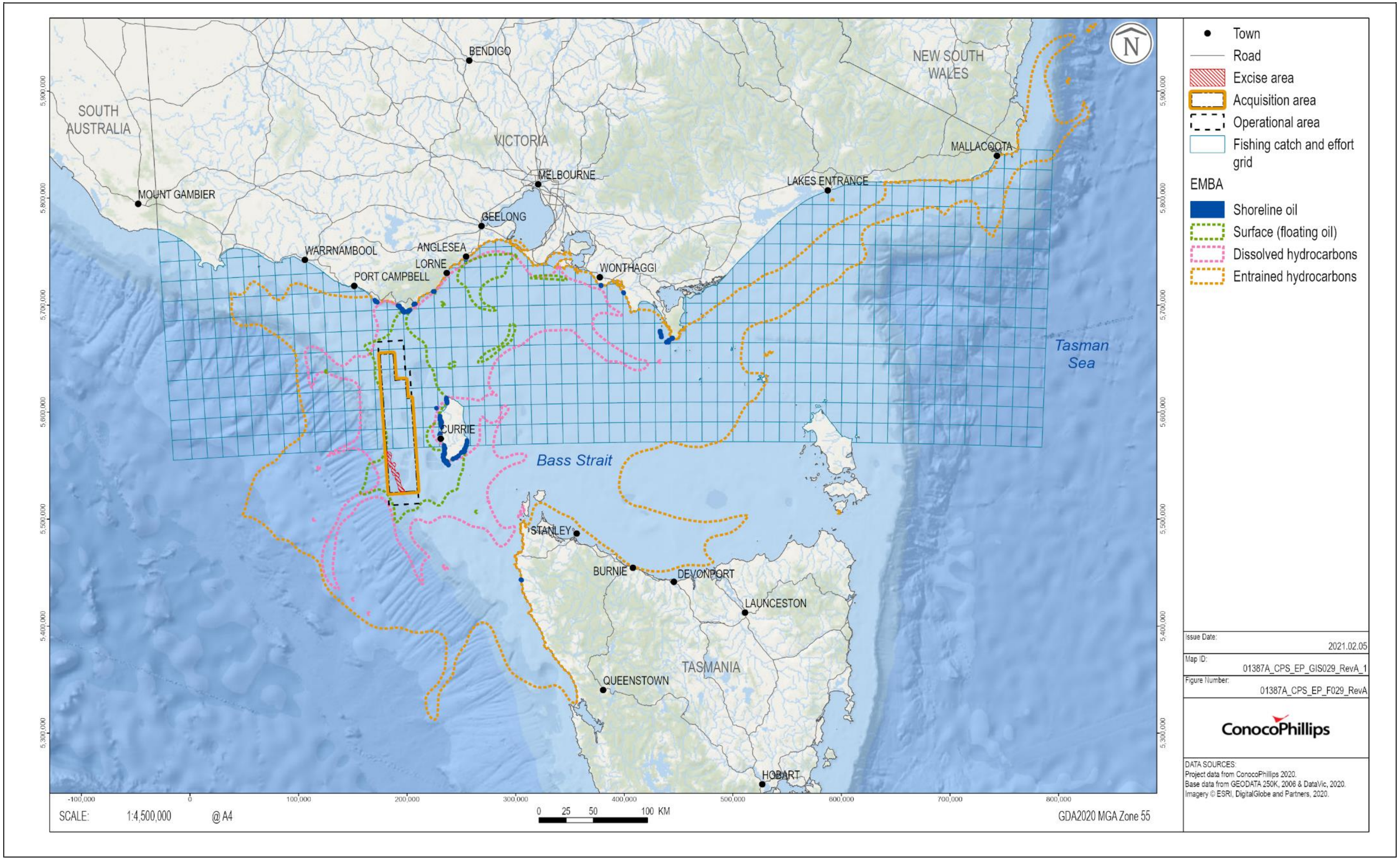


Table 5.70 Victorian-managed commercial fisheries in the survey area and EMBA

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Bass Strait Scallop Fishery (Victorian zone) (Figure 5.56)	Commercial scallop (*Pecten fumatus*).	Extends 20 nm from the high tide water mark of the entire Victorian coastline (excluding bays and inlets where commercial scallop fishing is prohibited). Management of the Bass Strait Scallop fishery was split between the Commonwealth, Victoria and Tasmania in 1986 under an Offshore Constitutional Settlement, whereby Commonwealth central, Victorian and Tasmanian zones were created.	**Survey area? Yes.** Fishing may occur in the survey area. However, the acquisition area is outside the jurisdiction of the fishery. The acquisition area intersects 0% of the total fishery area. The survey area intersects 0.5% of the total fishery area. **EMBA? Yes.** Highest fishing effort is concentrated in the eastern waters of the state, with most vessels launching from	12-month season, beginning 1st April. Fishing usually occurs during the winter months, but can occur from May to the end of November. While scallops are still present in the region, they are believed to be present in much lower numbers than historically. Scallops have highly variable levels of natural mortality, with an historical 'boom' or 'bust' nature. Fishing activity in the fishery is currently low, although the VFA is implementing	Towed scallop dredges (typically 4.5 m wide) that target dense aggregations ('beds') of scallop. A tooth-bar on the bottom of the mouth of the dredge lifts scallops from the seabed and into the dredge basket. There are a maximum of 91 licences available with 89 currently assigned. Only a few vessels fishing these licenses operate in any one year (generally between 10 and 15). Vessels are typically based out of Lakes Entrance or Port Welshpool, although licence holders may fish the entire coastline. Some licence holders also have entitlements to fish the Commonwealth scallop fishery, inshore trawl, Commonwealth	Zero quotas were in place for the 2010-11, 2011-12 and 2012-13 seasons due to a lack of commercial scallop quantities. The TACC has been set at 135 tonnes since 2013-14, to allow for exploratory fishing, and is likely to remain at this level for the foreseeable future. Scallop spawning normally occurs from late winter to early spring, with larvae drifting as plankton for up to six weeks before first settlement. Juvenile scallops reach marketable size within 18 months.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
			Lakes Entrance and Port Welshpool. The spill EMBA intersects 60.21% of the total fishery area.	management arrangements designed to increase activity across the fishery.	SESS fishery and the southern squid jig fishery.	

Abalone Fishery Figure 5.57)	Blacklip abalone (*Haliotis rubra*) is the primary target, with greenlip abalone (*H. laevigata*) taken as a bycatch.	Victorian Western Abalone Zone is located between the mouth of the Hopkins River and the Victorian/South Australian border. Most abalone live on rocky reefs from the shore out to depths of 30 m.	**Survey area? No.** Waters of the activity area are too deep for this fishery. The acquisition area intersects 1.19% of the total fishery area. The survey area intersects 1.74% of the total fishery area. **EMBA? Yes.** Based on catch distributed along the Victorian coast. The spill EMBA intersects 47.26% of the total fishery area.	12-month season, beginning 1st April.	Abalone diving activity occurs close to shoreline (generally no greater than 30 m depth) using hookah gear (breathing air supplied via hose connected to an air compressor on the vessel). Commercial divers do not use SCUBA gear. Divers use an iron bar to prise abalone from rocks. The fishery consists of 71 fishery access licences, with 14 in the western zone, 34 in the central zone and 23 in the eastern zone.	In the western zone, catches for the last five seasons were: • 2018/19 – 70 tonnes. • 2017/18 – 63 tonnes. • 2016/17 – 62 tonnes. • 2015/16 – 62 tonnes. • 2014/15 – 56 tonnes. Across all Victorian zones, the catches for the last five seasons with available data were: • 2018/19 – 694 tonnes valued at $31.3 million. • 2017/18 – 756 tonnes valued at $26.9 million. • 2016/17 – 721 tonnes valued at $20.49 million. • 2015/16 – 725 tonnes valued at $19.8 million.
Giant crab (Western Zone) (Figure 5.59)	Giant crab (*Pseudocarcinus gigas*)	The boundaries of the fishery are the same as those of the SRL Fishery, with fishing only occurring in the Western Zone.	**Survey area? Yes.** The survey area intersects the Apollo Bay region. The acquisition area intersects 1.76% of the total fishery area.	Closed season from: • Female crabs – 1 June to 15 November, to protect females in berry during	Fishers target giant crabs using baited rock lobster pots. As of 2020, there were 11 fishery access licenses.	Catches of giant crab for the last five seasons were: • 2018/19 – 10.5 tonnes. • 2017/18 – 9.8 tonnes. • 2016/17 – 10.0 tonnes. • 2015/16 – 10.0 tonnes. • 2014/15 – 10.5 tonnes.

			The excised part of the acquisition area has been designed specifically to avoid overlap with known giant crab fishing areas, so the overlap is now reduced to 0% (Figure 5.61). The survey area intersects 2.56% of the total fishery area. **EMBA?** **Yes.** The spill EMBA intersects all zones of the fishery, though fishing intensity is concentrated west of Apollo Bay. The spill EMBA intersects 44.9% of the total fishery area.	spawning period. • Male crabs – 15 September to 15 November, to protect males during their moulting period when soft shells increase their vulnerability.		Over the last 10 years, an annual average catch of 1.6 tonnes worth $161,000 has been taken from the survey area. This represents 16.3% of the total catch of the whole fishery. The excised part of the acquisition area means that there is no overlap with known giant crab fishing catches.
SRL Fishery	Southern rock lobster (*Jasus edwardsii*).	The western zone stretches from Apollo Bay to the	**Survey area?** **Yes.** The survey area intersects the	Closed season for: Female lobsters – 1 June to 15 November to	Fished from coastal rocky reefs in waters up to 150 m depth, with most of the catch coming from	The Rock Lobster Fishery is Victoria's most valuable fishery. In the western zone, catches for the last

Figure 5.58 & Figure 5.61)	Very small bycatch of species including southern rock cod (*Lotella* and *Pseudophycis spp*), hermit crab (family *Paguroidea*), leatherjacket (*Monacanthidae spp*) and octopus (*Octopus spp*).	Victorian/South Australian border. Rock lobster abundance decreases moving from western Victoria to eastern Victoria. Larval release occurs across the southern continental shelf, which is a high- current area, facilitating dispersal.	western zone and is within the jurisdiction of the fishery. The acquisition area intersects 1.76% of the total fishery area. The survey area intersects 2.56% of the total fishery area. **EMBA? Yes.** The spill EMBA intersects all regions of the fishery, though fishing intensity is concentrated west of Apollo Bay. The spill EMBA intersects 44.9% of the total fishery area.	protect females in berry during spawning period. Male lobsters – 15 September to 15 November to protect males during their moulting period when soft shells increase their vulnerability. Catches generally highest from August to January.	inshore waters less than 100 m deep. Baited pots are generally set and retrieved each day, marked with a surface buoy. As of 2020, there were 33 fishery access licences in the eastern zone.	five seasons with available data were: • 2018/19 – 245 tonnes values at $22 million. • 2017/18 – 230 tonnes valued at $18.6 million. • 2016/17 – 209 tonnes valued at $16.5 million. • 2015/16 – 230 tonnes valued at $19.4 million. • 2014/15 – 230 tonnes valued at $19.2 million. Effort during 2016/17 in the Western Zone was highest in December/ January (51,000 and 52,000 pot-lifts) and apart from the closed season, effort was lowest during May and June (12,000 and 4,000 respectively). Over the last 10 years, an average annual catch of 13 tonnes worth $1,280,000 has been taken from the survey area. This represents 5.2% of the total catch of the whole fishery (SETFIA and Fishwell Consulting, 2020).

Wrasse Fishery (Figure 5.60)	Blue-throat wrasse (*Notolabrus tetricus*), saddled wrasse (*N. fucicola*), orange-spotted wrasse (*N. parilus*).	Entire Victorian coastline out to 20 nm (excluding marine reserves, bays and inlets).	**Survey area? Yes.** The survey area intersects the western assessment zone of the fishery. The acquisition area intersects 1.19% of the total fishery. The survey area intersects 1.74% of the total fishery area. **EMBA? Yes.** In recent years, catches have been highest off the central coast (Port Phillip Heads, Western Port and Wilson's Promontory) and the west coast. The spill EMBA intersects 22.86% of the total fishery area.	Year-round.	Handline fishing (excluding longline), rock lobster pots (if in possession of a rock lobster access fishing licence). Preferred water depths for blue-throat wrasse is 20-40 m, while saddled wrasse prefer depths of 10-30 m. As of 2020, there were 22 fishery access licences.	Catches of all wrasse species for the last five seasons were: • 2018/19 – 33 tonnes valued at $672,000. • 2017/18 – 38 tonnes valued at $767,000. • 2016/17 – 24 tonnes valued at $557,000. • 2015/16 – 30 tonnes valued at $627,000. • 2014/15 – 29 tonnes valued at $490,000.

Pipi fishery (Eastern Zone) (Figure 5.62)	Pipi (Donax deltoids)	Covers the entire Victorian coastline, with pipis found in the intertidal zone of high-energy sandy beaches.	**Survey area? No.** The survey area is outside the required habitat (intertidal sandy beaches) for the target species and there is no overlap with the fishery. **EMBA? Yes.** Wherever there are high-energy sandy beaches. Venus Bay is a popular harvesting area.	Year-round.	This fishery opened in 2017-2018. Other than three specialised bait fisheries only Ocean Access Fishery licence holders are permitted to harvest pipis.	To date, Ocean Access Fishery licence holders have harvested 95% of the commercial pipi harvest. Pipis are sold for bait and for human consumption. There is no publicly available information regarding catch data and associated value.
Multi-species ocean fishery						
Ocean Purse Seine Fishery	Australian sardine (*Sardinops sagax*), Australian salmon (*Arripis trutta*) and sandy sprat (*Hyperlophus*	Entire Victorian coastline, excluding marine reserves, bays and inlets.	**Survey area? Yes.** An assumption based on limited data availability. **EMBA? No.**	Year-round.	Purse seine is generally a highly selective method that targets one species at a time, thereby minimising bycatch. The purse seine method does not touch the seabed. A lampara net may also be used.	Confidential data (due to operation of only one fisher).

	vittatus) are the main species. Southern anchovy (*Engraulis australis*) caught in some years.		An assumption, based on limited data availability.		Only one licence is active in Victorian waters (based out of Lakes Entrance), with fishing focused close to shore and during the day. This licence is held by Mitchelson Fisheries Pty Ltd, a family business that catches primarily sardines, salmon, mackeral, sandy sprat, anchovy and white bait using the *Maasbanker* purse seine vessel.	
Ocean Access (or Ocean General) Fishery	Gummy shark (*Mustelus antarcticus*), school shark (*Galeorhinus galeus*), Australian salmon (*Arripis trutta*), snapper (*Pagrus auratus*). Small bycatch of flathead (*Platycephalidae spp*).	Entire Victorian coastline, excluding marine reserves, bays and inlets.	**Survey area? Yes.** An assumption based on limited data availability. **EMBA? No.** An assumption, based on limited data availability.	Year-round.	Utilises mainly longlines (200 hook limit), but also haul seine nets (maximum length of 460 m) and mesh nets (maximum length of 2,500 m per licence). As of June 2020, there were 157 fishery access licences. Fishing usually conducted as day trips from small vessels (<10 m).	There is insufficient catch data (catch data is combined with other fisheries and therefore unable to be distinguished on a standalone basis).

Inshore Trawl Fishery	Key species are eastern king prawn (*Penaeus plebejus*), school prawn (*Metapenaeus macleayi*) and shovelnose lobster/Balmain bug (*Ibacus peronii*). Minor bycatch of sand flathead (*Platcephalus bassensis*), school whiting (*Sillago bassensis*) and gummy shark (*Mustelus antarcticus*).	Entire Victorian coastline, excluding marine reserves, bays and inlets. Most operators are based at Lakes Entrance.	**Survey area? Yes.** An assumption based on limited data availability. **EMBA? No.** An assumption, based on limited data availability.	Year-round, although the majority of prawn fishing occurs in the warmer months up until Easter.	Otter-board trawls with no more than a maximum head- line length of 33 m, or single mesh nets are used. As of 2020, there were 54 fishery access licences, with only about 15 active to various degrees.	The catch of eastern school prawn in 2015 was 75 t, the largest for the previous 10 years.

Source: VFA (2020).

Figure 5.56 Jurisdiction of the Victorian scallop fishery and its intersection with the survey area and EMBA

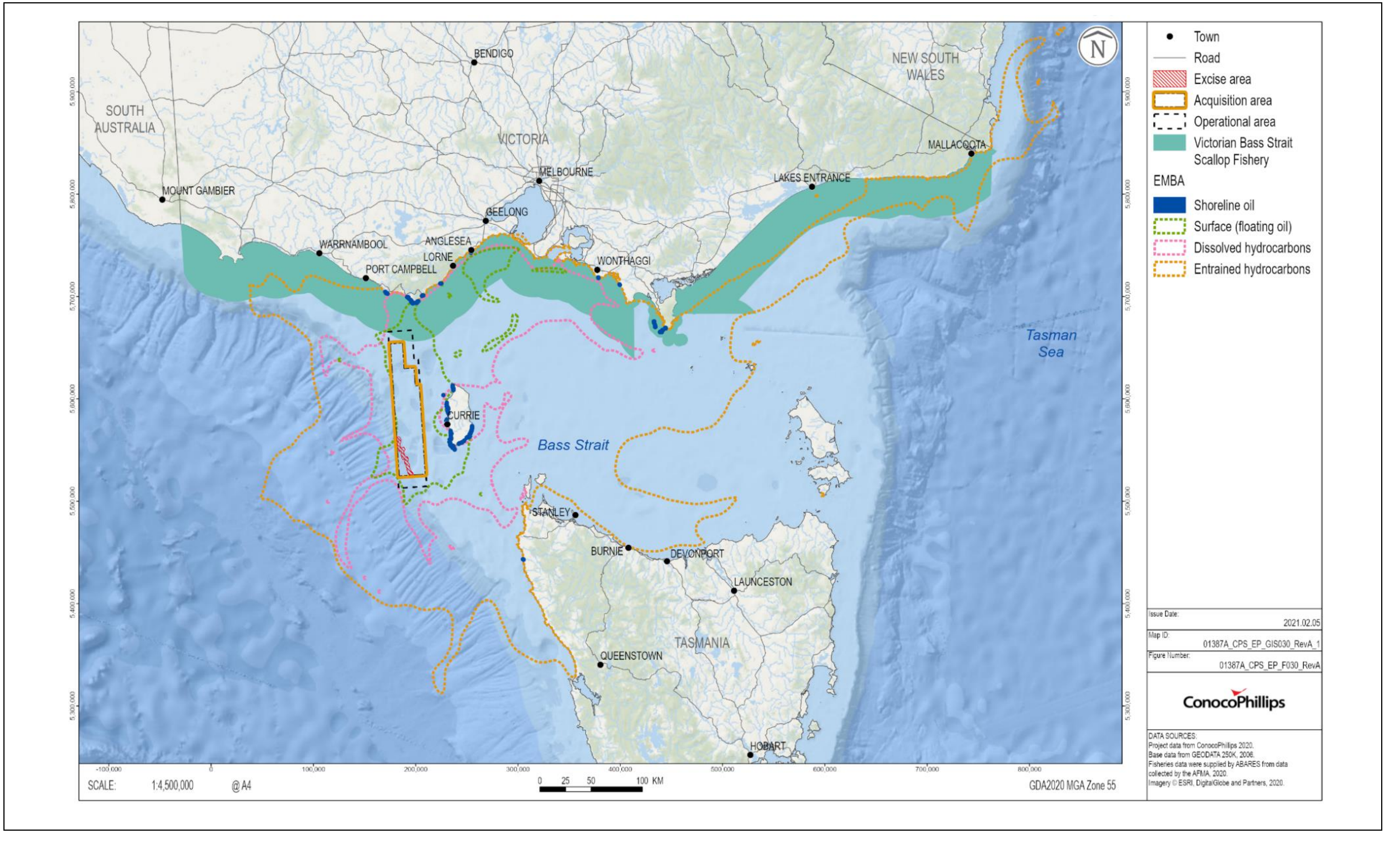


Figure 5.57 Jurisdiction of the Victorian abalone fishery and its intersection with the survey area and EMBA

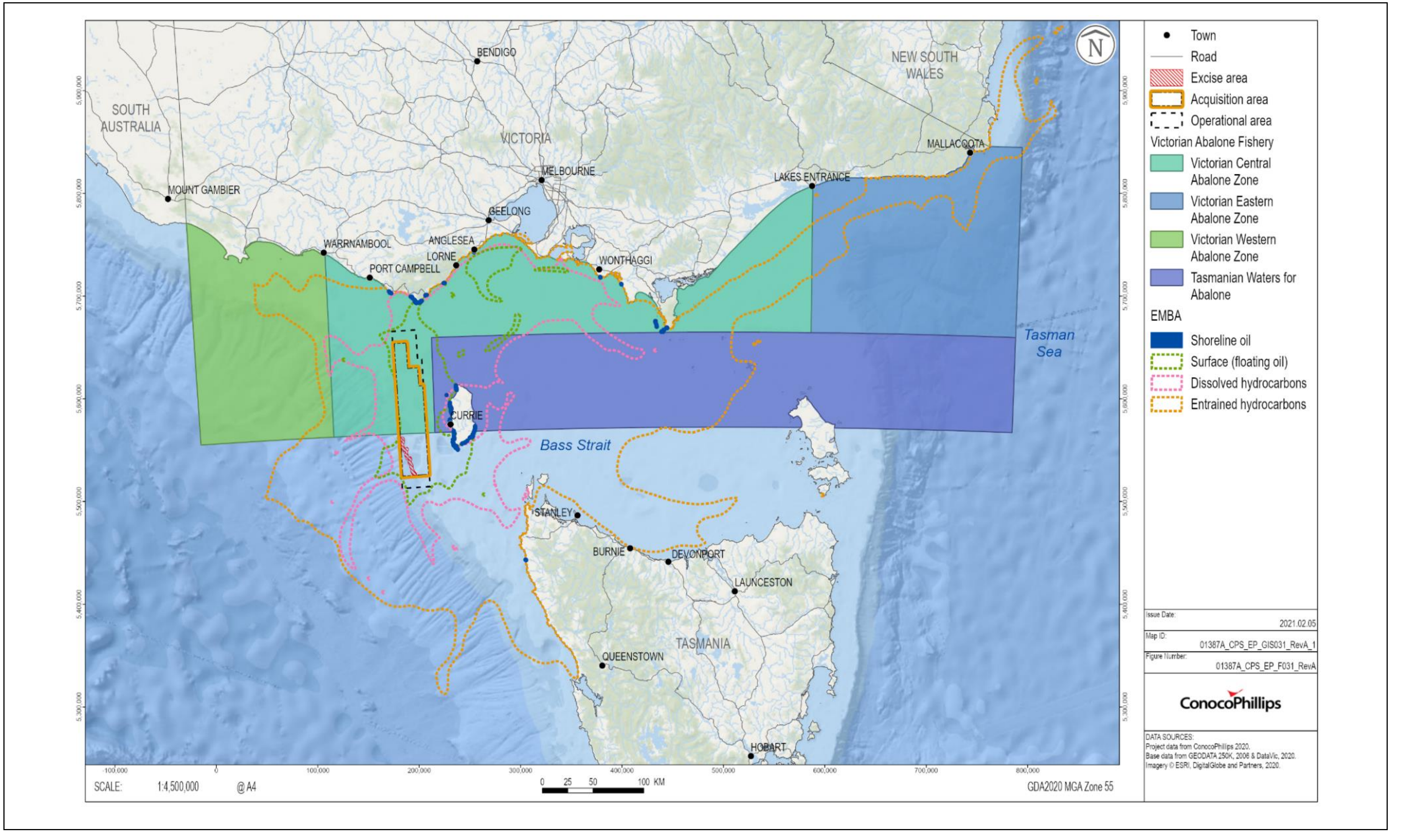


Figure 5.58 Jurisdiction of the Victorian rock lobster fishery and its intersection with the survey area and EMBA

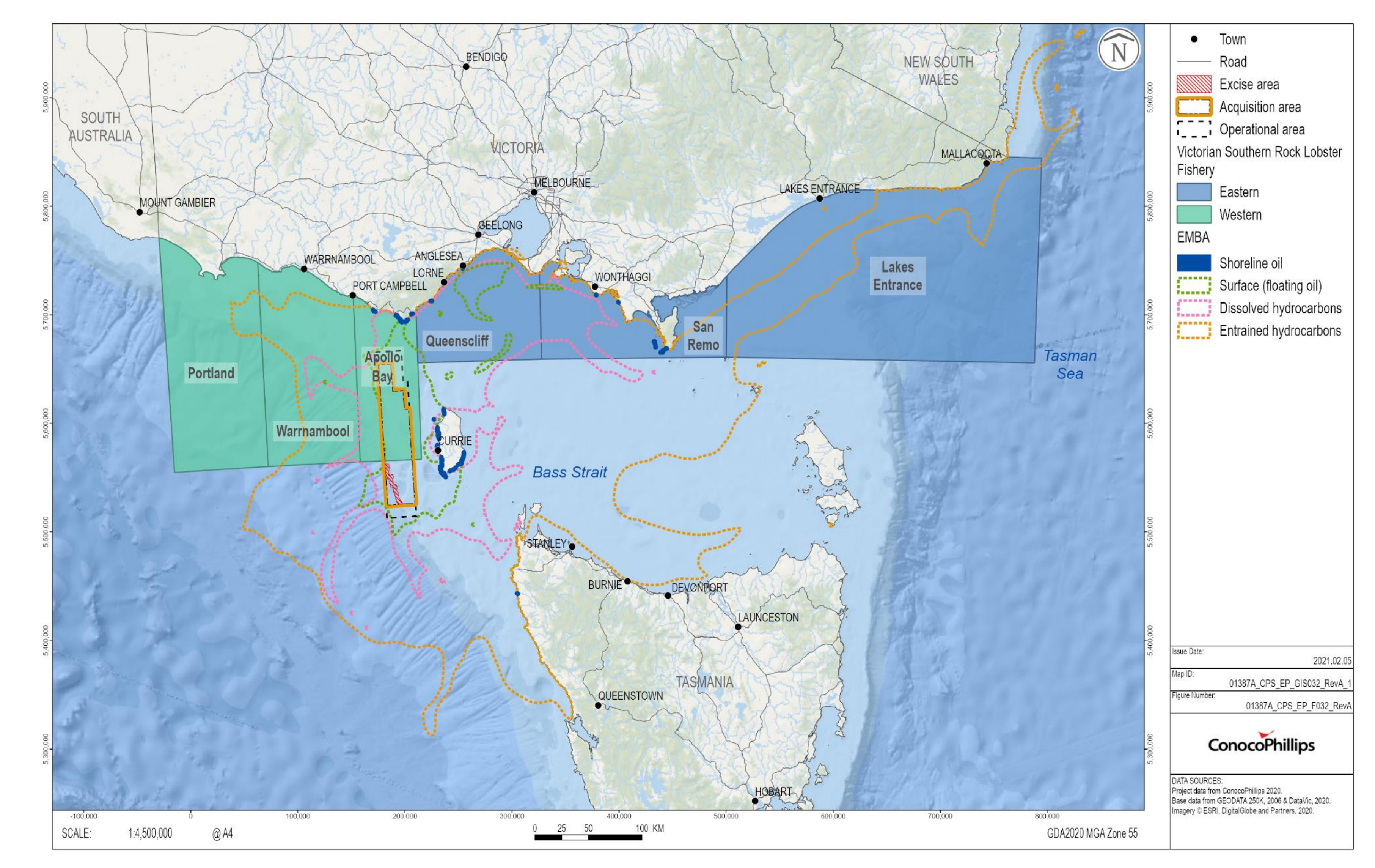


Figure 5.59 Jurisdiction of the Victorian giant crab fishery and its intersection with the survey area and EMBA

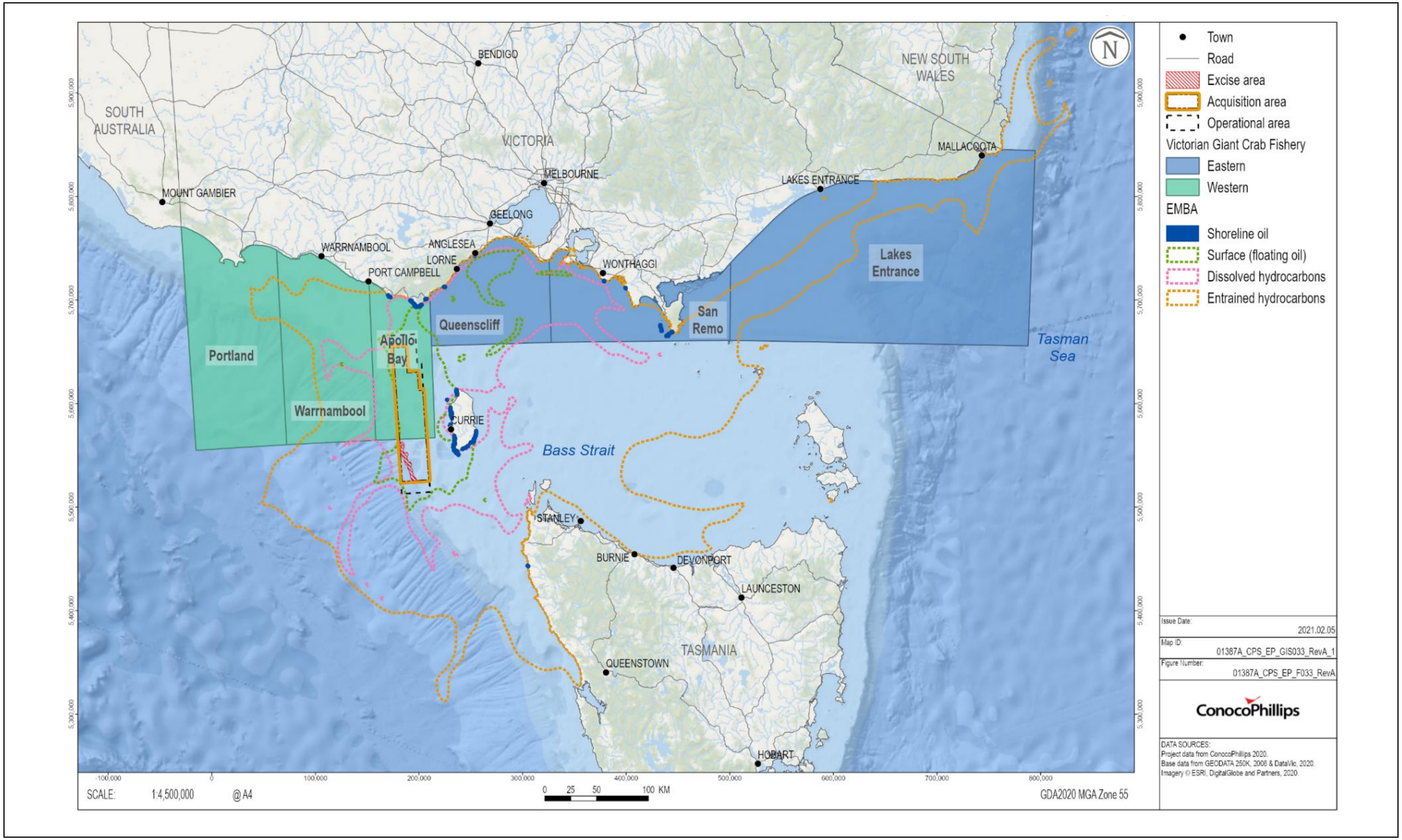


Figure 5.60 Jurisdiction of the Victorian wrasse fishery and its intersection with the survey area and EMBA

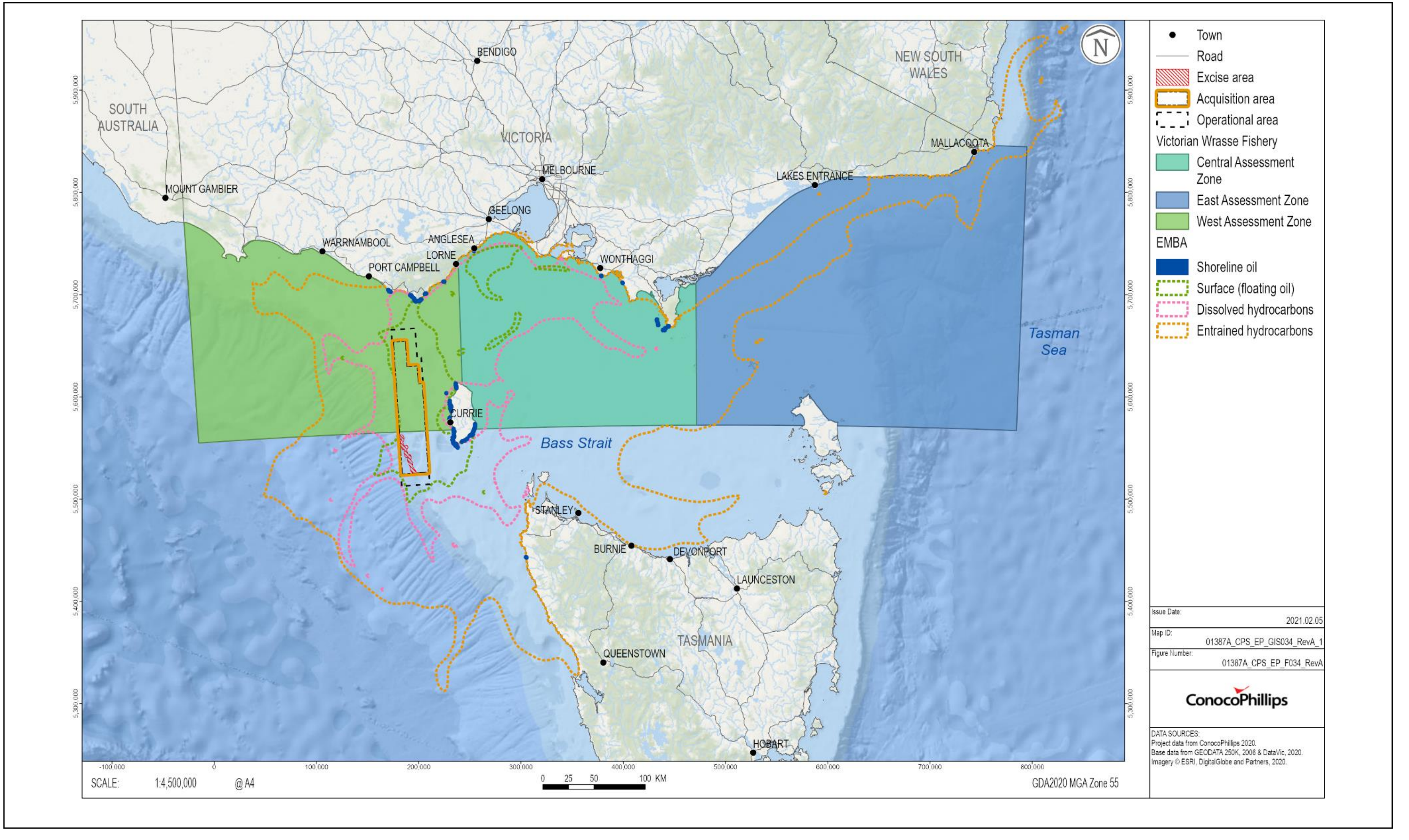


Figure 5.61 Jurisdiction of the Victorian rock lobster fishery

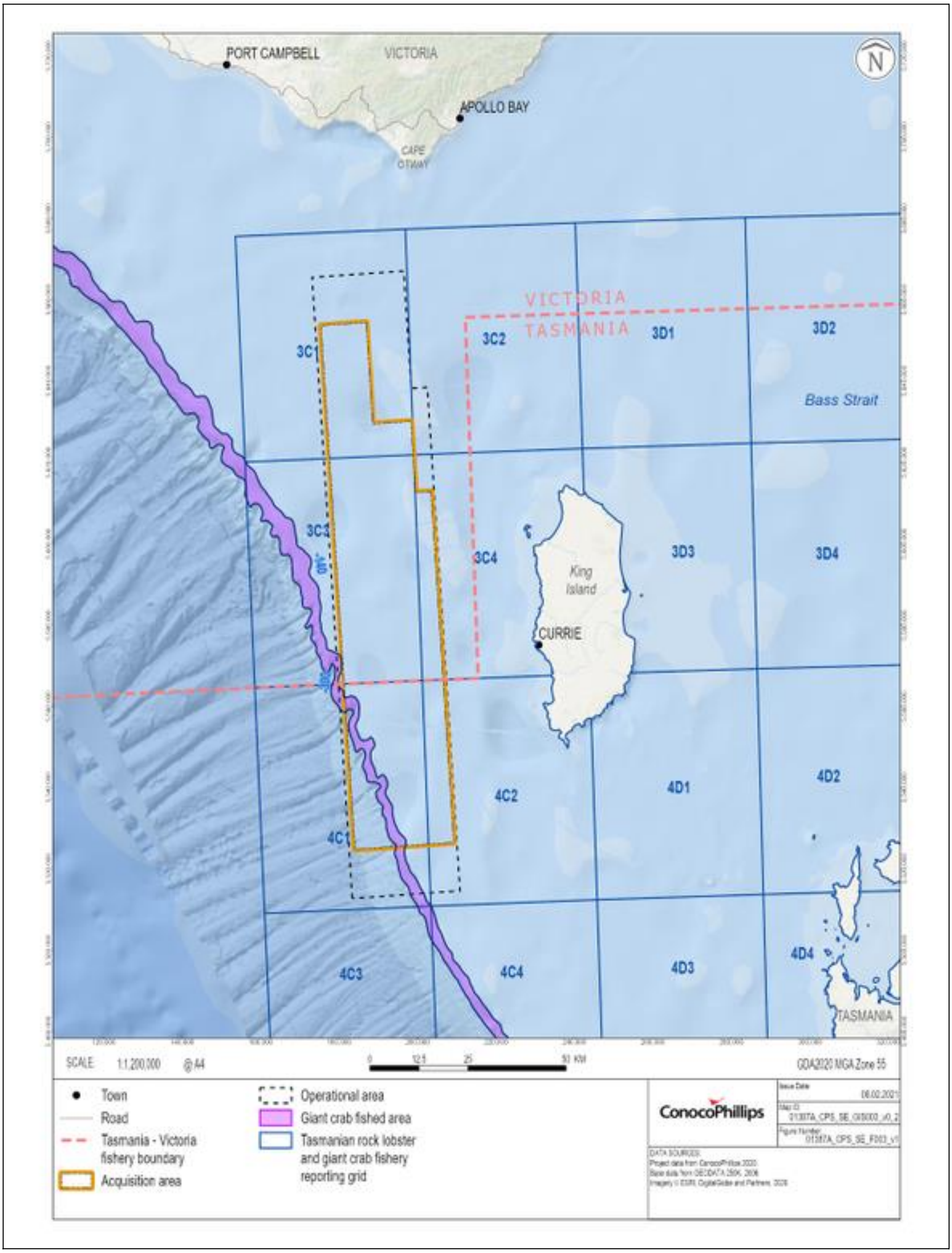
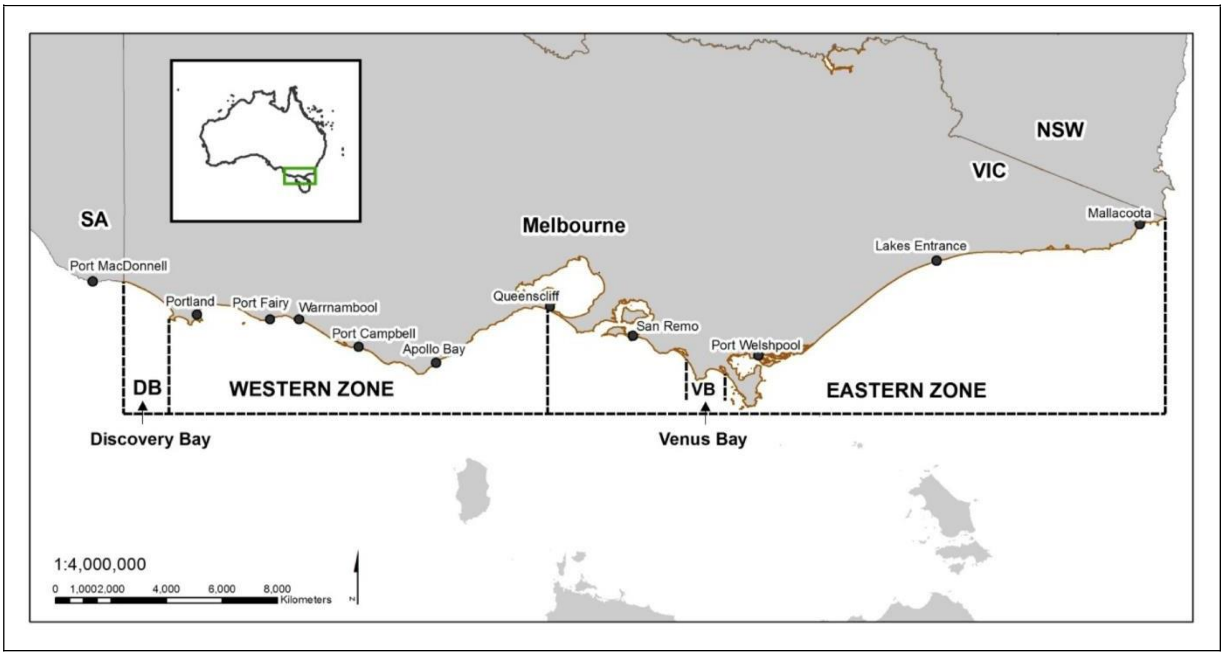


Figure 5.62 Jurisdiction of the Victorian pipi fishery



Tasmanian-managed Fisheries

Tasmanian-managed commercial fisheries with access licences that authorise harvest in the waters of the spill EMBA include the following:

- Abalone;
- Giant crab;
- Rock lobster;
- Scalefish;
- Scallop;
- Seaweed;
- Shellfish;
- Octopus; and
- Commercial dive.

Table 5.71 summarises the key information for each of these fisheries and indicates that all the above-listed fisheries, except the shellfish fishery, are actively fishing (or have jurisdiction to fish) in the spill EMBA

Table 5.71 Tasmanian-managed commercial fisheries in the spill EMBA and survey area

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Giant Crab Fishery (Figure 5.63 & Figure 5.65)	Tasmanian giant crab (*Pseudocarcinus gigas*).	Entire Tasmanian coastline, the fishery shares the same reporting grid as the SRL fishery (see Figure 5.45). Fishing is focused along the continental slope.	**Survey area? Yes.** Habitat for the target species is present in the survey area. The acquisition area intersects 1.11% of the total fishery area and overlaps fisheries reporting blocks 3C1, 3C3, 3C4, 4C1 & 4C2. The excised part of the acquisition area means been designed specifically to avoid overlap with known giant crab fishing areas, so the overlap is now reduced to 0%. The survey area intersects 1.6% of the total fishery area. **EMBA? Yes.** The spill EMBA	Males – year-round. Females – 15 November to 31 May.	Giant crabs are harvested on the continental shelf, with the most abundant catches at water depths of 110-180 m. They are harvested via baited pots.	Catches for the last five seasons for the whole fishery were: • 2018/19 – 20 t. • 2017/18 – 16 t. • 2016/17 – 30 t. • 2015/16 – 20 t. • 2014/15 – 23 t. Over the last 10 years, an average annual catch of 7.4 tonnes worth $737,000 has been taken from the survey area. This represents 39% of the total catch for the whole fishery. The excised part of the acquisition area means that there is no overlap with known giant crab fishing catches.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
			intersects 30.58% of the total fishery area.			
Rock Lobster Fishery (Figure 5.63 & Figure 5.66)	Southern rock lobster (*Jasus edwardsii*).	All Tasmanian waters. East Coast Stock Rebuilding Zone subject to temporary closures (well east of the survey area). TSIC advises that an extensive area of SRL occur in deep waters west of King Island, but is rarely fished as these bigger 'white' lobsters do not fetch the price of shallow water 'red' lobsters.	**Survey area? Yes.** The acquisition area intersects 1.11% of the total fishery area and intersects fisheries reporting blocks 3C1, 3C3, 3C4, 4C1 & 4C2. The survey area intersects 1.6% of the total fishery area. **EMBA? Yes.** The spill EMBA intersects 30.58% of the total fishery area.	Year-round. • Closure for females - 1 May to 15 November (for spawning). • For the 2020-21 season, waters in the survey area are open from 15 November 2020.	Fished from coastal rocky reefs in waters up to 150 m depth, with most of the catch coming from inshore waters less than 100 m deep. Baited pots are generally set and retrieved each day, marked with a surface buoy. There were 194 licenced vessels in 2017/18.	Catches of the rock lobster commercial fishery for the last five seasons for the whole fishery (subject to available data) were: • 2018/19 – 1,050 t. • 2017/18 – 1,050 t. • 2016/17 – 1,050 t. • 2015/16 – 1,050 t. • 2014/15 – 1,050 t. Over the last 10 years, an annual average catch of 2.4 tonnes worth $238,000 has been taken from the survey area. This represents <1% of the total catch for the whole fishery (SETFIA and Fishwell Consulting, 2020).

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Abalone Fishery (Figure 5.67)	Blacklip abalone (*Haliotis rubra*) is the primary target, with greenlip abalone (*H. laevigata*) taken as a bycatch.	Entire Tasmanian coastline including King Island and the Furneaux Group.	**Survey area? No.** Waters of the survey area are too deep for abalone fishing. There is no intersection between the	Year-round.	Abalone diving activity occurs close to shoreline (generally no greater than 30 m depth) using hookah gear (breathing air supplied via hose connected to an air compressor on the	Total state-wide catch of the abalone fishery for the last five seasons (subject to available data) were: • 2018 – 1,310 t. • 2017 – 1,561 t. • 2016 – 1,694 t. • 2015 – 1,855 t.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
			acquisition area or the survey area with the total of the fishery area. **EMBA? Yes.** The spill EMBA intersects 32.04% of the total fishery area.		vessel). Commercial divers do not use SCUBA gear. Divers use an iron bar to prise abalone from rocks.	• 2014 – 1,932 t. Abalone harvest on the west coast of King Island (outside the survey area) in 2016 (Block 1 and 3) was 52 t of blacklip abalone (27.5% TACC) and 3 t of greenlip abalone (2% TACC) (Mundy & Jones, 2017) or approximately $2.6M in revenue. The abalone fishery is open all year round, however the predominant harvest period of blacklip abalone is between July and December and for greenlip abalone, January to June. On King Island abalone is targeted by two divers (KIRDO, 2018).

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Scallop Fishery	Commercial scallop (*Pecten fumatus*).	Entire Tasmanian coastline	**Survey area? No.** Fishery currently closed for stock assessment. **EMBA? No.** Fishery currently closed for stock Assessment.	Fishery closed.	Towed scallop dredges (typically 4.5 m wide) that target dense aggregations ('beds') of scallop. A tooth-bar on the bottom of the mouth of the dredge lifts scallops from the seabed and into the dredge basket.	Closed since 2016.
Shellfish Fishery (Figure 5.64)	Pacific oyster (*Crassostrea gigas*), Native oyster (*Ostrea angasi*), Venerupis clam (*Venerupis largillierti*) and Katelysia cockle (*Katelysia scalarina*).	Designated zones occur at Georges Bay and Ansons Bay on the east coast of Tasmania (see Figure 5.64).	**Survey area? No.** The designated zones occur off the east coast of Tasmania. There is no intersect between the survey area and the fishery. **EMBA? No.** The designated zones occur off the east coast of Tasmania. There is no intersect between the EMBA and the fishery.	Year-round (assumed).	The shellfish targeted by the fishery can be collected by hand in shallow water using a basket rake. In deeper water a dredge is used.	Available data of catches for five seasons include: • 2014/15 – 25 t. • 2013/14 – 42 t. • 2012/13 – 49 t. • 2011/12 – 44 t. • 2010/11 – 44 t.

Seaweed Fishery	Bull kelp (Nereocystis luetkeana) and Wakame (Undaria pinnatifida).	Kelp harvesting occurs on the west coast of Tasmania and King Island. *Undaria pinnatifida* harvesting occurs on the east coast of Tasmania. On King Island seaweed is harvested between Cape Wickham and approximately 5 km due south of Ettrick Beach, the south coast of King Island from Surprise Bay to the east of Stokes point and the south-east coast of King Island from three areas around red Hut Point, Grassy harbour and City of Melbourne Bay.	**Survey area? No.** Seaweed is harvested as it washes ashore. There is no intersect between the survey area and collection sites. **EMBA? Yes.** The primary sites of the fishery occur off the east coast of Tasmania and west coast of King Island.	Year-round (assumed).	Seaweeds are harvested as they wash ashore. The collection of native seaweed species if they are attached to substrate or the sea is prohibited. Bull kelp is dried and alginates are extracted which are used in thickening solutions. Some is bagged and sold as garden mulch.	The annual average harvest on King Island is above 1200 tonnes (dried weight) and supplies approximately 5% of the world production of alginates. Kelp harvesting on King Island generates about $2.5M annually by one company – Kelp Industries Pty Ltd (exclusive licence). The company is supported by up to 80 individuals who have a fishing licence (marine plant) to collect cast bull kelp on the island.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Scalefish Fishery (Figure 5.68)	Multi-species fishery including banded morwong (*Cheilodactylus spectabilis*), tiger flathead (*Neoplatycephalus richardsoni*), southern school whiting (*Sillago flindersi*) Australian salmon (*Arripis trutta*), barracouta (*Thyrsites atun*), bastard trumpeter (*Latridopsis forsteri*) and blue warehou (*Seriolella brama*).	Entire Tasmanian coastline.	**Survey area?** **No.** There has been no recent (last 10 years) catch reported from the survey area (SETFIA and Fishwell Consulting, 2020). The acquisition area intersects 0.24% of the total fishery area. The survey area intersects 0.39% of the total fishery area. **EMBA? Yes.** The EMBA intersects areas of reported catch from the northwest, west, northeast and east regions, based on the fishery's 2017/18 assessment report. The spill EMBA intersects 36.65% of the fishery.	Year-round. Some seasonal closures depending on the target species.	The fishery targets multiple species and therefore uses multiple gear-types including drop-line, Danish seine, fish trap, hand-line and spear. There were 259 vessels operating in 2017/18 across the fishery.	Catches of key scalefish species for the last five seasons were: • 2017/18 – 318 t. • 2016/17 – 312 t. • 2015/16 – 348 t. • 2014/15 – 273 t. • 2013/14 – 320 t.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Commercial Dive Fishery (Figure 5.69)	Short spined sea urchin (*Heliocidaris erythrogramma*), long spined sea urchin (*Centrostephanus rodgersii*), periwinkles (genus *Turbo*) and Japanese kelp (*Undaria pinnatifida*).	Entire Tasmanian coastline).	**Survey area?** **No.** There has been no recent (last 10 years) catch reported from the survey area (SETFIA and Fishwell Consulting, 2020). There is no intersection between the acquisition area or the survey area with the fishery reporting grid. **EMBA? Yes.** EMBA intersects the northern and western and north eastern reporting zones of the fishery. The spill EMBA intersects 37.47% of the total fishery area.	1 September – 31 August.	There are currently 52 commercial dive licences.	Catch data for the north and western zones: from the 2019/2020 season at date of reporting was 76 tonnes with no value assigned. Historic catch data is not available.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Octopus Fishery (Figure 5.68)	Pale octopus (*Octopus pallidus*).	Entire Tasmanian coastline, the fishery shares the same reporting grid as the scalefish fishery	**Survey area?** **No.** Catch data reported in the fishery's 2018/19 assessment demonstrates that no catch has been reported in the survey area since at least 2013.	Year round.	There are currently only two active vessel licences.	Catch for the whole fishery for the last five seasons were: • 2018/19 – 129 t. • 2017/18 – 64 t. • 2016/17 – 81 t. • 2015/16 – 74 t. • 2014/15 – 90 t.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
			The acquisition area intersects 0.24% of the total fishery area. The survey area intersects 0.39% of the total fishery area. **EMBA? Yes.** Catch data reported in the fishery's 2018/19 assessment indicates that fishing activity occurs in the EMBA. The spill EMBA intersects 35.65% of the total fishery area.			

Source: DPIPWE (2020b-i), Moore & Hartmann (2019), Emery et al (2015), Hill et al (2020).

Figure 5.63 Jurisdiction and reporting blocks of the Tasmanian Rock Lobster and Giant Crab Fishery

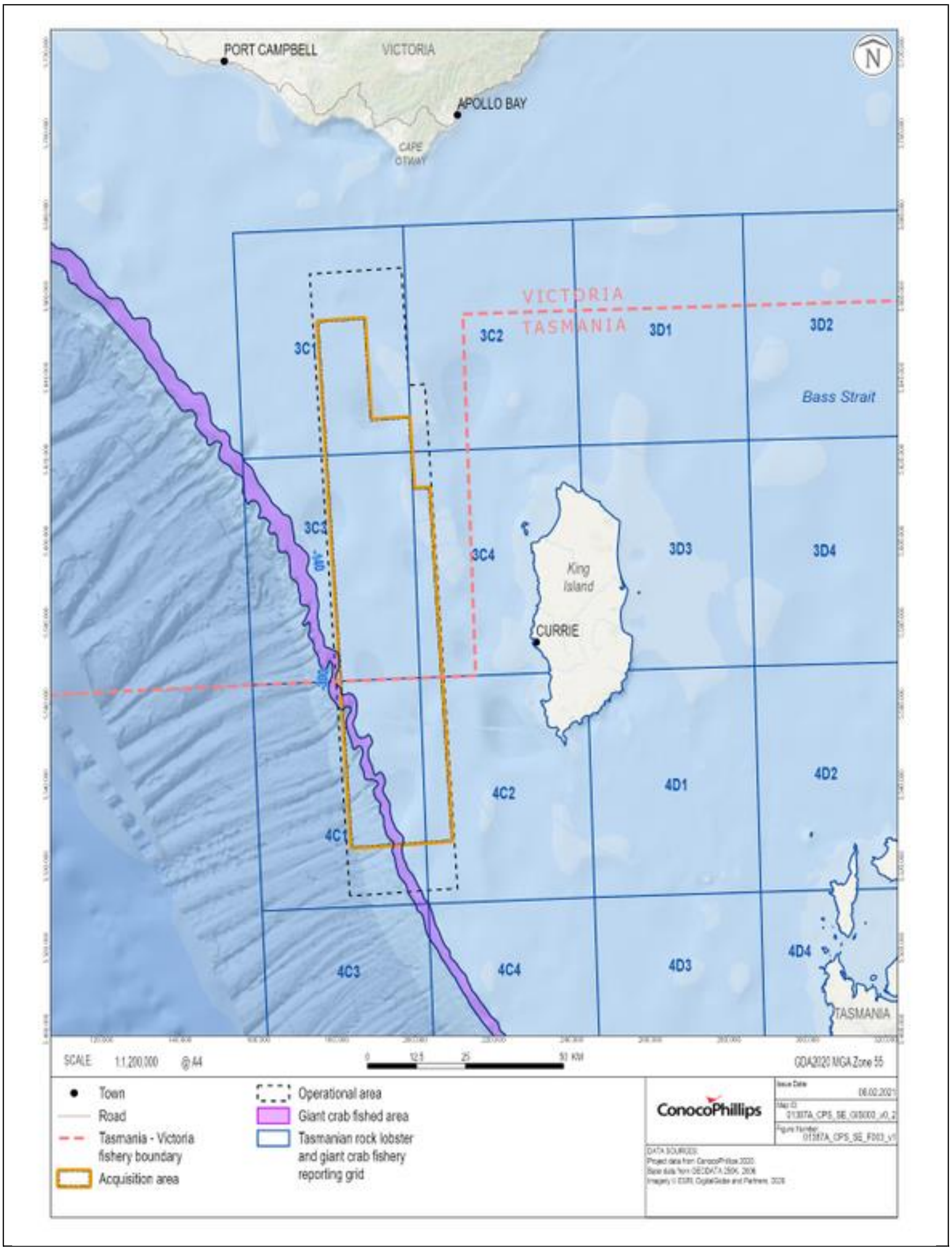


Figure 5.64 Tasmanian Shellfish Fishery areas of high catch and effort

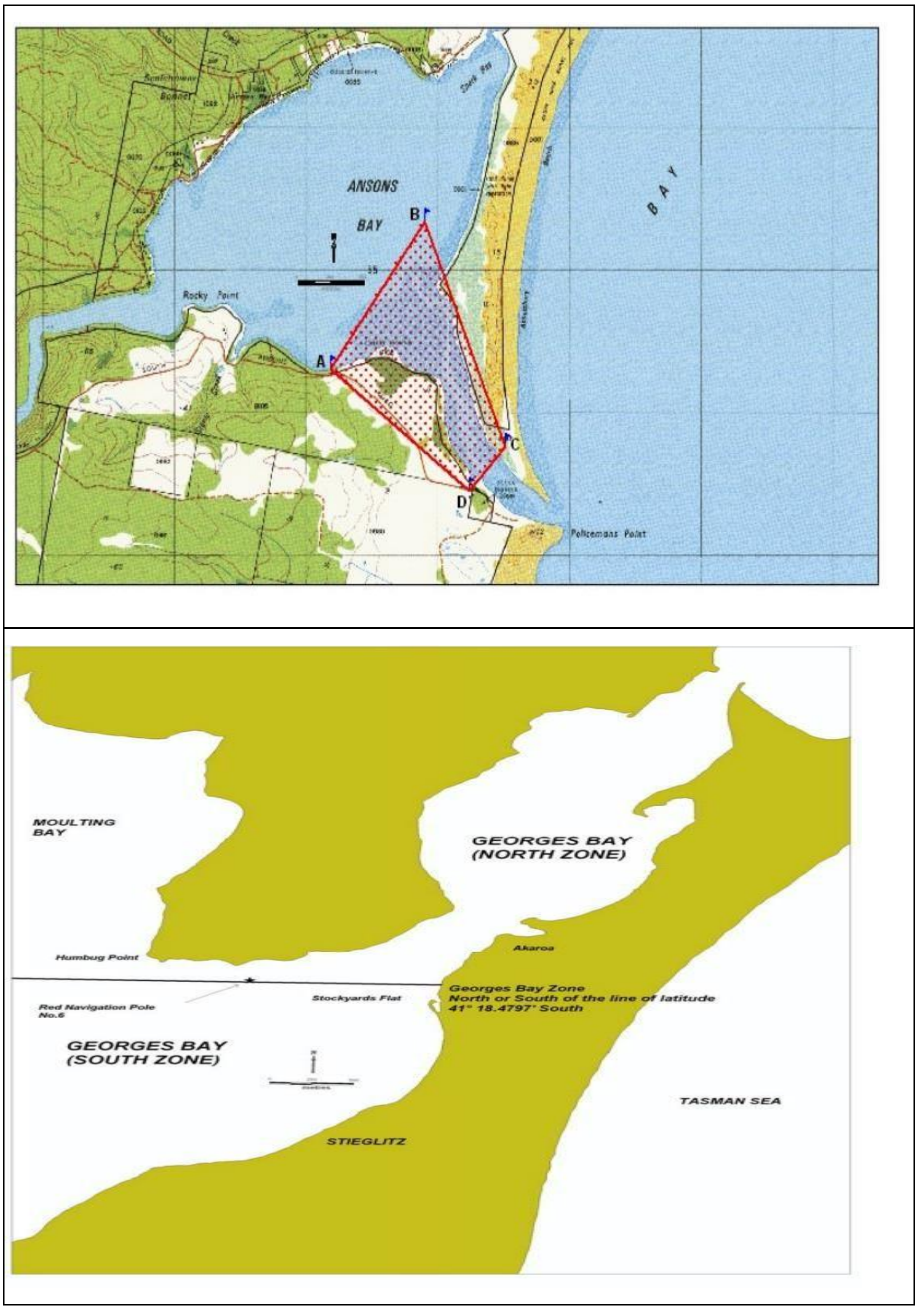


Figure 5.65 Jurisdiction and reporting blocks of the Tasmanian giant crab fishery

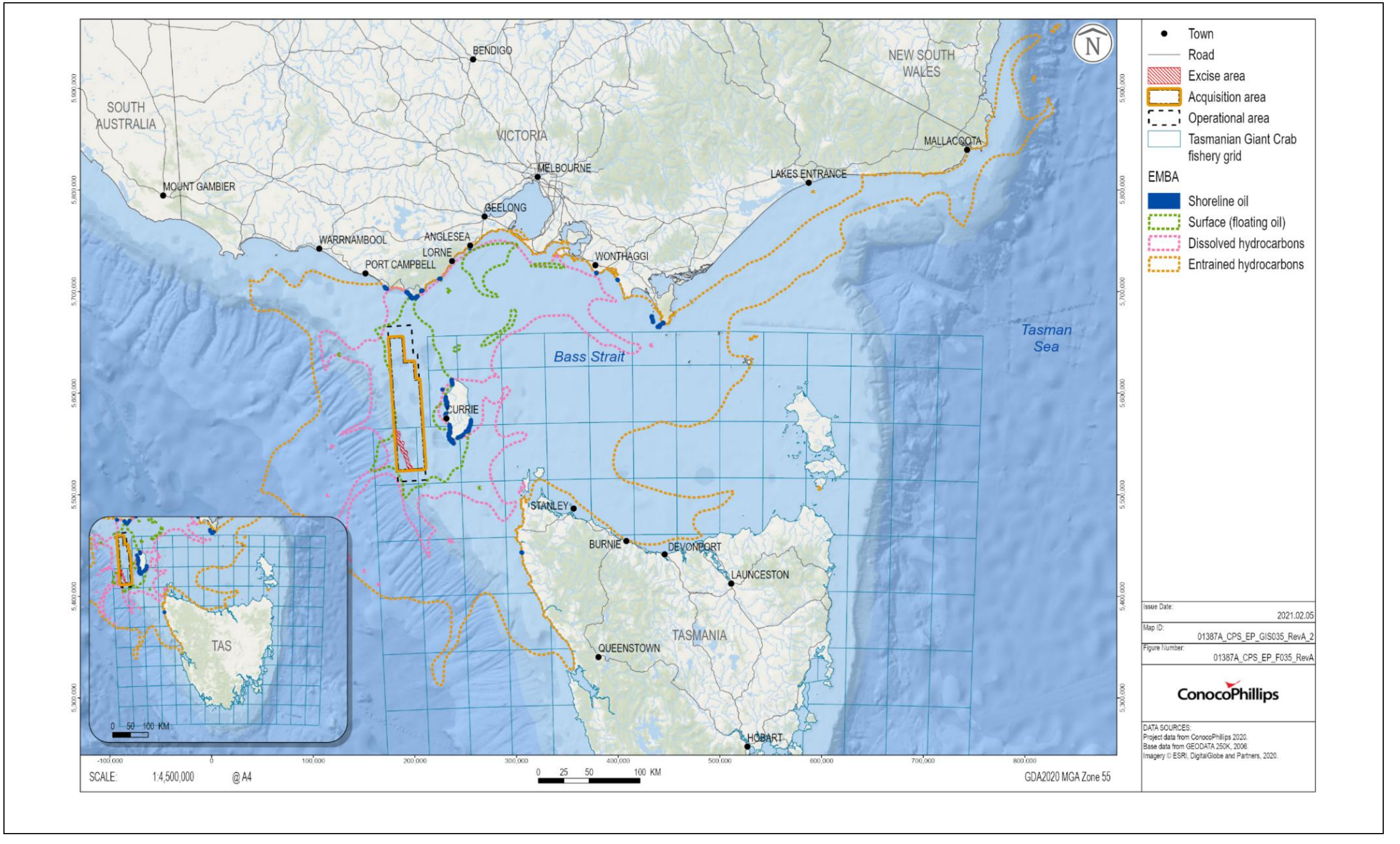


Figure 5.66 Jurisdiction and reporting blocks of the Tasmanian rock lobster fishery

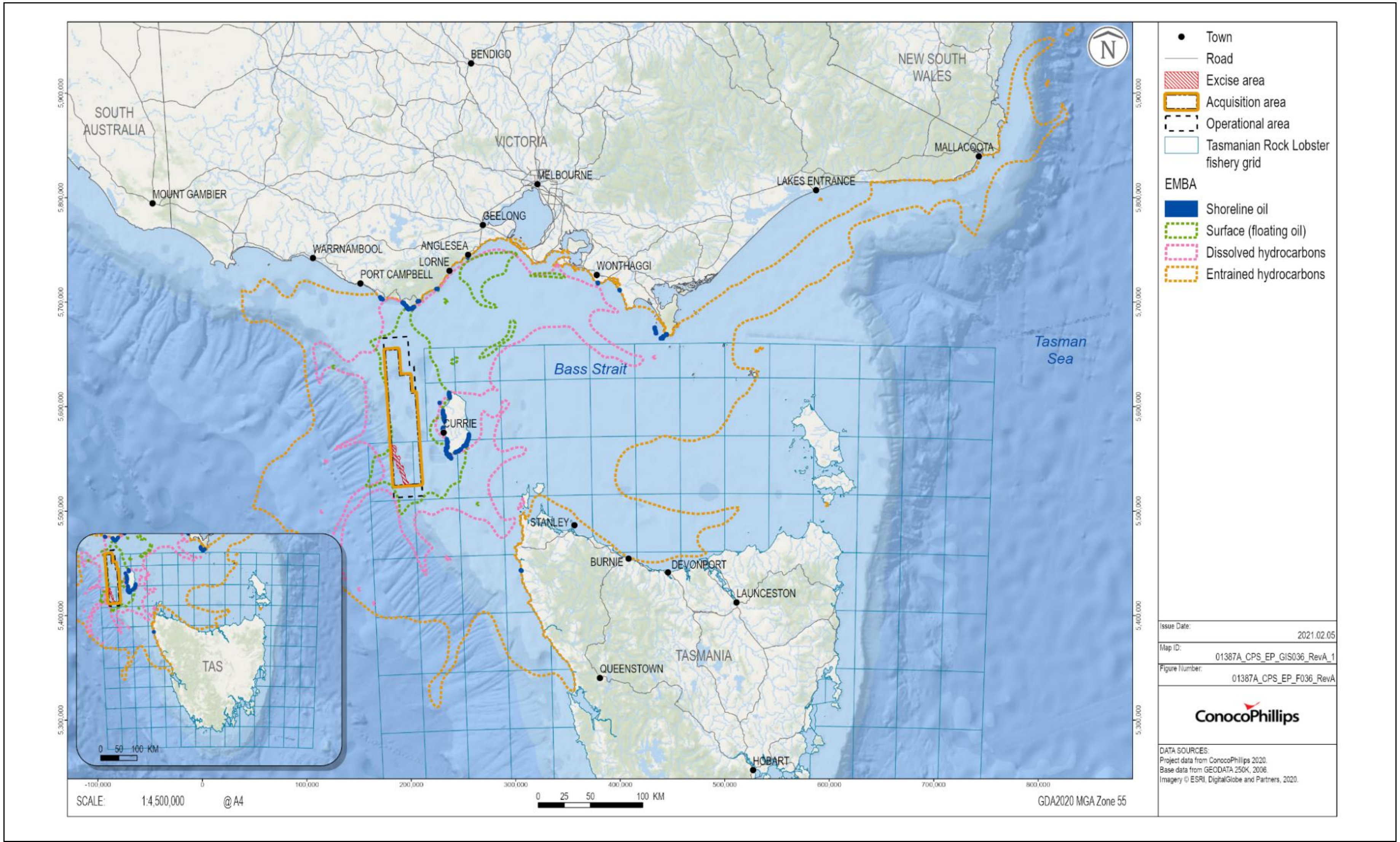


Figure 5.67 Jurisdiction and reporting blocks of the Tasmanian Abalone Fishery

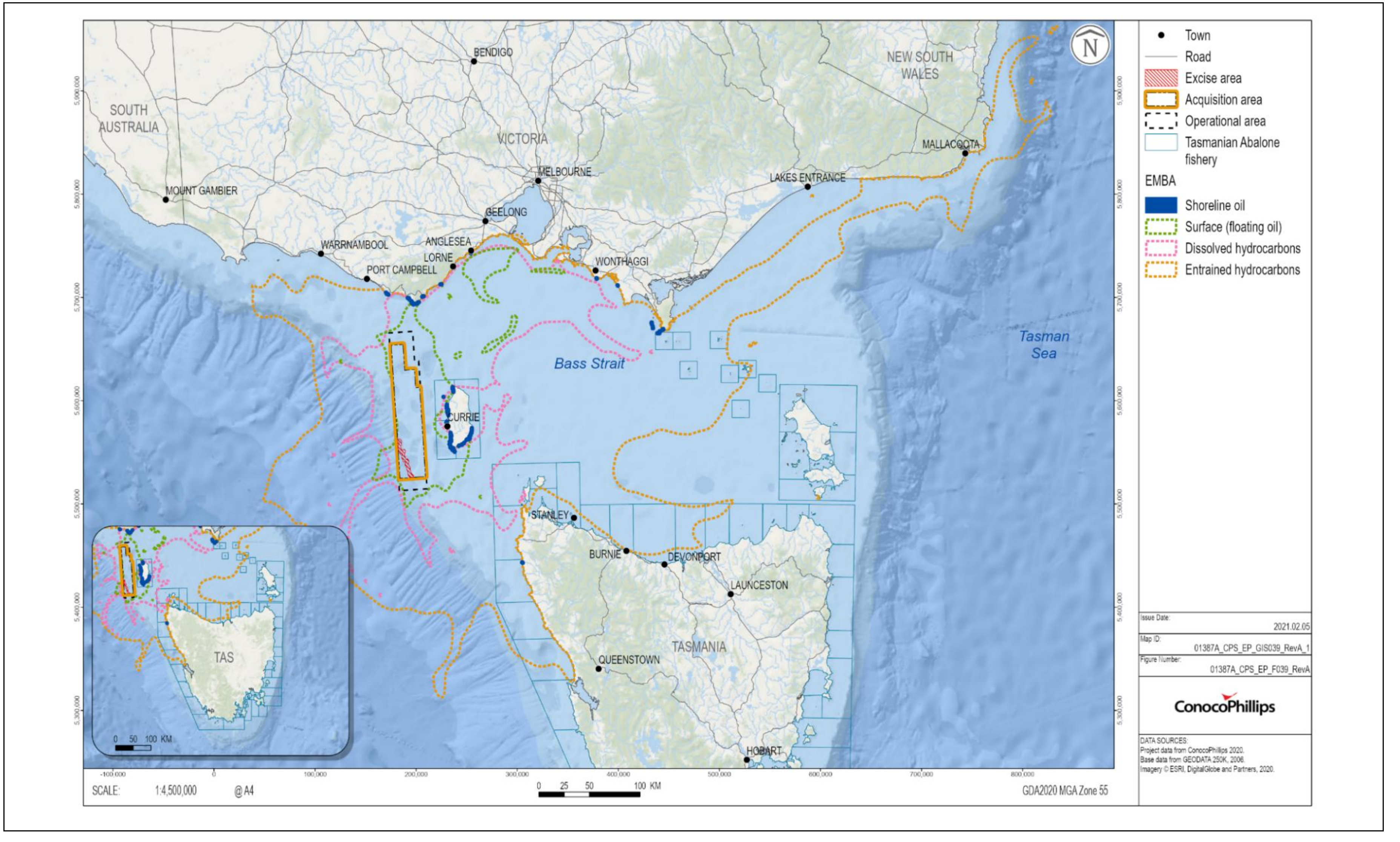


Figure 5.68 Jurisdiction and reporting blocks of the Tasmanian Scalefish and Octopus Fisheries

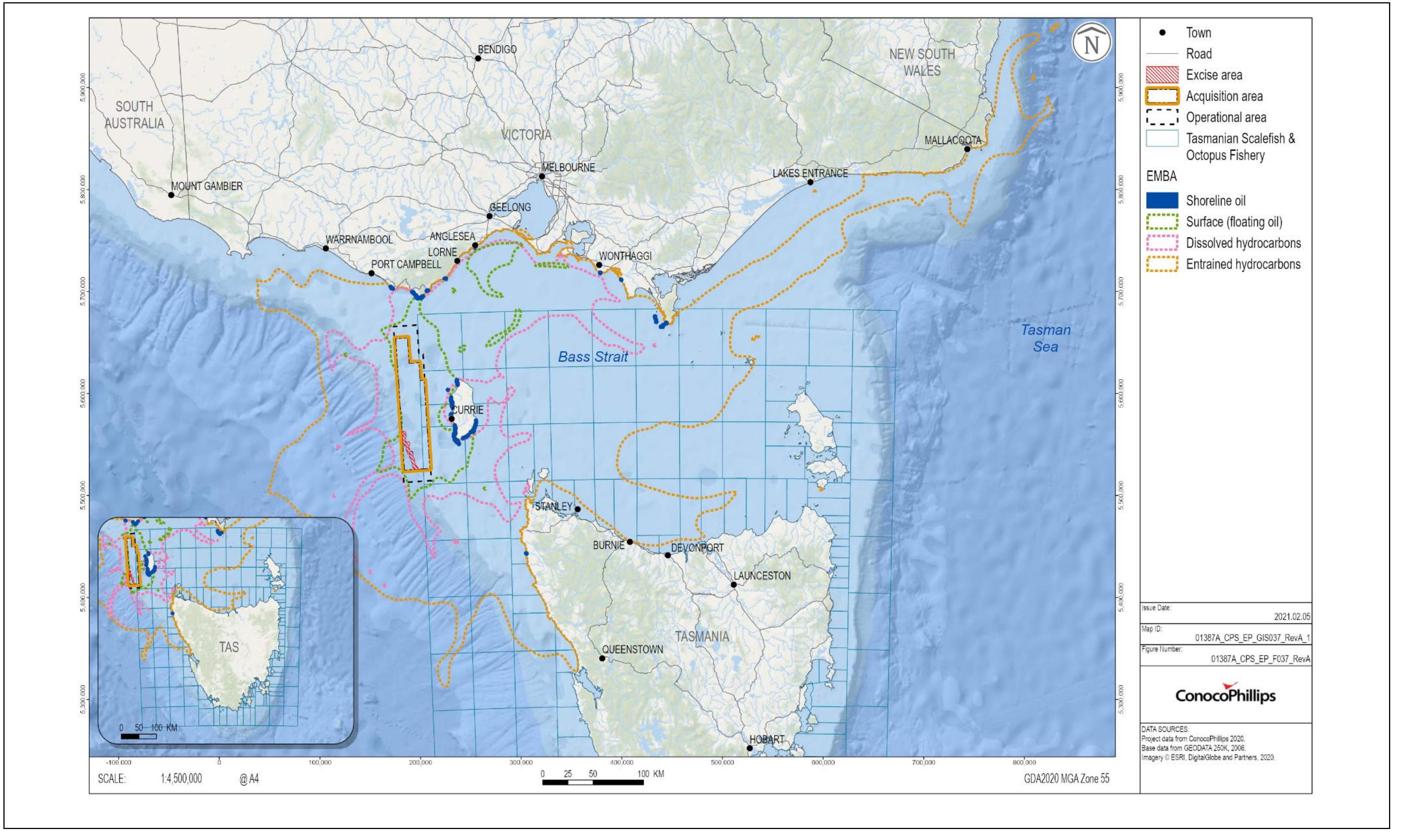
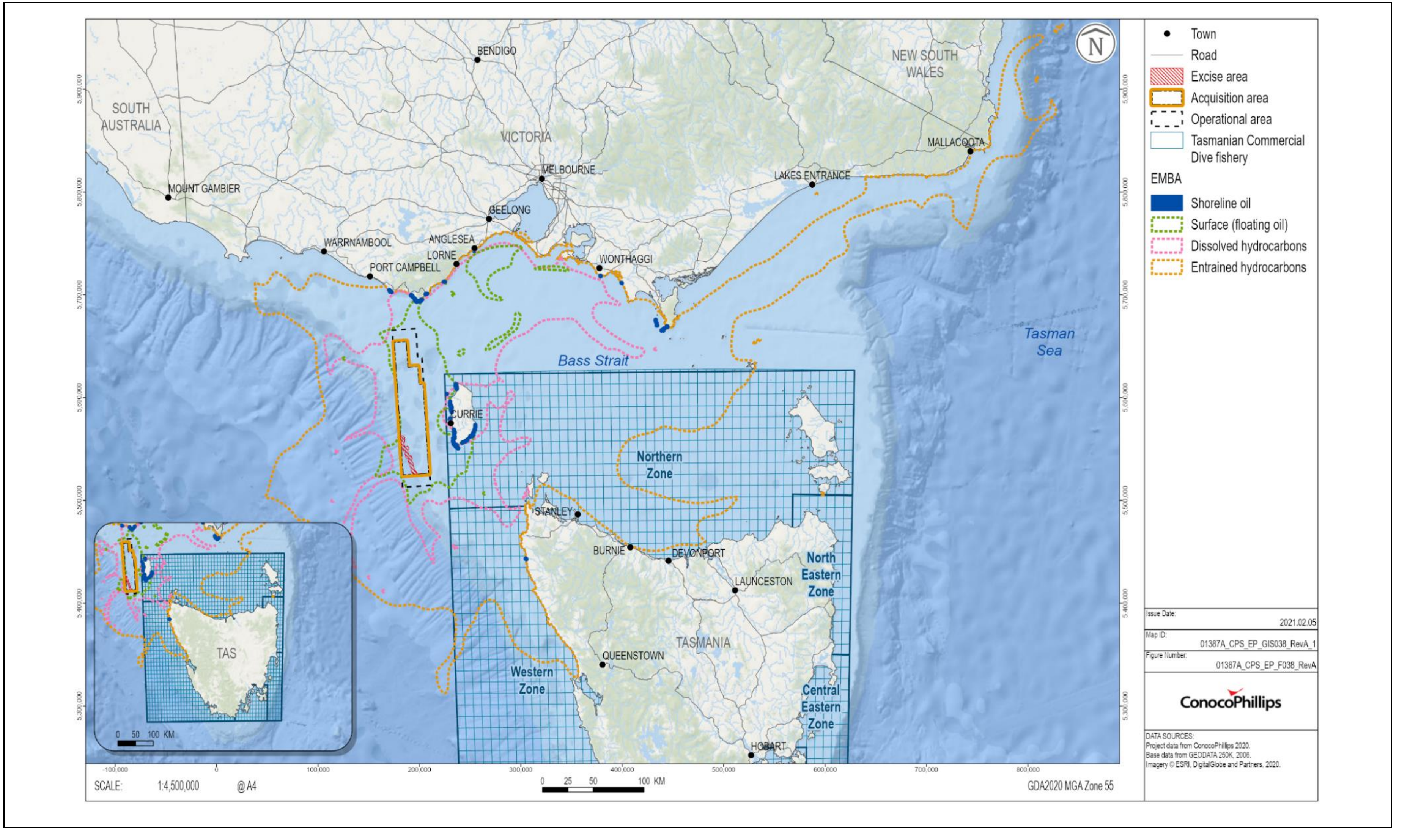


Figure 5.69 Jurisdiction and reporting blocks of the Tasmanian Commercial Dive Fishery



5.7.6. Commercial shipping

The South-east Marine Region (which includes Bass Strait) is one of the busiest shipping regions in Australia (DoE, 2015a). Shipping consists of international and coastal cargo trade, passenger services and cargo and vehicular ferry services across Bass Strait (DoE, 2015a)

The survey area lies to the south of the main shipping route that runs east/west along Australia's southern coastline. The survey vessel when operating in the northern sections of the survey area will encounter heavier concentrations of transiting commercial shipping (Figure 5.70).

A smaller route used by vessels that transit east/west into Bass Strait between King Island and the Fleurieu Group of islands is also present.

Based off the extract of shipping traffic recorded by AMSA during August 2020 for the survey area and western Bass Strait, a total of 206 ships passed through this area during August (Table 5.72). The majority of these (127) are cargo ships with tankers being the second most frequent (39). Based on this data, an average of seven ships per day pass through the waters of the survey area.

Table 5.72 Summary of shipping traffic recorded by AMSA in August 2020 in waters within and adjacent to the survey area

Vessel type	Count
Cargo ship	127
Tanker	39
Fisher	6
Other	4
Total	206

5.7.7. Defence activities

The south-east marine region is important for a range of defence activities particularly training exercises (Figure 5.71). Australian Defence Force (ADF) activities in the region include transit of naval vessels, training exercises, shipbuilding and repair, hydrographic survey, surveillance and enforcement and search and rescue (DoE, 2015a).

Unexploded ordnance (UXO) are a by-product of past training activities undertaken by the ADF. An interactive map is available to determine locations in Australian territory that are at risk of hosting UXO. This map was used to determine the risk of UXO to the survey

The four sites closest to the survey area and the likelihood of (UXO) with them are presented in Figure 5.71 and summarised below:

- Site 1052 - former air-to-air firing range. Air-to-air training activities conducted within these bounds. Majority of ammunition would have been Ball (non-high explosive). The ADF states that the risk to the MSS from this ammunition is negligible.
- Site 434 - known dump area of ammunition natures between 1945 to early 1970s. Exact natures uncertain but potentially includes high explosives.
- Site 1335 - known dump area for chemical warfare material post WW2.
- Site 1274 - known dump area of ammunition natures between 1945 to early 1970s. Natures include high explosive projectiles and fuses.

Figure 5.70 Commercial shipping activities in the survey area and EMBA

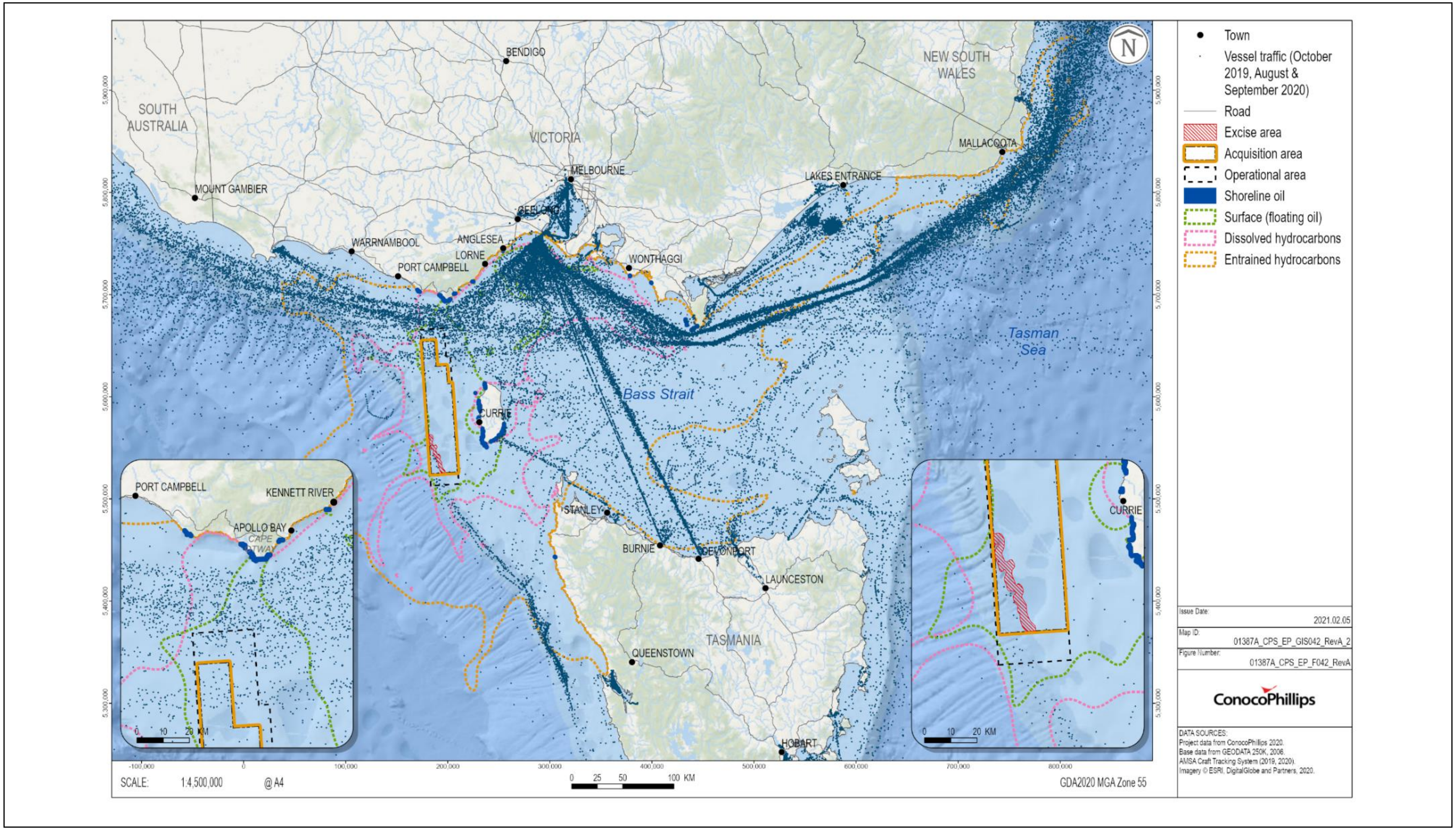
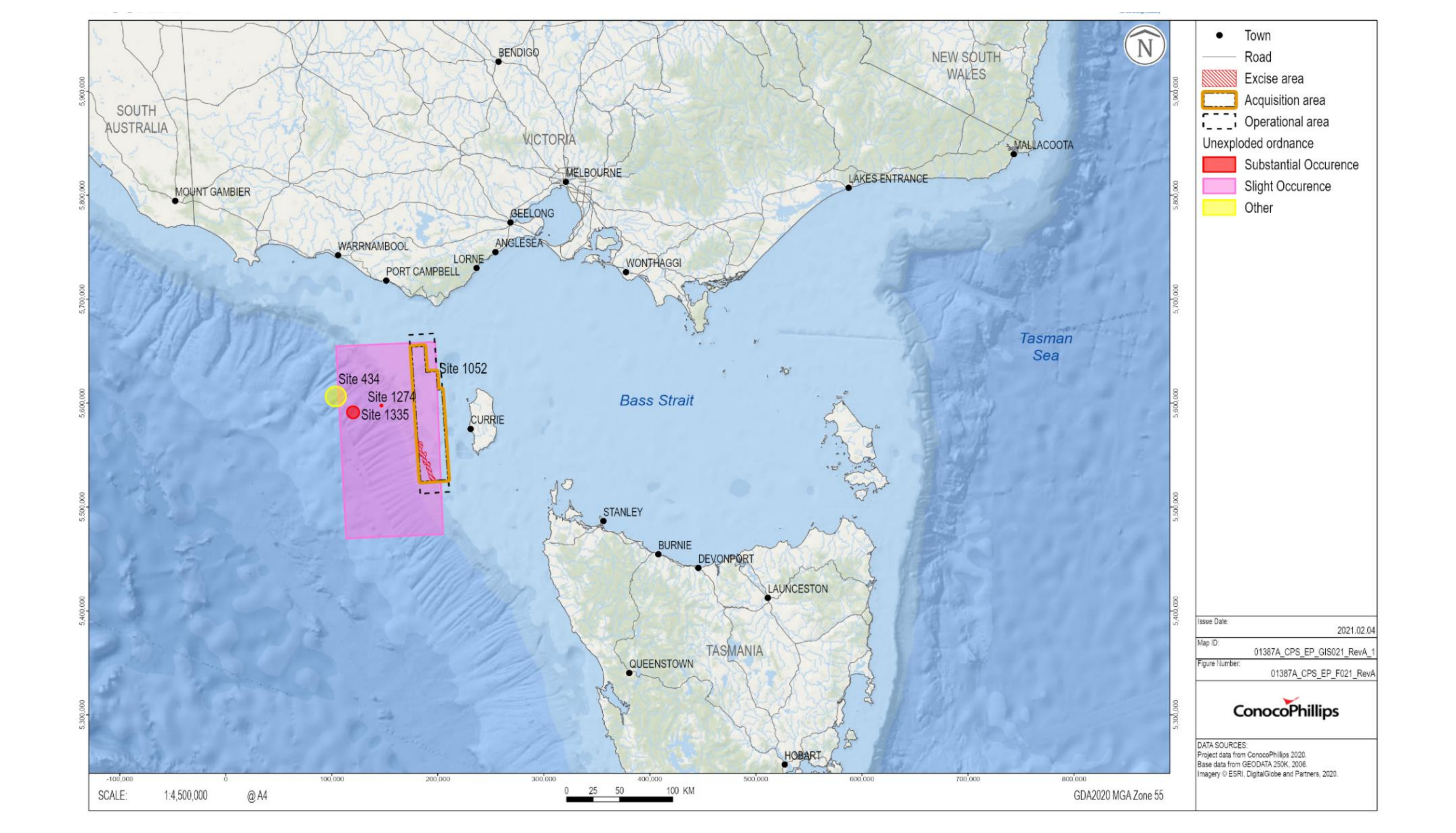


Figure 5.71 Defence activities intersected by the survey area and EMBA



6. Risk Assessment Methodology

6.1. Overview

In accordance with Regulation 13(5) of the OPGGS(E) Regulations, this section describes the environmental impact and risk assessment methodology used in this EP. The risk assessment process is based on the ConocoPhillips corporate risk assessment process, as outlined in the Risk Matrix Standard (Issue No 4.1, May 2018), which is consistent with: AS/NZS ISO 31000:2018: Risk Management – Principles and Guidelines, and AS/NZS ISO 14001:2016 EMS – Requirements with guidance for use.

The core steps of the ConocoPhillips environmental risk assessment (ERA) process are summarised in Figure 6.1 and described in detail throughout this chapter. Commonly used environmental risk assessment terminology is presented in Table 6.1.

Figure 6.1: ConocoPhillips environmental risk assessment process

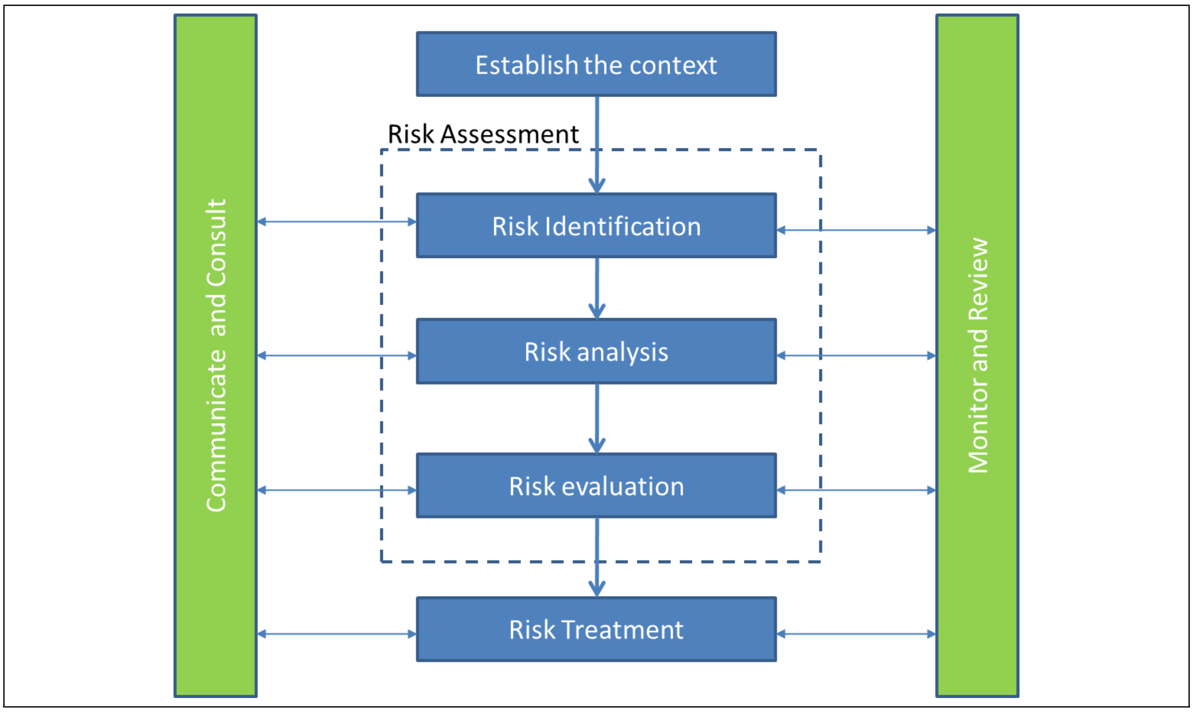


Table 6.1: Risk assessment terminology definitions

Term	Definition
Activity	Refers to a 'petroleum activity' as defined under the OGGGS(E). ConocoPhillips Australia defined the activity as: *The acquisition of seismic data by a survey vessel within the Sequoia acquisition area and any other activity immediately prior to or directly after the acquisition that is required to acquire seismic data that takes place within the operational area.*
As low as reasonably practicable (ALARP)	A term used to identify an impact or risk that has been reduced to a level that is 'as low as reasonably practicable'. In practice this means a titleholder must demonstrate through reasoned and supported arguments that there are no other practicable options that could reasonably be adopted to reduce risks further.
Consequence	The impact on personnel, on or off-site property, communities, the environment and the company. An event can lead to a range of consequences. A consequence can be certain or uncertain and can have positive or negative effects.
Control	Any device, system, or action that would likely interrupt the chain of a hazardous event occurring through prevention (reduce likelihood) or mitigation (reduce consequence).
Environmental aspect	Elements of ConocoPhillips' activities or products or services that can interact with the environment. These include routine/non-routine planned and unplanned activities, including those associated with emergency conditions.
Event	An occurrence of a particular set of circumstances. An event can be one or more occurrences and can have several causes.
Hazard	A physical situation with the potential to cause harm, such as injury or death to workers, damage to property, disruption of business or pollution of the environment.
Impact	A change to the environment, whether adverse or beneficial, wholly or partially resulting from the activity.
Likelihood	A measure of the chance of something happening that can be described using general terms or mathematically (such as, a frequency over a given time period). Likelihood can be further defined as a measure of subjective expectation, a degree of confidence in an outcome whose numerical value can be estimated by logical reasoning, or the relative frequency with which an event occurs in a class of events.
Receptor	Relevant natural, socio-economic and cultural features of the environment (as described throughout Chapter 5).
Risk	Risk means the actual or potential threat to the environment of adverse impacts from an offshore activity. The degree of risk is measured in the consequence severity of the potential loss multiplied by the likelihood of that potential loss.
Risk ranking	A numerical value and qualitative text description assigned to the magnitude of the potential human injury, property damage, environmental damage, stakeholder impact, economic loss or other detrimental consequence outcomes in terms of both actual or realistic potential consequence and likelihood.

6.2. Establish the Context

The first step in the ERA process (outlined in Figure 6.1) is to establish the context. This involves:

- Defining the activities that will cause impacts and create risks (outlined in the 'Activity Description' in Chapter 2);
- Understanding the regulatory framework in which the activity takes place (described in the 'Regulatory Framework' in Chapter 3);
- Understanding what other pre-existing, existing or proposed activities could lead to cumulative impacts and risks (outlined in Section 7.1);
- Understanding the concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Chapter 4, 'Stakeholder Consultation');
- Describing the environment in which the activity takes place (the 'Existing Environment', described in Chapter 5); and
- Factoring in NOPSEMA's assessment within the Key Matters Report – 3D Oil Dorrigo Marine Seismic Survey.

Once the context has been established, the hazards of the activity can be identified, along with the impacts and risks of these hazards. This process is described in the following sections.

6.3. Hazard Identification

The second step in the ERA process involves identifying the environmental hazards.

To this effect, ConocoPhillips Australia undertook an environmental identification (ENVID) assessment during July and August 2020 to identify and assess the impacts and risks associated with the activity. The ENVID assessment was aligned with NOPSEMA's Hazard Identification and Risk Assessment Guidance Note (N-04600-GN1613) and had input from representatives from ConocoPhillips's geophysical, HSE, emergency response, external affairs, commercial and supply chain teams. The assessment was informed by:

- The description of the Sequoia 3DMSS (as described in Chapter 2);
- The environmental and socio-economic setting of the activity (as described in Chapter 5);
- Existing operations and proposed activities within the region;
- The knowledge, training and experiences of participants with regard to MSS activities and the sensitivities of the survey area.

The ENVID participants agreed on the hazards that were classified as impacts and those that are classified as risks. Each hazard was assessed to identify its likelihood of occurrence and its consequences. The outputs of the ENVID are incorporated into this EP.

6.4. Risk Analysis

The ERA is a qualitative risk-screening tool for evaluating the environmental impacts and risks posed by the MSS.

For this activity, ConocoPhillips Australia has determined that impacts and risks are defined as:

- Impacts – occur from planned events. There will be consequences associated with the event occurring. Impacts are an inherent part of the activity. For example, acoustic discharges will be generated during the MSS and this will have consequences for marine life. For impacts, only a consequence is assigned (likelihood is irrelevant given that the event does occur).
- Risks – results from unplanned events. There may be consequences if an unplanned event occurs. Risks are not an inherent part of the activity. For example, a hydrocarbon spill may occur if the survey vessel collides with another vessel, but neither the collision nor the spill are certain to occur. The risk of this

event is determined by multiplying the consequence of the impact (using factors such as the type and volume of hydrocarbons and the nature of the receiving environment) by the likelihood of this event happening (which may be determined objectively or subjectively, qualitatively or quantitatively). For risks, the consequence and likelihood are combined to determine the risk rating.

ConocoPhillips Australia assesses risks in two key stages:

- Unmitigated risk analysis – The level of risk (with existing control measures in place) before application of additional risk control measures arising from risk assessment processes.
- Residual risk analysis – The risk remaining after all proposed control measures have been implemented. Two key factors underpin the ERA:
- The severity of the consequences if impact does occur; and
- The likelihood of receptors at risk being impacted.

The ERA frames the assessment of controls that could be applied during execution of activities that pose a potential hazard to receptors. It also provides a framework to identify the measures to mitigate the severity of the impact arising from either planned or unplanned events. The process provides essential input into the assessment of control measures to ensure that the level of risk posed by an activity to a sensitive receptor is reduced to ALARP and is acceptable.

6.4.1. Assessing Consequence

In assessing the level of consequence of a hazard, the following factors have been considered:

- Extent of hazard – whether it affects the local or wider regional environment;
- Duration of the impact – how long it will interact with the receiving environment; and
- Sensitivity of the receiving environment (including seasonal sensitivities) – nature, importance (local, national or international significance) and the sensitivity or resilience to change of the receptor that could be affected. This also considers any relevant laws, regulations or standards aimed at protecting the receiving environment.

Table 6.2 provides the consequence descriptions in accordance with the ConocoPhillips Risk Matrix Standard, which have been applied to the risk assessment utilised in this EP (Table 6.3).

The level of risk is determined by establishing the potential consequence of a hazard on an environmental, socio-economic or cultural receptor resulting from an aspect of the activities associated with the MSS. Following the determination of the level of consequence, the likelihood of the consequence occurring is then assigned. The assigned consequence and likelihood are mapped on the risk matrix to determine the level of risk, as seen in Table 6.3.

Table 6.2: Risk assessment consequence definitions

Rating	Biodiversity	Socio-cultural and economic
5 High	• High environmental impact, very severe such as resulting in catastrophic release. • Long term impacts to sensitive habitats and multiple ecosystems. • Impacts causing to drinking water supply or fishing areas. • Significant offshore release with potential to impact shoreline.	• Extended permanent loss of access (greater than 2 years) and loss of operations or planned activities. • Severe impact to/from key stakeholders requiring executive level involvement. • Damage is permanent.
4 Major	• Major environmental impact, requires significant mitigation measures that address ecological systems or sensitive habitats • Off-site impacts realised from one to several kilometres or more. • Release affecting public infrastructure or roads that results in public evacuation or closure of transportation routes such as roads or waterway • Widespread surface water or groundwater contamination.	• Permanent partial restriction on access (3 months to 2 years) and major impact to operations or planned activities. • Major impact to/from key stakeholders. Mitigation requires senior level management involvement. • Issue will take a significant amount of time to resolve.
3 Moderate	• Moderate environmental impact most likely requires emergency response but not always. • Uncontained release with off-site environmental impacts realised greater than the surrounding area of the facility with observable off-site impacts to flora/fauna. • Release affects surrounding area and impacts flora/fauna. • Multiple exceedances of regulatory limit during a prolonged incident or operational condition – regulatory enforcement likely (all media). • Off-site localised groundwater contamination.	• Temporary restriction on access (1 to 3 months) and moderate impact to operations or planned activities. • Moderate impact to/from key stakeholders. • Mitigation requires focused efforts with various business unit groups. • Issue resolved in a moderate amount of time.
2 Minor	• Minor environmental impact, but with impacts being readily remediated or addressed by natural attenuation processes. • Onshore release impact limited to facility and adjacent surrounding area. • Offshore release mitigated through natural attenuation. • Single to multiple exceedances of a permit or regulatory limit – regulatory enforcement likely (all media).	• Brief restriction on access (1 day to 1 month) and minor impact to operations or planned activities. • Minor impact to/from key stakeholders. Likely addressed by prompt mitigation by stakeholder engagement professionals. • Issue resolved in a minimum amount of time.

1 Negligible	• Negligible environmental impact. • Immediate or instantaneous duration, no remediation required. • Small, contained release that stays on site. • No exceedance or single exceedance of a permit or regulatory limit – regulatory enforcement unlikely (all media).	• No restriction on access and no impact to operations. • Negligible impact to/from key stakeholders Issue resolved quickly.

Table 6.3: ConocoPhillips risk assessment matrix

Risk Matrix					
Likelihood	Consequence severity				
	Level 1 (Negligible)	Level 2 (Minor)	Level 3 (Moderate)	Level 4 (Major)	Level 5 (High)
Frequent (5)	RRII	RRII	RRIII	RRIV	RRIV
Probable (4)	RRI	RRII	RRIII	RRIII	RRIV
Rare (3)	RRI	RRII	RRII	RRIII	RRIII
Remote (2)	RRI	RRI	RRII	RRII	RRII
Improbable (1)	RRI	RRI	RRI	RRI	RRII

Risk rating		
Risk score	Risk rating	Description of risk level
RRIV	High	• Manage risk using additional or improved risk-reducing measures with priority. • Inform appropriate management level with risk assessment detail and obtain appropriate approvals per the business unit's requirements. • Cessation until the residual risk is reduced to 'significant' or below unless exposure is authorised as indicated.
RRIII	Significant	• Manage risk using additional or improved risk-reducing measures with priority. • Inform appropriate management level with risk assessment detail and obtain appropriate approvals per the business unit's requirements. • Ensure action to deal with this risk is incorporated into business plan. • Ensure ALARP Principle is demonstrated.
RRII	Medium	• No additional risk-reducing measures required where controls can be verified as functional. • Improvements based on lessons learned are encouraged. • Tolerable if cost of risk reduction exceeds improvement.
RRI	Low	• No additional risk-reducing measures required. • Improvements based on lessons learned are encouraged.

6.4.2. Assessing Likelihood

Table 6.4 provides the likelihood descriptions that have been used for the risk assessment, which are based on the ConocoPhillips Risk Matrix Standard.

The likelihood of a consequence occurring due to a planned or unplanned activity considers the effective implementation of industry standard safeguards.

Table 6.4: Risk assessment likelihood definitions

Level	Descriptor	Enhanced description
1	Improbable	Virtually unrealistic, never heard of in the oil and gas industry
2	Remote	Occurred or has been heard of within the oil and gas industry
3	Rare	Has occurred within ConocoPhillips or more than once per year within the oil and gas industry
4	Probable	Occurred within the ConocoPhillips business unit or more than once per year within ConocoPhillips
5	Frequent	Occurs multiple times per year in the ConocoPhillips business unit

6.4.3. Cumulative Risk

Cumulative risk arises from the successive, incremental, and combined effects (both positive and negative) of our and other activities on society, the economy, and the environment.

As depicted in Figure 6.2, cumulative risks may result from:

- Combined elements of a single activity/project;
- Combined elements of multiple activities/projects; and/or
- Interactions with other past, current and (reasonably) foreseeable future activities/projects.

Figure 6.3 illustrates the approach ConocoPhillips takes to cumulative risk assessment, which are 'fit for purpose' in relation to the activity and/or project being assessed, within the regulatory, environmental, and social context. Key considerations in conducting a cumulative risk assessment are:

- Assessment scoping;
- Forecasting of other activities/projects; and
- Evaluating cumulative consequences.

For the Sequoia 3DMSS, underwater sound has been deemed the only impact necessary to be subject to cumulative risk assessment. The cumulative impact assessment combines the ConocoPhillips methodology with NOPSEMA's requirements for cumulative impact assessment, as outlined in Acoustic impact evaluation and management information paper (N-04750-IP1765, Rev 2, December 2018) and is presented in Section 7.1.

Figure 6.2: Project-specific and cumulative risk total effects and trigger/thresholds

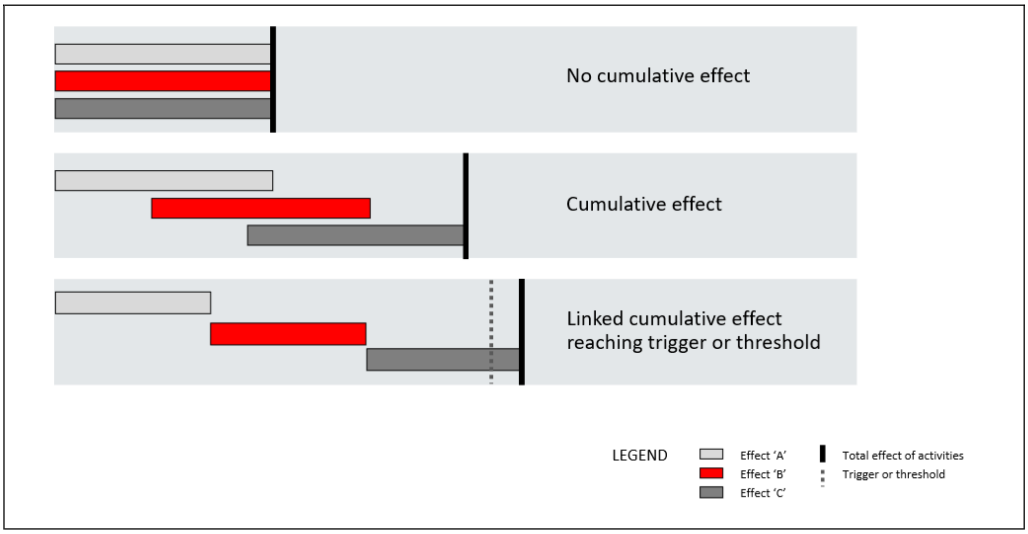
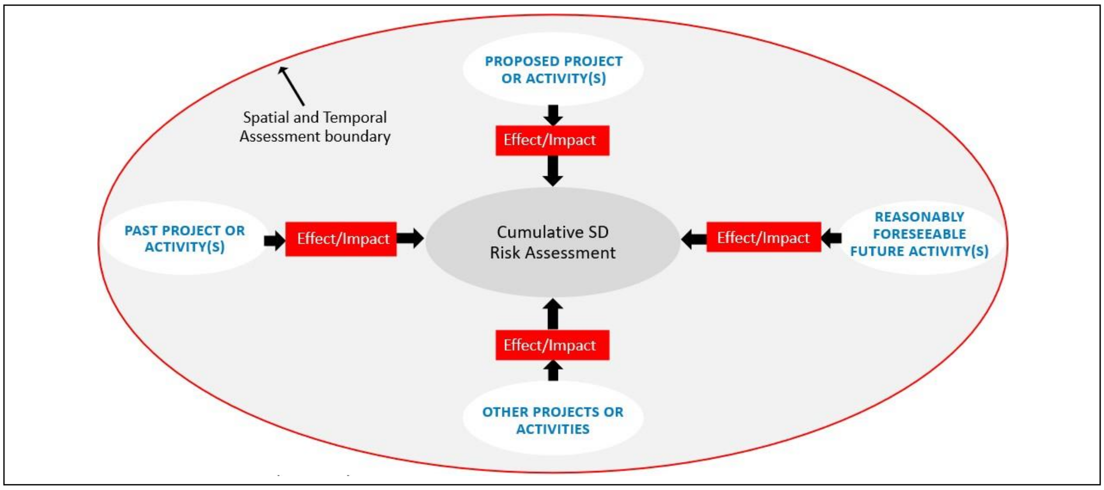


Figure 6.3: Cumulative risk assessment process



6.5. Risk Evaluation

The evaluation of the environmental risks is undertaken in the context of ALARP and acceptability, which are described in detail in this section.

6.5.1. Demonstration of ALARP

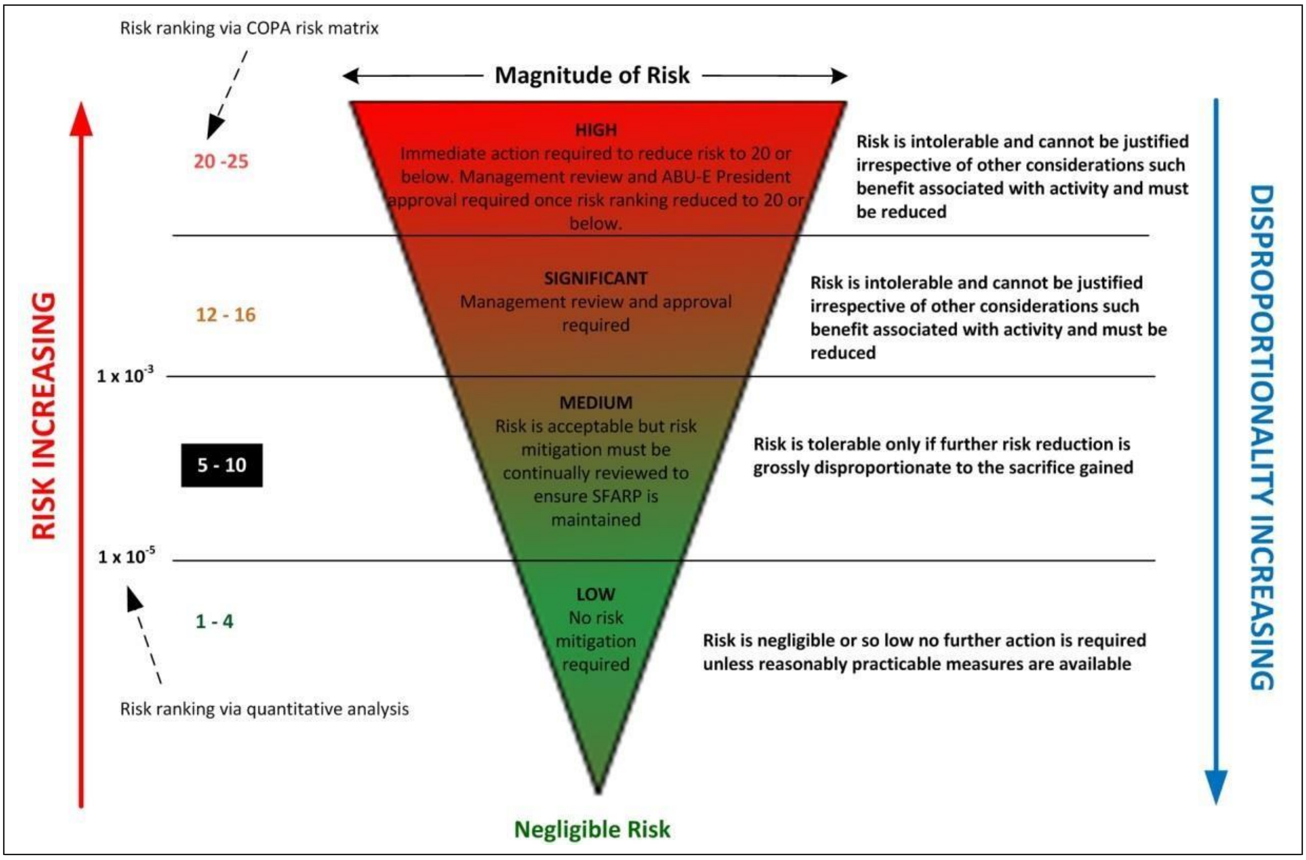
ConocoPhillips Australia demonstrates risks are reduced to ALARP when the cost and effort required to further reduce risk is grossly disproportionate to the risk benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent attempting to reduce an impact or risk to zero. This concept is shown diagrammatically in Figure 6.4. Demonstrating that risks have been reduced to ALARP involves the following:

- Complying with relevant legislation;

- Complying with accepted industry codes, guidelines and standards;
- Implementing effective HSE management system controls;
- Assessing the effectiveness of the controls in place and determining whether the controls are adequate
- according to the 'hierarchy of controls' principle; and
- For higher order impacts and risks, implementing further controls if feasible and reasonably practicable to do so.

For inherently significant and high-risk activities, significant effort is made to assess and implement risk reduction opportunities such as quantitative studies and cost benefit analyses and undertaking detailed review of the risk in consultation with management. For inherently low or medium risk activities, further controls are assessed qualitatively/semi-quantitatively based on the nature and scale of the risk and taking into consideration regulator expectations.

Figure 6.4: The ALARP Principle



NOPSEMA's *Environment Plan decision making guideline* (GL1721, Rev 6, November 2019) states that in order to demonstrate ALARP, a titleholder must be able to implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure.

There is no universally accepted guidance to applying the ALARP principle to environmental assessments. For this EP, the guidance provided in NOPSEMA's *Environment Plan decision making guideline* has been applied and augmented where necessary.

The level of ALARP assessment is dependent upon the:

- Residual impact and risk level (high versus low); and
- The degree of uncertainty associated with the assessed impact or risk.

An iterative risk evaluation process is employed until such time as any further reduction in the residual risk ranking is not reasonably practicable to implement. At this point, the impact or risk is reduced to ALARP. The determination of ALARP, comparing NOPSEMA's terminology with that of ConocoPhillips Australia, is outlined in Table 6.5.

Table 6.5: Alignment of ALARP with impacts (using consequence ranking) and risks (using risk ranking)

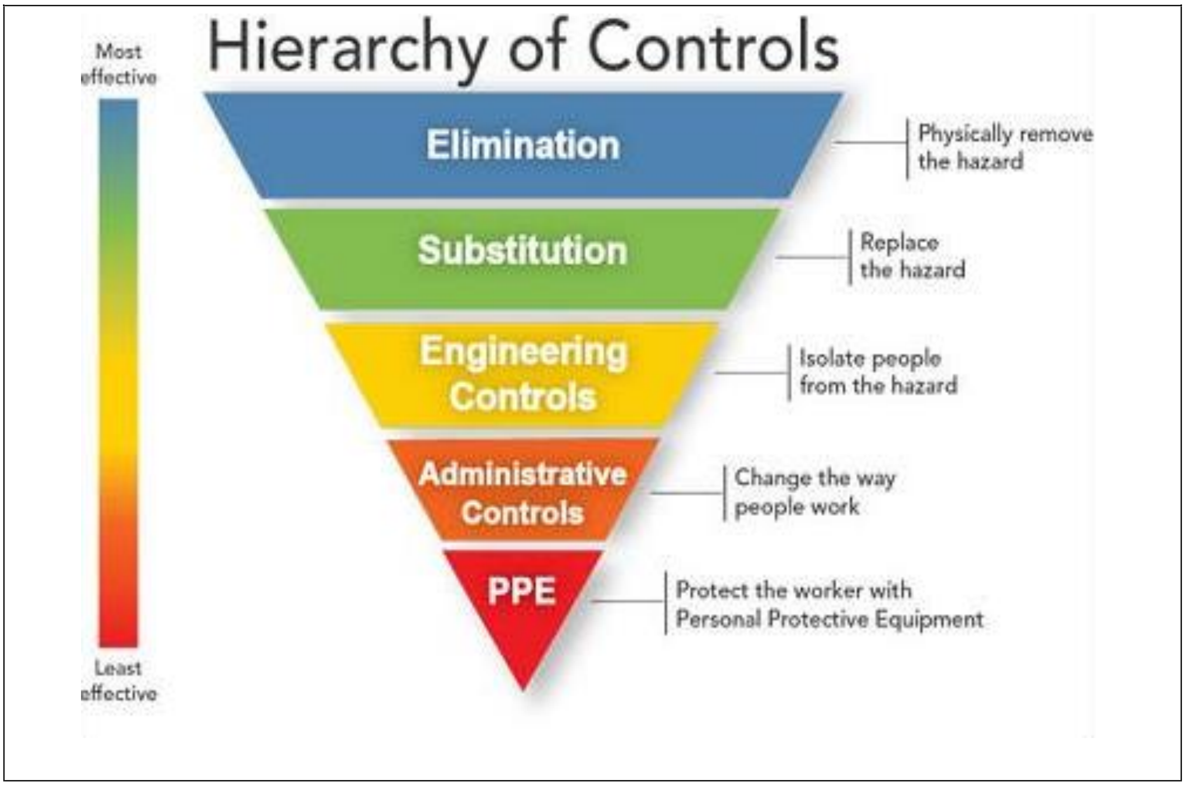
Consequence ranking	Negligible	Minor	Moderate	Major	High
ALARP level – planned event	Broadly acceptable		Tolerable if ALARP	Intolerable	
Residual impact category	Lower order		Higher order		
Risk ranking	Low	Medium	Significant	High	
ALARP level - unplanned event	Broadly acceptable		Intolerable		
Residual risk category	Lower order risks		Higher order risks		

6.5.1.1. Hierarchy of Controls

ConocoPhillips Australia applies the 'hierarchy of controls' philosophy (Figure 6.5) as part of demonstrating ALARP. The hierarchy of controls is a system used across hazardous industries to minimise or eliminate exposure to hazards. In order of effectiveness, the hierarchy of controls is as follows:

- Elimination (of the hazard) - Note that elimination of a hazard precludes further risk analysis, as impacts and risks will no longer credibly occur once the hazard is eliminated.
- Substitution (e.g., using a less hazardous process);
- Engineering controls (e.g., using a smaller acoustic source array);
- Administrative (e.g., using written procedures); and
- Personal protective equipment (PPE). Use of PPE is always viewed as the last line of defence or as a supplement to other controls (but is not relevant for an ERA).

Figure 6.5: The Hierarchy of Controls



6.5.1.2. Residual Impact and Risk Levels

This section details how NOPSEMA's Environment Plan decision making guideline (GL1721, Rev 6, November 2019) is applied in this EP.

Lower-order Environmental Impacts and Risks

NOPSEMA defines lower-order environmental impacts and risks as those where the environment or receptor is not formally managed, less vulnerable, widely distributed, not protected and/or threatened and there is confidence in the effectiveness of adopted control measures.

Impacts and risks are considered to be lower-order and ALARP when, using the ConocoPhillips Risk Matrix Standard (see Table 6.3), the impact consequence is rated as 'negligible' or 'minor' or risks are rated as 'low' or 'medium' (see also Table 6.5). In these cases, applying 'good industry practice' is sufficient to manage the impact or risk to ALARP.

Higher-order Environmental Impacts and Risks

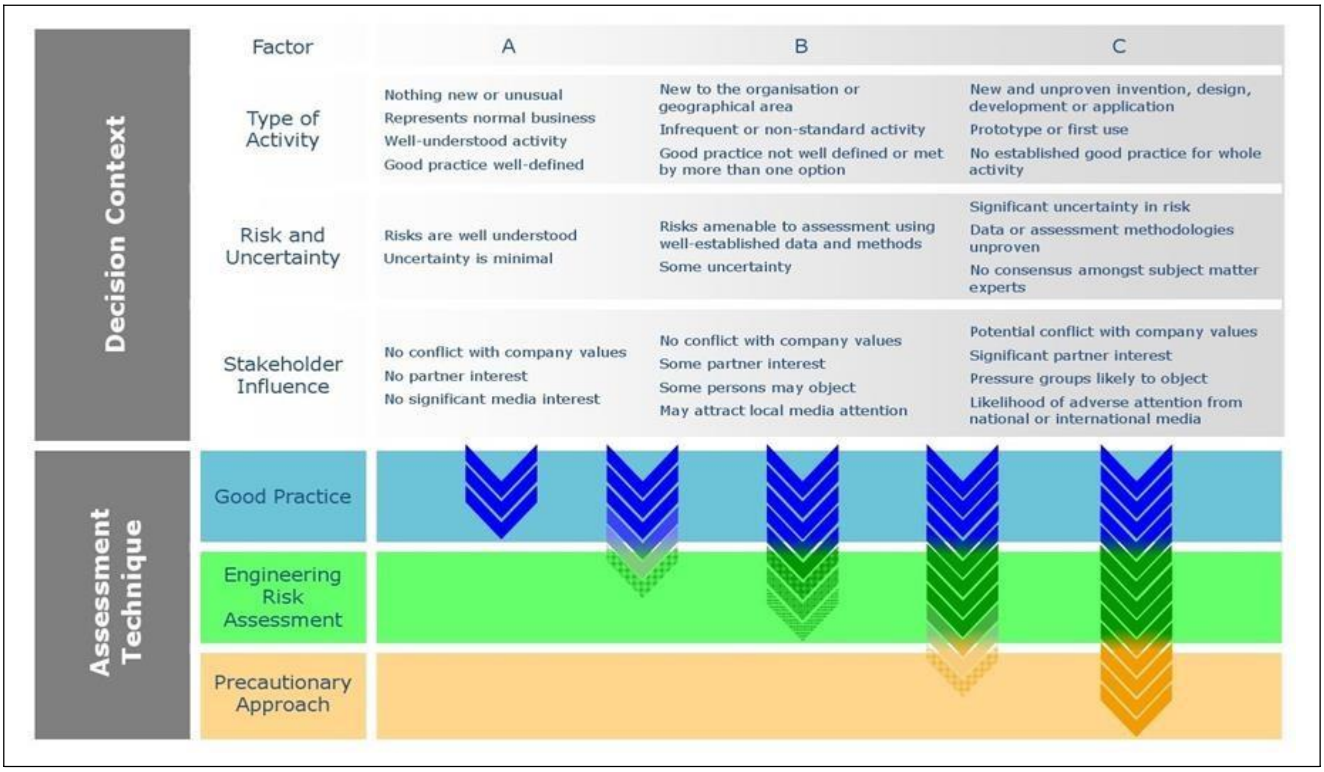
NOPSEMA defines higher-order environmental impacts and risks as those that are not lower order risks or impacts (i.e., where the environment or receptor is formally managed, vulnerable, restricted in distribution, protected or threatened and there is little confidence in the effectiveness of adopted control measures).

Impacts and risks are considered to be higher-order when, using the ConocoPhillips Risk Matrix Standard (see Table 6.3), the impact consequence is rated as 'moderate', 'major' or 'high', or when the risk is rated as 'significant' or 'high' (see also Table 6.5). In these cases, further controls must be considered.

6.5.1.3. Uncertainty of Impacts and Risks

Based upon the level of uncertainty associated with the impact or risk, the following framework, adapted by NOPSEMA (2015) from the Guidance on Risk Related Decision Making (Oil & Gas UK, 2014) (Figure 6.6) provides the decision-making framework to establish ALARP.

Figure 6.6: Impact and risk 'uncertainty' decision-making framework



Source: CER (2015)

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 Figure 6.4.

Table 6.6: Risk assessment likelihood definitions

Decision type	Decision-making tools
A	Good industry practice Identifies the requirements of legislation, codes and standards that are to be complied with for the activity. Applies 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. Identifies further engineering control standards and guidelines that may be applied over and above that required to meet the legislation, codes and standards.
B	In addition to decision type A: Engineering risk-based tools Engineering risk-based tools to assess 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.
C	In addition to decision type A and B: Precautionary Principle Application of the Precautionary Principle is to be applied when good industry practice and engineering risk-based tools fail to address uncertainties.

Good Practice

In the absence of an Australian definition, the OGUK (2014) and the Irish Commission for Energy Regulation (CER) (2015) define 'Good Practice' as:

The recognised risk management practices and measures that are used by competent organisations to manage well-understood hazards arising from their activities.

NOPSEMA has not endorsed any 'approved codes of practice' or standards to give them a legal status in terms of good practice. Good practice is taken to refer to any well-defined and established standard or codes of practice adopted by an industrial/occupational sector, including 'learnings' from incidents that may yet be incorporated into standards.

Good practice can also be used as the generic term for those standards for controlling risk that have been judged and recognised as satisfying the law when applied to a particular relevant case in an appropriate manner. For this EP, sources of good practice, adapted from CER (2015) are the relevant:

- Commonwealth and state legislation and regulations (outlined in Section 3.1 to 3.3);
- Government guidance (outlined in Section 3.5);
- Industry standards (outlined in Section 3.7 and Section 3.8); and
- International conventions (outlined in Section 3.7).

Good practice also requires that hazard management is considered in a hierarchy, with the concept being that it is inherently safer to eliminate a hazard than to reduce its frequency or manage its consequences (CER, 2015). This being the case, the 'Hierarchy of Controls' philosophy is applied to reduce the risks associated with hazards (described in Section 6.3).

Engineering Risk Assessment

All impacts and risks that require assessment beyond that of good practice (i.e., decision type A) are subject to an engineering risk assessment.

Engineering risk-based tools can include, but are not limited to, engineering analysis (e.g., structural, fatigue, mooring, process simulation) and consequence modelling (e.g., ship collision, dropped object) (CER, 2015). A cost-benefit analysis to support the selection of control measures identified during the risk assessment process may also be undertaken.

Precautionary Principle

All impacts and risks that do meet decision type A or type B and require assessment beyond that of good practice and engineering risk assessment are subject to the 'Precautionary Principle'. CER (2015) states that if the assessment, taking account of all available engineering and scientific evidence, is insufficient, inconclusive or uncertain, then the precautionary principle should be adopted in the hazard management process. While there is no globally recognised definition of the Precautionary Principle, it is generally accepted to mean:

Uncertain analysis is replaced by conservative assumptions which will increase the likelihood of a risk reduction measure being implemented. (CER, 2015)

The degree to which this principle is adopted should be commensurate with the level of uncertainty in the assessment and the level of danger (hazard consequences) believed to be possible.

Under the precautionary principle, environmental considerations are expected to take precedence over economic considerations, meaning that an environmental control measure is more likely to be implemented. In this decision context, the decision could have significant economic consequences to an organisation.

6.5.2. Demonstration of Acceptability

Regulation 13(5)(c) of the OPGGS(E) requires the EP to demonstrate that environmental impacts and risks are acceptable.

NOPSEMA's *Environment Plan decision making guideline* (GL1721, Rev 6, November 2019) states that stakeholder consultation plays a large part in establishing the context for defining an acceptable level of environmental impact or risk may be.

ConocoPhillips Australia considers a range of factors to demonstrate the acceptability of the environmental impacts and risks associated with its activities. This evaluation works at several levels, as outlined in Table 6.7. The criteria for demonstrating acceptability were developed based on ConocoPhillips Australia's

interpretation of NOPSEMA's Guidance Note for EP Content Requirements (N04750-GN1344, Rev 0, February 2014, noting that this has since been superseded) and NOPSEMA's Environment Plan decision making guideline (GL1721, Rev 6, November 2019).

Table 6.7: Acceptability criteria

Test	Question	Acceptability demonstrated
Internal context		
Policy compliance	Is the proposed management of the hazard aligned with ConocoPhillips' HSE Policy?	The impact or risk must be compliant with the objectives of the company policies.
Management System Compliance	Is the proposed management of the hazard aligned with ConocoPhillips' HSEMS?	Where specific ConocoPhillips procedures, guidelines, expectations are in place for management of the impact or risk in question, acceptance is demonstrated.
External context		
Stakeholder engagement	Have stakeholders raised any concerns about activity impacts or risks? If so, are measures in place to manage those concerns?	Merits of claims or objections raised by stakeholders must have been adequately assessed and additional controls adopted where appropriate.
Legislation, industry standard and best practice		
Legislative context	Do the management controls meet the expectations of existing legislation?	The proposed management controls align with legislative requirements.
Industry practice	Do the management controls align with international and Australian industry guidelines and practices?	The proposed management controls align with relevant industry guidelines and practices.
Environmental context	What are the overall impacts and risks to MNES and other areas of conservation significance? Do environmental controls align with the aims and objectives of marine park management plans and species conservation advice, recovery plans or threat abatement plans?	There are no long-term impacts to MNES and the proposed management controls do not conflict with the aims and objectives of marine park management plans and species conservation advice, recovery plans or threat abatement plans.
ESD Principles*	Are the management controls aligned with the principles of ESD?	The EIA presented throughout Chapter 7 is consistent with the principles of ESD.

* See Table 6.8 for further information.

Principles of Ecologically Sustainable Development

Based on Australia's National Strategy for Ecologically Sustainable Development (Council of Australian Governments, 1992), Section 3A of the EPBC Act defines ESD as:

"Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased. "Table 6.8 outlines the principles of ESD as defined under the EPBC Act and describes how this EP aligns with these principles.

Table 6.8: Assessment of ESD principles

Principle		EP demonstration
A	Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	This principle is inherently met through the EP assessment process.
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.	Serious or irreversible environmental damage resulting from the Sequoia 3DMSS has been eliminated through the project design (see Chapter 2). None of the residual impacts is rated higher than 'minor' and none of the residual risks is rated higher than 'medium.' Scientific certainty has been maximised by employing a spill EMBA as a risk assessment boundary and by undertaking underwater sound modelling.
C	The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The EP assessment methodology ensures that risks from the activity are managed to be ALARP and acceptable.
D	The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	This principal is considered for each hazard in the adoption of environmental controls (i.e., environmental performance outcomes and environmental performance standards) that aim to minimise environmental harm. There is a strong focus in this EP on conserving biodiversity and ecological integrity by understanding the marine environment and commercial fishing activity in and around the operational area (Chapter 5) and implementing controls to minimise impacts and risks (Chapter 7).
E	Improved valuation, pricing and incentive mechanisms should be promoted.	This principle is not relevant to this activity.

6.6. Risk Treatment

Selecting the most appropriate risk treatment option(s) involves balancing the potential benefits derived in relation to the achievement of the objectives against costs, effort or disadvantages of implementation. Risk treatment involves the process of:

- Developing and selecting risk treatment options;
- Planning and implementing risk treatment;
- Assessing the effectiveness of the residual risk; and
- Deciding whether the remaining risk is acceptable.

This EP records the environmental control measures that were determined by an expert team familiar with MSS and the sensitivities of the existing environment and stakeholder views in the survey area and EMBA. These control measures will be rigorously enforced during the survey (detail about this process is addressed in the Implementation Strategy in Chapter 88).

6.7. Monitor and Review

Monitoring and review activities are incorporated into the ERA process to ensure that controls are effective and efficient in both design and operation. This is achieved through the environmental performance outcomes (EPO), environmental performance standards (EPS) and measurement criteria that are described for each hazard (in Chapter 7). Monitoring and review activities are described in detail in the Implementation Strategy in Chapter 8.

7. Environmental Impact and Risk Assessment

This chapter presents the environmental impact assessment (EIA) and environmental risk assessment (ERA) for the environmental impacts and risks identified for the Sequoia 3DMSS using the methodology described in Chapter 6, as required under Regulations 13(5)(6) of the OPGGS(E).

This chapter also presents the Environmental Performance Objectives (EPO), Environmental Performance Standards (EPS) and measurement criteria required to manage the identified impacts and risks. The following definitions are used in this section, as defined in Regulation 4 of the OPPGS(E):

- EPO – a measurable level of performance required for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level (i.e., the environmental objective);
- EPS – a statement of the performance required of a control measure; and
- Measurement criteria – defines the measure by which environmental performance will be measured to determine whether the EPO has been met.

A summary of the impact consequence rankings and risk ranking for each hazard identified and assessed in this chapter is presented in Table 7.1. Note that for impacts, only a consequence is assigned (likelihood is irrelevant given that the event does occur).

Table 7.1: Sequoia MSS environmental impacts and risk summary

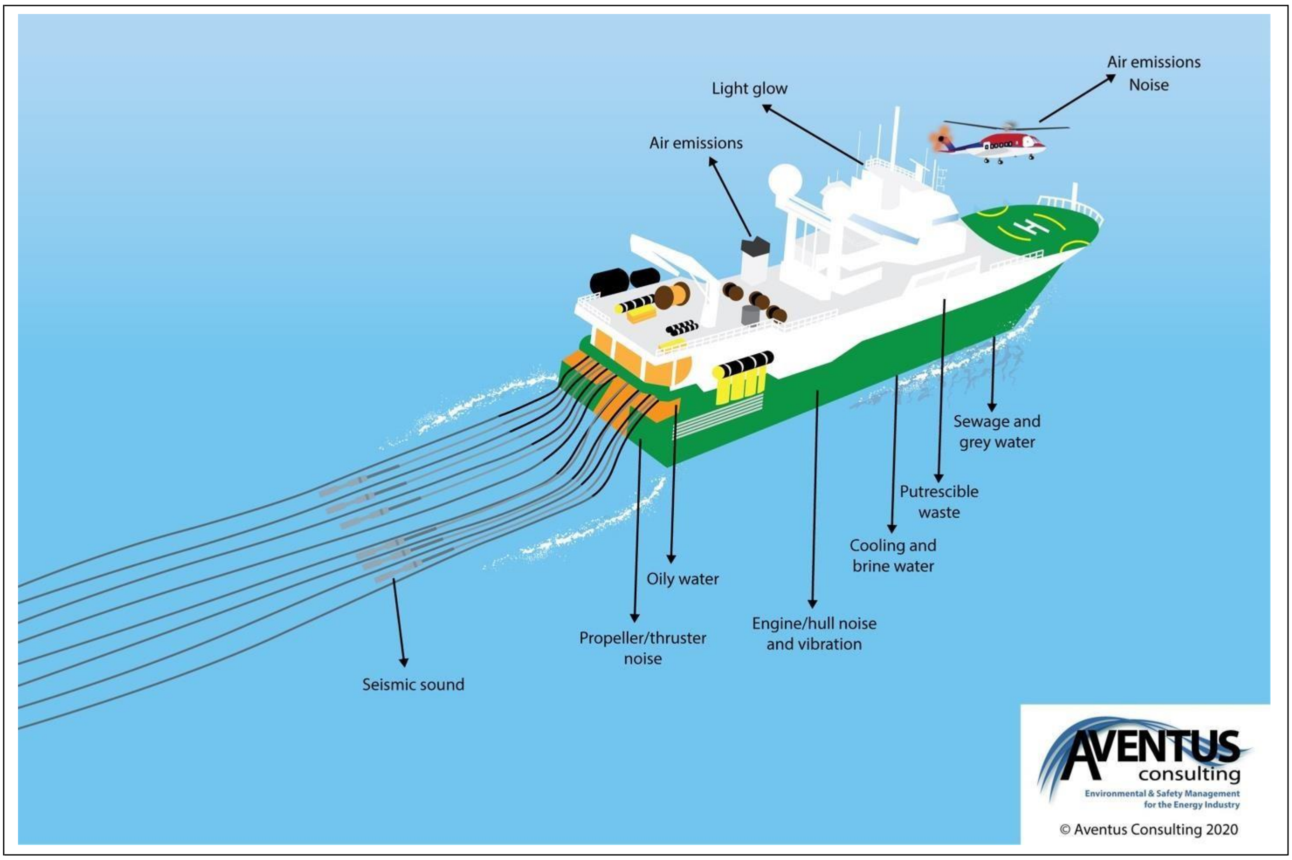
Identifier	Hazard	Unmitigated	Residual
Impact		Consequence rating	
Survey-specific impacts			
1	Underwater sound – impacts to biological receptors		
	- Plankton	Negligible	Negligible
	- Crustaceans (e.g., rock lobster, giant crabs)	Negligible	Negligible
	- Molluscs, sponges and corals (benthic)	Negligible	Negligible
	- Molluscs (pelagic)	Negligible	Negligible
	- Fish - with swim bladders	Negligible	Negligible
	- Fish - without swim bladders	Negligible	Negligible
	- Cetaceans – low-frequency	Negligible	Negligible
	- Cetaceans – mid-frequency	Negligible	Negligible
	- Cetaceans – high-frequency	Negligible	Negligible
	- Pinnipeds	Negligible	Negligible
	- Turtles	Negligible	Negligible
	- Birds	Negligible	Negligible
	- Human divers	Minor	Negligible
	- Human swimmers	Negligible	Negligible
2	Underwater sound – impacts to commercial fisheries		
	- Rock lobster (Vic)	Negligible	Negligible
	- Rock lobster (Tas)	Negligible	Negligible
	- Giant crab (Vic)	Minor	Minor
	- Giant crab (Tas)	Moderate	Minor
	- SESS (gillnet, hook and trap)	Negligible	Negligible

Identifier	Hazard	Unmitigated	Residual
Impact		Consequence rating	
Survey-specific impacts			
	- CTS (otterboard trawl)	Negligible	Negligible
3	Underwater sound – impacts to values/infrastructure		
	- AMPs	Negligible	Negligible
	- KEFs	Negligible	Negligible
	- Indigo communications cable	Negligible	Negligible
	- UXOs	Negligible	Negligible
Routine vessel impacts			
4	Light emissions	Minor	Negligible
5	Atmospheric emissions	Minor	Negligible
6	Putrescible waste discharges	Minor	Negligible
7	Sewage and grey water discharges	Minor	Negligible
8	Cooling and brine water discharges	Minor	Negligible
9	Oily water (bilge water/deck drainage) discharges	Minor	Negligible
Risk		Risk rating	
1	Displacement of or interference with third party vessels - Displacement	Medium	Low
	- Interference	Medium	Low
2	Accidental discharge of hazardous and non-hazardous materials and waste	Medium	Low
3	Vessel strike or entanglement with megafauna - Individual animal	Medium	Medium
	- Population level	Low	Low
4	Introduction and establishment of invasive marine species	Significant	Medium
5	Marine Diesel Oil (MDO) spill		
	- Benthic fauna	Low	Low
	- Macroalgal communities	Low	Low
	- Plankton	Low	Low
	- Pelagic fish	Low	Low
	- Cetaceans	Low	Low
	- Pinnipeds	Low	Low
	- Marine reptiles	Low	Low
	- Seabirds	Low	Low
	- Shorebirds	Medium	Low
	- Sandy beaches	Low	Low
	- Rocky shores	Low	Low
	- Commercial fisheries	Medium	Low

Identifier	Hazard	Unmitigated	Residual
Impact		Consequence rating	
Survey-specific impacts			
	- Public amenity (beaches, recreational fishing)	Medium	Low
	- Desalination plant	Medium	Low
6	Spill response activities		
	- Fauna disturbance	Low	Low
	- Fauna injury	Medium	Low
	- Fauna death	Low	Low

The following sections assess environmental impacts (arising from planned events, being events that do or will happen), as listed in Table 7.1 and presented pictorially in Figure 7.1.

Figure 7.1: Simplified pictorial representation of impacts arising from the survey vessel



7.1. IMPACT 1 – Underwater Sound from the Survey

7.1.1. Causal Pathway

The following activities will generate underwater sound:

- Sound pulses from the seismic acoustic source array; and
- Engine noise transmitted through the hull and propeller noise from the survey and support vessels; and

- Sound emitted from the helicopter during take offs from and landings on the survey vessel.

Seismic source

The dominant source of underwater sound during the MSS will be from the operation of the seismic source (acoustic source array). The seismic survey contractor has not been selected at the time of submitting this EP and, therefore, the exact configuration of the acoustic source arrays is not known, however the maximum and minimum sound levels to undertake the survey have been defined based on contractor tenders, allowing an assessment of impacts and risks to be undertaken.

The seismic source will be fired at regular intervals, producing pulses of high intensity, low frequency sound. Seismic pulses typically have ~98% of the signal power in at frequencies less than 200 Hz; predominantly in the 10 to 200 Hz range (McCauley, 1994), which is the range most useful for seismic data imaging.

The air gun array comprises a series of acoustic sources that are fired in pre-determined order to achieve the desired sound energy and frequency of discharges (shot point interval) with minimal interference. The volume of the acoustic source array (in cubic inches) is a useful indicator of sound energy (in dB); however, the configuration of individual arrays has a significant effect on the actual power output.

Vessel sound

The survey and support vessels will generate continuous sound. The operation of motorised vessels involves numerous mechanical processes that create underwater sound as a by-product. These processes range from the sound of the propeller, cavitation caused by propellers, flow noise from the vessel moving through the water, engines and auxiliary machinery in the vessel hull.

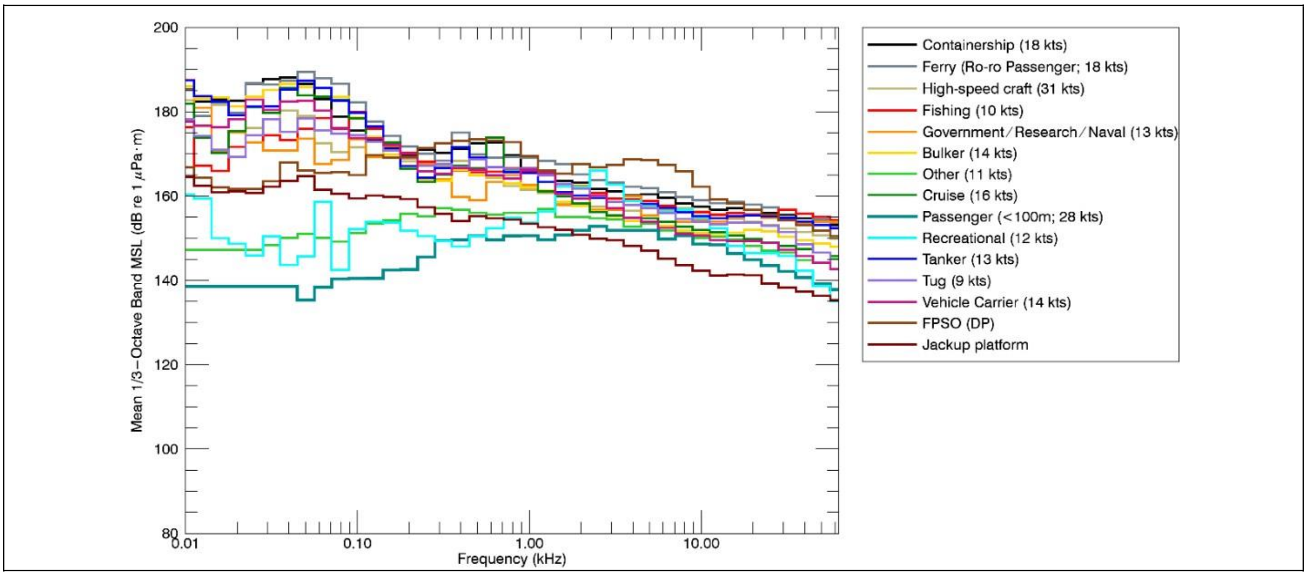
This sound source will be at a much lower level than that emitted from the acoustic source array. During operation of the acoustic source array, the underwater sound generated by the vessels will generally be masked by the acoustic source sound.

There will be limited periods of time when the seismic source is not operational (e.g., during line turns, maintenance and marine fauna shut-downs), during which engine sound will be the major source. Given that underwater sound from the acoustic source arrays is the dominant source of noise during the survey, the EIA for underwater sound is focussed on the seismic source array rather than vessel operations.

Sound emitted from vessels differs strongly, depending mainly on meteorological and oceanographic factors such as sea surface conditions and currents, type and state of propulsion system (including if the vessel is operating under DP), vessel installed power, size, transit speed and load (MacGillivray et al., 2018).

Figure 7.2 provides generic examples of frequency-dependent source levels for the most common vessel categories in 1/3 octave bands (McPherson et al., 2019). The categories include vessel types relevant to the oil and gas industry such as tankers and Floating Production Storage and Offloading (FPSO) vessel. Seismic exploration vessels fall within the ‘Government / Research / Naval’ class shown.

Figure 7.2: Example of frequency dependent source levels for several categories of vessels in 1/3-octave bands



Source: McPherson et al (2019).

The survey vessel for the Sequoia 3DMSS is expected to range in length from 90 to 130 m in length (and 40 to 70 m wide), while the support vessels are likely to be approximately 20 m in length.

The typical sound levels generated by vessels are:

- Tugboats, crew boats, supply ships, and many research vessels in the 50-100 m size class – 165-180 dB re 1µPa range (Gotz et al., 2009);
- Vessels up to 20 m size class – 151-156 dB re 1µPa (Richardson et al., 1995);
- Trawlers – peak at around 175 dB re 1µPa (Gotz et al., 2009); and
- Large ships – levels exceeding 190 dB re 1µPa (Gotz et al., 2009).

Kent et al (2016) details that propeller cavitation noise is broadband due to the range of bubble sizes involved, from a few Hz to tens of kHz. 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., <1 kHz) from the operation of machinery on-board, hydrodynamic flow noise around the hull, engine noise transmitted through the hull and from propeller cavitation (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 (Skjoldal et al., 2009). In the absence of an operating acoustic source, survey vessels have been measured to have a broadband source level (SLbb) of 180–191 dB re 1 µPa @ 1 m (Kent et al., 2016). This is similar to fishing vessels that have been measured to have a broadband source level (SLbb) of 174–195 dB re 1 µPa @ 1 m (Kent et al., 2016). Studies of the radiating underwater sound generated from the thrusters and propellers of support vessels when holding position alongside drilling rigs indicate highest measured levels of up to 182 dB re 1Pa with levels of 120 dB re 1 µPa SPL RMS measured at 3–4 km (McCauley, 1998).

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 pinniped similar to fur seals) – tolerate close and frequent approaches by vessels and sometimes congregate around fishing vessels. However, the amount of evidence is limited, and it is not known whether these animals are affected or are stressed by these encounters (Richardson et al., 1995).

- Dolphins – tolerate and even approach vessels but sometimes 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 (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 – have been observed to ignore weak vessel sounds and move away in response to strong or rapidly changing vessel noise. Avoidance is particularly strong when vessels approached directly (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 (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 (Richardson et al., 1995).
- Fish and turtles – there is no direct evidence of mortality or potential mortality to fish or sea turtles from continuous ship sound (Popper et al., 2014).

For most of the Sequoia 3DMSS, the acoustic array will be the dominant noise source. For periods where the array is not operating, underwater sound generated by vessel activity may result in changes in behaviour of marine fauna such as behavioural disturbance, localised avoidance or attraction. Given the survey vessel (and support vessels) are constantly moving, noise impacts in any one area may lead to temporary avoidance around the vessels. Impacts to marine fauna from vessel sound are assessed as **negligible**.

Helicopter sound

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. Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. Richardson et al (1995) reports figures for a Bell 214 helicopter (stated to be one of the noisiest) being audible in the air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. Noise from helicopter activities would therefore be localised and will also be infrequent (as personnel transfers will occur every few weeks, based on the assumption that the crew will undertake their first rotation after mobilising to the vessel from an Australian port).

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).

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 overflights probably have no long-term consequences (NMFS, 2001). 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 (undertaking crew transfers) 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.

Underwater sound from helicopter noise will be infrequent and of very short duration (mostly during take offs and landings), so impacts to marine fauna will be very localised and temporary and the consequence is assessed as **negligible**.

7.1.2. Known and Potential Environmental Impacts

In general, the impacts and risks resulting from underwater sound are generally well understood with regard to potential mortality and/or physiological injury for species in the water column, however, uncertainty lies in understanding the spatial and temporal extents of behavioural disturbances and the potential effects on populations and requires the application of context-specific information. The potential impact pathways to marine fauna from high levels of underwater sound are:

- Physical injury to auditory tissues or other air-filled organs;
- Hearing impairment, being temporary threshold shift (TTS), or permanent threshold shift (PTS);
- Direct behavioural effects through disturbance or displacement, and consequent disruption of natural behaviours or processes (e.g., migration, resting, calving or spawning); and
- Indirect behavioural effects by impairing/masking the ability to navigate, find food or communicate, or by affecting the distribution or abundance of prey species.

These terms are defined in more detail below:

TTS in hearing	Defined simply, TTS is the temporary loss of hearing sensitivity caused by excessive noise exposure. Exposure to sufficiently intense sound may lead to an increased hearing threshold in any living animal capable of perceiving acoustic stimuli (Finneran, 2015). If this shift is reversed and the hearing threshold returns to normal, the effect is called a TTS. The onset of TTS is often defined as threshold shift of 6 dB above the normal hearing threshold (Southall et al., 2019). Impairment to the hearing apparatus of a marine animal may result from a fatiguing stimulus measured in terms of sound exposure level (SEL), which considers the sound level and duration of the exposure signal. Intense sounds may also damage the hearing apparatus independent of duration, so an additional metric of peak pressure (PK) is needed to assess acoustic exposure impairment risk.
PTS in hearing	PTS is the permanent loss of hearing sensitivity caused by excessive noise exposure. It is considered an auditory injury. If a TTS does not return to normal, the residual shift is called a PTS.
Behavioural response	The context of sound exposure plays a critical and complex role in behavioural responses in marine mammals (Gomez *et al*., 2016). For example, different species (and different individuals or groups within a species) may respond differently to varying levels of sound depending on their behaviours and motivation at the time (depending on whether they're foraging, socialising, resting or mating) and other factors such as the type of sound, duration of exposure, and the suddenness of the onset of the received sound (Ellison et al., 2012; Gomez *et al*., 2016). The National Marine Fisheries Service (NMFS) in the USA uses an impulsive noise criteria threshold of 160 dB re 1 µPa (SPL) for potential behavioural disturbance to marine mammals (NOAA, 2019). The threshold for behavioural response represents the level at which a moderate behavioural response may occur, such as changes in swimming speed, direction and dive profile, localised deviations in migratory patterns, brief to moderate shift in group distribution, short term cessation or modification of vocal behaviour (McCauley *et al*., 2000; Southall *et al*., 2007; Tyack, 2008). Avoidance, however, is not directly related to sound level thresholds but also influenced by the

	state of the individuals (e.g., their reproductive, health and foraging condition) and the context of exposure. It is considered that avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from areas of biological importance such as nursery, resting or feeding areas during an important period for the species. Higher received levels are not always associated with stronger behavioural responses and vice versa, and a clear dose-response relationship has not been identified (Southall *et al*., 2007). In addition, a behavioural response does not necessarily equate to a significant avoidance or deviation in cetacean movements that would actually displace individuals or the population from the wider area. Similarly, proximity of the animal to the sound source, irrespective of received level, has been identified as an influencing factor, with behavioural response in humpback whales being both dependent on the proximity of whale to the vessel source and also the received level (i.e., at the same received level no behavioural response was detected when the source was greater than 3 km away) (Dunlop *et al*., 2018).
Masking	Acoustic masking may occur when a noise impedes the ability of an animal to perceive a signal (Wood *et al*., 2012; Erbe *et al*., 2016). For this to occur the noise must be loud enough, have similar frequency content to the signal, and must happen at the same time (Wood *et al*., 2012). Masking and the potential effects of masking on communication and listening space of marine mammals are not fully understood and remain an area of active research (Terhune et al., 1979; Cunningham & Mountain, 2014; Tenneson & Parks, 2016; Cholewiak et al., 2018; Dunlop, 2018; 2019; Gabriele et al., 2018; Putland et al., 2018. Currently, there are no specific received level thresholds for reliably assessing or regulating masking responses to seismic noise (Gomez et al., 2016).

Specifically, underwater sound from seismic sources has the potential to adversely affect the following environmental values and sensitivities within the acquisition area and the acoustic EMBA (see Table 7.2), to varying degrees:

- Plankton (including commercially important fish larvae/eggs);
- Marine invertebrate assemblages;
- Fish:
  - Mobile pelagic and demersal species that are likely to move away from the source as sound levels crease.
  - Site-attached/dependent fish species associated with reef habitats. These species are less likely to move away from the sound source and are expected to seek shelter within reef areas. There are no such habitats within the survey area.
- Cetaceans:
  - Migrating and transient whales known to occur in the region (e.g., pygmy blue whales);
  - Dolphin species (e.g., bottlenose dolphin, common dolphin).
- Pinnipeds - foraging habitat for the Australian fur-seal and New Zealand fur-seal;
- Foraging habitat for seabirds and shorebirds;
- Target species for commercially-important fisheries known to operate in and around the acquisition area (e.g., southern rock lobster, giant crab, shark); and
- Environmental values of Australian Marine Parks (AMPs) and Key Ecological Features (KEFs).

The potential impacts on individual animals from exposure to elevated sound levels above ambient sound levels in a given area depends on a number of factors, including the extent of sound propagation underwater, its frequency characteristics and duration, its distribution relative to the location of the organisms, the sensitivity and range of spectral hearing among species (Carroll et al., 2017).

7.1.3. EMBA

The EMBA (or maximum distance to effect) for underwater sound is based on the results of the sound transmission loss modelling (STLM) results, presented throughout this section. Table 7.2lists the predicted distances to behavioural, TTS, PTS, injury and mortality thresholds for the various groups of pelagic fauna, while Table 7.3 provides the same data for benthic fauna.

Table 7.2: Maximum horizontal distances to noise effect criteria from the seismic sound pulse for single-impulse (PK) modelled sites and cumulative (SEL24hr) modelled sites for species in the water column

<table>
<tr><th rowspan="2">Pelagic fauna</th><th rowspan="2">Behavioural</th><th colspan="3">Injury</th><th rowspan="2">Mortality/potential mortality</th></tr>
<tr><th>TTS</th><th>PTS</th><th>Recoverable injury</th></tr>
<tr><td>Plankton</td><td>*</td><td>*</td><td>*</td><td>*</td><td>210 m</td></tr>
<tr><td>Fish (with no swim bladders, including sharks)</td><td>Near^ – high risk
Intermediate^ – moderate risk
Far^ – low risk</td><td rowspan="3">2.55 km</td><td>*</td><td>80 m</td><td>81 m</td></tr>
<tr><td>Fish (with swim bladders, involved and not involved in hearing)</td><td>Near – high risk
Intermediate – moderate to high risk
Far – low to moderate risk</td><td rowspan="2">*</td><td rowspan="2">170 m</td><td rowspan="2">170 m</td></tr>
<tr><td>Fish eggs and larvae</td><td>Near – moderate risk
Intermediate – low risk
Far – low risk</td></tr>
<tr><td>Cephalopods*</td><td>3.66 km</td><td>*</td><td>*</td><td>*</td><td>*</td></tr>
<tr><td>Cetaceans – low frequency</td><td rowspan="3">11.1 km</td><td>56.6 km$^{\propto}$</td><td>1.18 km</td><td>*</td><td>*</td></tr>
<tr><td>Cetaceans – mid-frequency</td><td>80 m</td><td>Not reached</td><td>*</td><td>*</td></tr>
<tr><td>Cetaceans – high-frequency</td><td>620 m</td><td>340 m</td><td>*</td><td>*</td></tr>
<tr><td>Fur-seals</td><td>5.4 km</td><td>80 m</td><td>Not reached</td><td>*</td><td>*</td></tr>
<tr><td>Turtles</td><td>1.66 - 5.43 km$^{\pm}$</td><td>500 m</td><td>80 m</td><td>*</td><td>*</td></tr>
</table>

In accordance with the requirements of the various criteria, only the furthest distance to reach threshold criteria is reported, regardless of whether this is in the water column or seafloor, single pulse or 24-hr exposure.

* No exposure criterion is available to measure against.

^ Near = tens of metres, intermediate = hundreds of metres, far = thousands of metres.

± Depending on the exposure criteria applied.

∝ Noting that the MSS will be acquired when these whales are not present in the region.

Table 7.3: Maximum horizontal distances to noise effect criteria from the seismic sound pulse for single-impulse (PK) modelled sites and cumulative (SEL_{24hr}) modelled sites for benthic species

Pelagic fauna	Behavioural	Injury			Mortality/potential mortality
		TTS	PTS	Recoverable injury	
Sponges and corals	*	*	*	*	Not reached
Bivalves	*	*	*	*	1.5 m
Crustaceans	*	*	*	761 m	*

** No formal or defined exposure criteria is available to measure against.*

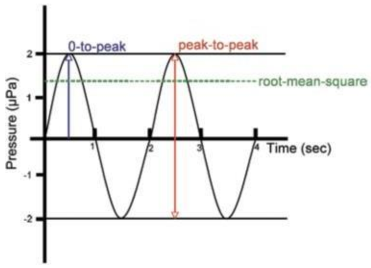
7.1.4. Evaluation of Environmental Impacts

Various studies have investigated the effects of seismic sound upon a range of marine biota and generally concluded that, although a seismic source may pose a potential risk to individuals in proximity to the source, the transitory nature of seismic operations and the limited range over which possible effects can occur make it unlikely that seismic noise poses a significant hazard to populations of marine species (McCauley et al., 2000a; Wardle et al., 2001; Gausland, 2000; Thomson et al., 2014).

Table 7.4defines the acoustic terms used through this EIA.

Table 7.4: Definitions of acoustic terms

Term	Definition
Sound	A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.
Decibel (dB)	Sound is measured on a logarithmic scale that expresses the ratio of two values of a physical quantity. It is used to measure the amplitude or 'loudness' of a sound. As the dB scale is a ratio, it is denoted relative to some reference level, which must be included with dB values if they are to be meaningful. The reference pressure level in underwater acoustics is 1 micropascal (µPa), whereas the reference pressure level used in air is 20 µPa, which was selected to match human hearing sensitivity. As a result of these differences in reference standards, sound levels in air are not equal to underwater levels. There are four main metrics for underwater sound (ISO/DIS 18405.2:2017) – SEL, SPL, PK and PK-PK, all described in this table.
Frequency	The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. **Unit:** hertz (Hz). 1 Hz is equal to 1 cycle per second.

Source level	A measure of sound pressure at a nominal distance of 1 m from a theoretical point source that radiates the same total sound power as the actual source. It is a theoretical value for a seismic source because a seismic source is not a point source, but rather, comprises individual elements in a defined area. Source level can be expressed as an SPL, SEL or PK. **Unit:** dB re 1 µPa^2m^2 (pressure level) or dB re 1 µPa^2m^2s (exposure level).
Impulse/ Pulse	The terms used to refer to the discharge of a seismic source are impulse and pulse, therefore the terms used to describe a single discharge are per-impulse or per-pulse.
Sound exposure level (SEL)	A measure related to the sound energy in one or more pulses, or the ratio of the time-integrated squared sound pressure to the specified reference value. **Unit:** dB re 1 µPa^2·s
SEL_{24hr}	SEL is specified in terms of either per-impulse (per-pulse) or accumulation period. In this report, the accumulation period applied is 24 hours, and therefore the SEL is referred to as either per-impulse SEL or SEL_{24hr}.
Zero-to-peak sound pressure (PK) Impulsive sounds	The greatest magnitude of the sound pressure during a specified time interval. PK levels are modelled to assess mortality and potential mortality to fish larvae and eggs, fish and turtles. A simple sound wave and three common methods to characterise the loudness of sounds, including zero-to-peak sound pressure, are illustrated below. **Unit:** dB re 1 µPa. 
Peak-to-peak sound pressure (PK-PK) Impulsive sounds	Sum of the peak compressional pressure (highest pressure variation) and the peak rarefactional pressure (lowest pressure variation) during a specified time interval. PK-PK is the difference between the minimum and maximum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound. **Unit:** dB re 1 µPa. See also the graph above.
Root-mean-square 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 over the duration of the acoustic event (i.e., the duration of a single seismic pulse). Because the SPL represents the effective sound pressure over the full duration of the acoustic event rather than the maximum instantaneous peak pressure (PK or PK-PK), it is regularly used to represent the effective or perceived loudness of a sound and to assess the potential for a behavioural response from marine fauna. **Unit:** dB re 1 µPa. See also the graph above.
Particle motion	The motion caused by a sound wave of a given infinitesimal part of the medium relative to the medium as a whole, and it is an integral part of any sound field. Particle motion is directional (unlike pressure) and is typically described using three-dimensional vector notation. Particle motion levels can be expressed in a variety of units related to displacement; velocity or acceleration. Acoustic particle velocity is the time derivative of particle displacement, and likewise, acceleration is the time derivative of velocity.

	Sound particle velocity (v) - contribution to velocity of a material element caused by the action of sound, in units of metre per second (m/s). It is the physical speed of a particle in a material moving back and forth in the direction of the pressure wave. Sound particle acceleration (a) - the contribution to acceleration of a material element caused by the action of sound, in units of metre per second squared (m/s^2). It is the rate of change of the velocity with respect to time. Benthic invertebrates (e.g., scallops) and many types of fish are sensitive only to particle velocity or acceleration rather than pressure, however, limited measurements of data are available on the levels of particle motion that may result in effects. Some measurements are available from studies on bivalves and therefore modelled particle motion values have been referenced for this EIA.
Transmission loss	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. It can also be referred to as propagation loss.

Sound Transmission Loss Modelling

While the energy from seismic acoustic source arrays is highest at low frequencies (typically below 500 Hz), they also produce sound at higher frequencies (Madsen et al., 2016; Hermannsen et al., 2015; Popper et al., 2016). Source levels depend upon the specific array and its configuration. The acoustic source array proposed for the Sequoia 3DMSS is a 3,480 cui array with a horizontal per-impulse SEL source level of 225.3 dB re 1 µPa2·s.

The source arrays are arranged in precise offset distance and locations according to their volume, amplitude and frequency group called sub-arrays. These are specifically designed and oriented such that the sound energy is directed vertically downwards towards the seafloor to be most efficient and effective in transmitting the tuned sound source signal through the water column to the seafloor.

Attenuation of sound sources with distance varies according to the source propagation levels, the depth of water, water temperature, water salinity and the nature of the seafloor. For example, pulses travelling upslope and along rock or sand bottoms are attenuated faster than those radiated alongshore or downslope (Richardson et al., 1995).

JASCO Applied Sciences (JASCO) was commissioned to undertake sound transmission loss modelling (STLM) for the Sequoia 3DMSS to enable an EIA specific to the survey to be undertaken. The STLM includes:

- Adoption of a 3,480 cui sound volume from a known array configuration;
- Establishing 11 modelling sites across representative water depths of the acquisition area (ranging in depth from 61 m to 798 m) (see Table 7.5);
- Single-shot propagation modelling – sampling at each of the 11 modelling sites;
- Accumulated SEL – 9,472 impulses for one full survey line and one partial line during a 24-hour period; and
- Particle motion – calculations of the 'peak magnitude particle motion acceleration', calculated using the peak (maximum) of the vector sum of the acceleration, at the surface layer of the seafloor directly below the source array at two of the single shot modelling locations (Site A and Site 1) to assess for impacts to benthic invertebrates, such as giant crab and SRL.

The metrics of sound pressure (SPL, Lp), zero-to-peak pressure levels (PK, Lpk), peak-to-peak pressure levels (PK-PK; Lpk-pk), particle acceleration (peak magnitude) and either single impulse (i.e., per-pulse) or accumulated SEL (LE) are used to evaluate noise and its effects on marine life. Appropriate subscripts indicate any applied frequency weighting, and unweighted SEL is defined as required. Acoustic particle motion has been reported in terms of acceleration and velocity. The acoustic metrics in the JASCO report (and used throughout the EP) reflect the updated ISO standard for acoustic terminology, ISO/DIS 18405:2017 (Underwater acoustics–Terminology).

Table 7.5 provides the location details for the single shot modelling sites, and Figure 7.3 illustrates these locations. The representative tow direction for each site is 30° and 210°.

Table 7.5: Location details of STLM sites

Site	SEL_{24hr} scenario	Water depth (m)	Latitude	Longitude
1	1	103	39° 32' 59.4733" S	143° 26' 19.3794" E
2		69	39° 40' 06.7164" S	143° 32' 16.2022" E
3		102	39° 54' 02.2895" S	143° 33' 26.1863" E
4		115	40° 11' 11.5813" S	143° 34' 04.2856" E
5	1&2	118	40° 20' 36.9605" S	143° 27' 16.1199" E
6	2	798	40° 20' 56.8961" S	143° 19' 04.1966" E
7		606	40° 16' 21.1050" S	143° 19' 34.8480" E
8		299	40° 12' 07.4725" S	143° 19' 28.5108" E
9		125	40° 03' 08.4701" S	143° 19' 17.8496" E
10		106	39° 50' 12.3846" S	143° 20' 18.0476" E
*	N/A	61	39° 40' 07.2803" S	143° 31' 43.9395" E

** Seafloor receptors (sponges, corals, molluscs, crustaceans) modelled site only*

Figure 7.3: Locations of STLM sites

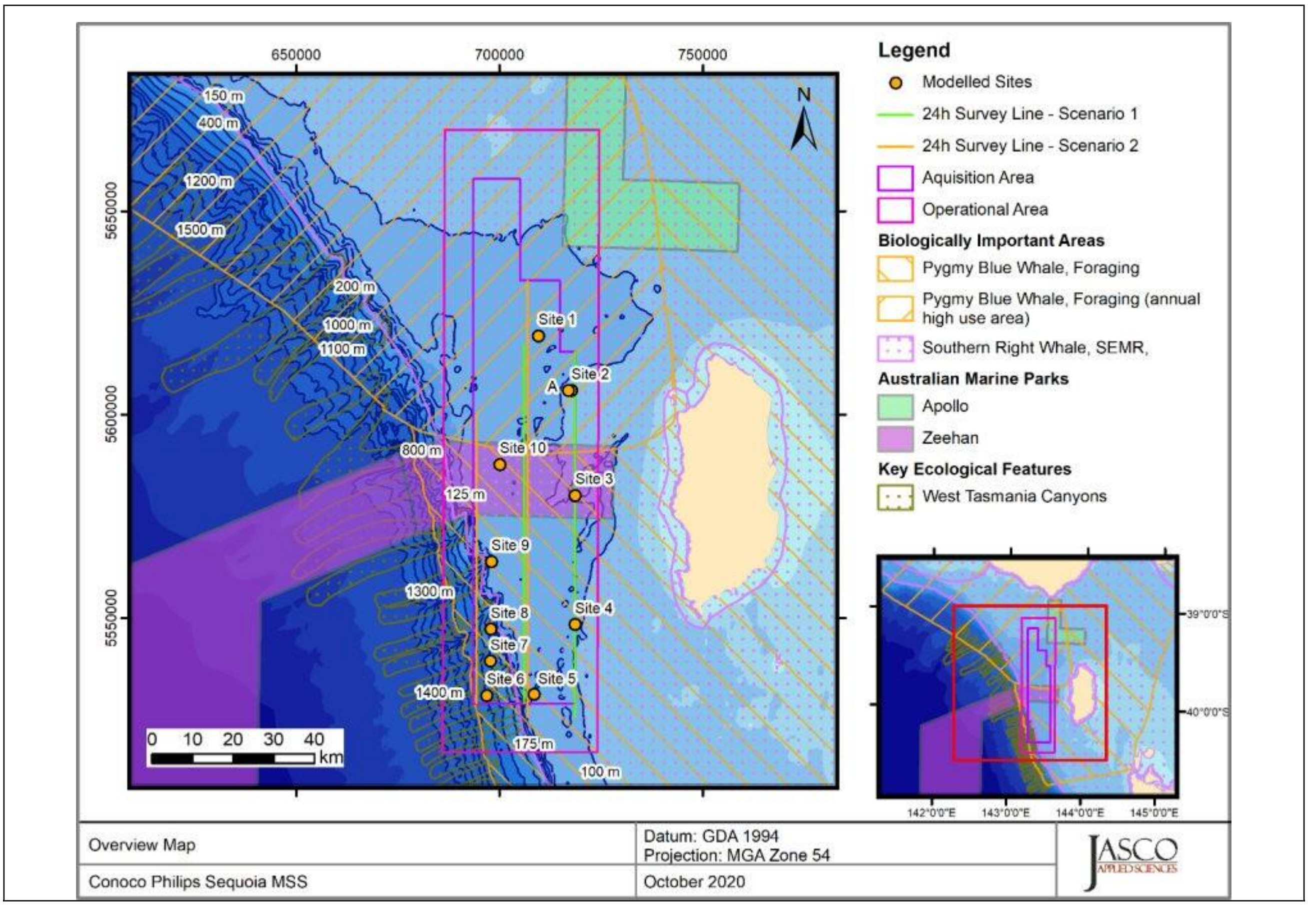


Figure 7.6Table 7.6 presents the PK and per-pulse SEL source levels in the broadside (perpendicular to tow direction), endfire (along the tow direction), and vertical overpressure signature and corresponding power spectrum levels for the sound source. The signature consists of a strong primary peak, related to the initial

release of high-pressure air, followed by a series of pulses associated with bubble oscillations. Most energy was produced at frequencies below 500 Hz.

Table 7.6: Far-field source level specifications for the 3,480 cui source for a 6 m tow depth

Direction	Peak source pressure level (Ls.pk; dB re 1 μPa m)	Per-pulse source SEL (Ls.E; dB re 1 uPa^{2}m^{2}s)	
		10-2,000 Hz	2,000-25,000 Hz
Broadside	248.6	225.3	185.7
Endfire	247.5	225.1	190.6
Vertical	258.1	230.9	197.9
Vertical (surface affected source level)	258.1	233.5	200.9

STLM scenario

Eleven stand-alone single impulse sites and two scenarios for survey operations over 24 hours were modelled to assess accumulated SEL (as listed in Table 7.5 and illustrated in Figure 7.3). In line with the proposed survey method described in Chapter 2, the modelling assumed that the survey vessel sailed along survey lines at 4.5 knots with an impulse interval of 18.75 m. The 24-hour modelling scenario considered one and a half sail lines (the distance covered by the vessel over 24 hours).

The single impulse sites and accumulated SEL scenarios were selected based on the survey lines being acquired along lines orientated 0°/180°. The orientations of the single impulse sites were selected as they provide for the greatest sound propagation radii broadside from the sound source towards to assist in the assessment of sound levels received within whale BIAs, KEFs and AMPs (modelling sites 3 and 10 are within the Zeehan AMP and sites 6, 7, 8 and 9 are located in or very close to the West Tasmanian Canyons KEF, which is also an important fishing area for giant crabs, see Figure 7.3).

The accumulated SEL scenarios consisted of two acquisition lines with a total active source time of 21.31 hours and 2.7 hours for the line turns.

Table 7.7 and Table 7.8present the per-pulse results for the 3,480 cui seismic source towed at 6 m for SPL and SEL isopleths in the water column from each of the modelled sites.

Table 7.7: Maximum (Rmax) and 95% (R95%) horizontal distances (in km) from the source array to modelled maximum- over-depth SPL isopleths from modelled single impulse sites

SPL (L_p; dB re 1 µPa)	Site 1 (103 m)		Site 2 (69 m)		Site 3 (102 m)		Site 4 (115 m)		Site 5 (118 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
190	0.2	0.17	0.24	0.2	0.2	0.17	0.2	0.18	0.18	0.16
180	0.86	0.67	0.96	0.76	0.84	0.68	0.8	0.64	0.74	0.59
175[#]	1.62	1.29	1.66	1.26	1.62	1.28	1.48	1.18	1.42	1.14
170	3.04	2.41	2.98	2.44	2.96	2.37	2.92	2.23	2.8	2.17
166[†]	4.72	3.68	5.43	3.94	4.5	3.55	4.34	3.38	4.62	3.47
160[‡]	8.74	7.21	10.6	8.39	8.7	6.95	8.05	6.26	8.55	6.26
150	23.6	19.6	31.3	25	22.9	17.9	20.1	16.3	36.1	21.3
140	49.5	38.9	48.9	40.4	36	28.1	37.9	28.2	>100	-
130	>100	-	>100	-	>100	-	>100	-	>100	-

	Site 6 (798 m)		Site 7 (606 m)		Site 8 (299 m)		Site 9 (125 m)		Site 10 (106 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}
200	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
190	0.12	0.11	0.12	0.11	0.12	0.11	0.18	0.18	0.2	0.18
180	0.4	0.34	0.4	0.34	0.74	0.58	0.74	0.61	0.84	0.68
175#	0.75	0.69	1.36	0.77	1.26	0.95	1.38	1.15	1.62	1.31
170	2.42	1.87	3.12	1.86	3.19	2	2.53	2.05	2.94	2.31
166†	3.89	2.9	4.45	3.38	5.14	3.78	5.32	3.53	4.2	3.46
160‡	11.1	6.48	10.4	6.36	8.88	7.7	7.78	6.07	8.43	6.92
150	32.6	24.9	42.2	27.7	44.3	31	36.8	21.3	21.2	15.9
140	>100	-	>100	-	>100	-	>100	-	49.3	36
130	>100	-	>100	-	>100	-	>100	-	>100	-

 # Threshold for turtle behavioural disturbance from impulsive sound (McCauley et al., 2000b).

† Threshold for turtle behavioural response to impulsive sound (NSF, 2011).

‡ Marine mammal behavioural threshold for impulsive sound sources (NOAA, 2019).

A dash indicates that R95% radius to threshold is not reported when the Rmax is greater than the maximum modelling extent.

Table 7.8: Maximum (Rmax) and 95% (R95%) horizontal distances (in km) from the source array to modelled maximum- over-depth unweighted per-pulse SEL isopleths from modelled single impulse sites

Per-pulse SEL (L_p; dB re 1 µPa^2·s)	Site 1 (103 m)		Site 2 (69 m)		Site 3 (102 m)		Site 4 (115 m)		Site 5 (118 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
190	0.04	0.04	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04
180	0.26	0.2	0.28	0.24	0.24	0.21	0.22	0.2	0.16	0.15
170	1.08	0.84	1.1	0.88	1.02	0.8	0.98	0.77	0.88	0.6
160*	3.84	3.07	4.39	3.27	3.68	2.93	3.54	2.82	3.84	3.07
150	10.5	8.38	12.9	10.3	10.5	8.27	10	7.42	10.9	8.23
140	28.9	23.1	33.6	27.7	25.5	20.1	20.7	17.3	35	27.3
130	53.5	40.8	57.4	46.5	37.5	31.1	51.2	31.7	138	105
120	>100	-	>100	-	>100	-	>100	-	>100	-
	Site 6 (798 m)		Site 7 (606 m)		Site 8 (299 m)		Site 9 (125 m)		Site 10 (106 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
190	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
180	0.14	0.12	0.14	0.12	0.14	0.12	0.24	0.2	0.24	0.2
170	0.46	0.39	0.48	0.41	0.8	0.69	0.92	0.7	1.04	0.8

160*	2.8	2.16	3.7	2.18	3.67	3.34	4.44	2.92	3.76	2.93
150	11.8	9.09	11.3	8.41	13.8	9.21	9.28	7.24	9.9	8.16
140	41.6	30.8	55.3	36.8	56.9	40.9	38.7	26.8	24.7	18.8
130	>100	-	>100	-	>100	-	>100	-	68.5	39.3
120	>100	-	>100	-	>100	-	>100	-	>100	-

** Low power zone assessment criteria (DEWHA, 2008).*

A dash indicates that R95% radius to threshold is not reported when the Rmax is greater than the maximum modelling extent.

7.1.4.1. Impacts to environmental receptors

For the key receptor groups in the marine environment, this section presents the:

- Sensitivity to sound generated by MSS;
- Noise effect criteria used in the STLM;
- STLM results; and
- Implications of the STLM results for each receptor group.

Impacts to Plankton

Plankton (described in Section 5.5.2) are very widely dispersed throughout the ocean and are transported by prevailing wind and tide driven currents. They cannot take evasive behaviour to avoid seismic sources.

However, the potential for population level noise effects is limited due to their widespread distribution and rapid population growth rates. This means that only a small percentage of a cohort will be exposed at any one time.

Sensitivity to Sound – International Studies

Research on zooplankton published by Fields et al (2009) involved studying captive zooplankton (copepods) exposed to seismic pulses at various distances up to 25 m from a seismic source in 2009 and 2010 in Norway. The source levels produced were estimated to be 221 dB re 1 µPa2.s, comparable to the far-field source levels associated with some MSS. The key findings are:

- Mortality one week after exposure was 9% higher relative to controls in the copepods placed within
- 10 m of the acoustic sources, but not significantly different from the controls at a distance of 20 m from the acoustic sources;
- The increase in cumulative mortality (relative to controls) after one week did not exceed 30% of copepods at any distance from the acoustic source;
- No sublethal effects occurred at any distance greater than 5 m from the seismic source. These findings indicate that the potential effects of seismic pulses to zooplankton are limited to within 10 m of the seismic source;
- There were no significant effects of distance from the acoustic source on any behavioural metrics; and
- Neither time after exposure nor size of the animal has any discernible effect on gene expression relative to the controls.

Gausland (2000) noted several studies confirming that that signal levels exceeding 230-240 dB re 1 µPa (PK-PK) are necessary for harm to occur and so therefore physical damage can only occur within a few metres from the air guns.

Sensitivity to Sound - Australian studies

In the only known study of the effects of seismic acoustic source exposure on early-stage embryonic (entirely soft tissue) SRL (Jasus edwardsii), Day et al (2016) found that exposure to seismic sound 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) and did not result in compromised larvae or morphological abnormalities, noting that in this study, the embryos were protected by the hard tail of an adult female SRL (i.e., not free floating in the water column). These results are aligned with those of Pearson et al (1994) that suggest early life stage crustaceans (Dungeness crab, Cancer magister, in the Pearson study) may be more resilient to seismic acoustic source exposure than other marine organisms.

Parry et al (2002) undertook studies on the effects of MSS on scallop fisheries in Bass Strait, including on larvae. This study was undertaken in December 2001 and February 2002 during a 3DMSS undertaken by Esso Australia in Gippsland, which used a 3,542 cui source towed 6 m below the sea surface. Plankton samples (impact and duplicate) were collected from five sites located 500 m apart in water depths of 55 m in a Before-After-Control-Impact (BACI) experimental study. The study results found few bivalve larvae in the live plankton samples and there was no significant difference in the number of bivalve larvae found in samples collected before and after passage of the seismic vessel (the same was true for all planktonic taxa). Parry et al (2002) postulate that invertebrates that do not contain gas spaces (like swim bladders in fish) appear to be very resilient to seismic pulses. The research also notes that while the study does not exclude the possibility that some changes to planktonic communities resulted from the MSS, the failure to detect any impacts of MSS occurred because impacts were small. Parry et al (2002) also indicates there is no evidence of mortality-associated population effects such as reduced abundance or catch rates in plankton a few hours after exposure.

Despite these results, research released by McCauley et al (2017) in June 2017 stated that there have been no published studies conducted on the impacts of seismic sound on plankton and as such, the understanding of these impacts is still developing. The McCauley et al (2017) study was undertaken in early March 2015, using two replicated experiments in Storm Bay in southeast Tasmania. It involved the deployment of acoustic noise loggers to measure air gun signals and used an acoustic source volume of 150 cui and operating pressure of 2,000 psi. The study measured zooplankton abundance and the proportion of the population that was dead at three distances from the acoustic source - 0, 200 and 800 m. The experiment estimated the proportion of the zooplankton that was dead, both before and after exposure to acoustic source sound, using net samples to measure zooplankton abundance, and bioacoustics to identify the distribution of zooplankton. 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). There was movement of water through the experimental area, which made interpreting their results more difficult (Richardson et al., 2017).

The results of the experiment found that zooplankton exposure to acoustic sources increased the mortality rate from a natural level of 19% per day to 45% per day (on the day of exposure), with this mortality rate observed out to 1.2 km. This is more than two orders of magnitude greater than the 10 m previously assumed (McCauley et al., 2017). These results escalated the concerns that some stakeholders had about the effects of MSS on plankton, particularly fishers and conservation groups.

This study postulates that the external sensory hairs that zooplankton possess may be extremely sensitive and in response to seismic sound, may 'shake' to the point where damage could accrue to sensory 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 also be large when compared to the impacted ecosystem.

In response to this research, Australian Petroleum Production and Exploration Association (APPEA) commissioned the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to assess the potential local and regional impacts on zooplankton of a typical MSS. A large-scale MSS conducted on the

North West Shelf of Australia was modelled in a hydrodynamic model using the McCauley et al (2017) mortality results. This is reported in Richardson et al (2017). The modelled survey parameters include a survey area of 2,900 km2, 60 survey lines, waters 300-800 m deep, an acoustic source source of 3,000-3,200 cui and operating pressure of 2,000 psi. This paper reports that impact is recorded within the survey area and within 15 km of it, but that these impacts are not discernible at the bioregion scale and barely discernible within 150 km of the survey area. Zooplankton populations recovered quickly after seismic exposure due to their fast growth rates and due to the dispersal and mixing of zooplankton from both inside and outside of the impacted region. The modelling undertaken by Richardson et al (2017) found that while there was a maximum decline of 22% in zooplankton populations in the survey and a 14% decline within 15 km of the survey area, it took only 3 days following the completion of the survey for zooplankton biomass to recover to pre-MSS levels within the survey area and within an area of 15 km around the survey area. The study notes that because zooplankton growth rates are slower in colder regions (e.g., Bass Strait), the recovery rate of zooplankton populations following exposure to MSS is likely to be slower in colder waters.

Fields et al (2019) (described under 'international studies') noted that the findings of McCauley et al (2017) are difficult to reconcile with these findings and other available research and may therefore provide an overly conservative estimate of the potential effects of seismic pulses to zooplankton

The IAGC asked several leading international plankton biologists to review the McCauley et al (2017) results. All reviewers found the paper unconvincing and all spoke to serious defects in the study and its interpretation, leading to their unwillingness to accept the results as presented. Criticisms related to the sample size, net sampling methods, acoustic sampling methods, characterisation of the physical environment and the hypotheses advanced to interpret the results. Some of the key questions about the paper included:

- If the sound source was supposed to have killed or disabled plankton, why didn't dead large zooplankton (e.g., euphausids and juvenile fish) show up in the net samples after sound exposure? While adult euphasids and juvenile fish might arguably have avoided the nets while alive, this would not be true of dead or disabled individuals.
- A clear, strong scattering layer near the bottom can be seen in the acoustic data suggesting the possibility that animals swam toward the bottom (a common anti-predator behaviour that might have been associated with the sound or simply the passage of the vessel and towed gear).
- One reviewer noted that immobile zooplankton like eggs, appendicularia, and Noctiluca should have been present in equal numbers in control and exposed samples. Sample sizes were too small to analyse for some of these immobile groups, but those with adequate sample sizes showed the same decrease in numbers in the exposed samples as mobile zooplankton, strongly suggesting that the apparent difference between control and exposed samples was not due to mortality and sinking or movement downward, but due to differences in the water masses being sampled during control and experimental sampling (i.e., that there was no sound-induced reduction in numbers in the experimental sample, but rather the experimental sample was a different piece of water with different densities of zooplankton than the control).

The IAGC (2017) conducted its own review of the McCauley et al (2017) paper, noting that:

"… the small sample sizes, the large day-to-day variability in both the baseline and experimental data, and the large number of speculative conclusions that appear inconsistent with the data collected over a two-day period."

The IAGC (2017) also noted that the McCauley et al (2017) paper has not yet been accepted by the expert scientific community.

In summary, failure to document the baseline spatial and temporal granularity of the zooplankton distribution at the study site is a major problem in separating any effect from sound exposure from the normal baseline fluctuations in passing water masses during sampling. As such, using the McCauley et al (2017) results as a pseudo-threshold criteria to determine the distance to effects to plankton from MSS is not considered suitable.

In early 2018, the CarbonNet Project undertook the Pelican 3DMSS in waters 15 m to 35 m deep located between 1 km and 13 km from the Gippsland shoreline in Victoria. Underwater sound and

its potential impact on the marine environment was a key issue raised by stakeholders, particularly the commercial fishing industry. In response, and among other actions, CarbonNet undertook zooplankton surveys before, during and after the MSS to ascertain whether any differences in abundance could be attributed to the MSS. The design of the survey was overseen by an independent Advisory Panel to provide advice on the survey methodology and interpretation of the survey results and its implications. A total of ten zooplankton samples were collected within the MSS area (six sites) and outside of the MSS area (four reference/control sites) two weeks prior to the MSS commencing and again three days after completion of the MSS (three sites in close proximity to the final seismic line and repeats at three reference sites).

While the full report contains commercial-in-confidence information on commercial fisheries and is therefore not publicly available, the summary report (CarbonNet, 2018) notes that the pre-MSS plankton samples collected were dominated by copepods, cladocerans and salps. Post-MSS plankton samples were dominated by the dinoflagellate Noctiluca scintillans. Variance both between and within assessments was high, with samples exhibiting levels of diversity and abundance typical of healthy temperate coastal waters. There was a high proportion of live copepods at all sites both pre- and post-MSS, but also a high proportion of dead cladocerans. Cladocerans are known for their delicate structure and were most likely destroyed during the sampling process, rather than any impact from the MSS. This was evidenced by the fact that high mortality rates were seen in samples collected both before and after the MSS. Overall, no impacts were observed that could be attributed to CarbonNet's Pelican 3DMSS, with the pre- and post-MSS zooplankton populations considered to be typical of a healthy temperate marine ecosystem.

Noise Effect Criteria for the STLM

Table 7.9 outlines and justifies the STLM threshold criteria applied to plankton, fish eggs and larvae for this study. In the absence of accepted threshold criteria for plankton, Jasco has applied the criteria for fish eggs and larvae from Popper et al (2014). These criteria are extrapolated from simulated pile driving signals that have a more rapid rise time and greater potential for trauma that pulses from a seismic source (and are therefore considered conservative).

Table 7.9: Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts for plankton, fish eggs and larvae

	Threshold		
	Behavioural	**TTS and recoverable injury**	**Mortality/potential mortal injury**
Threshold value	Near distance: tens of metres (moderate risk)		Per pulse: 207 dB PK
	Intermediate distance: hundreds of metres (low risk)		24 hrs: 210 dB SEL_{24h}
	Far distance: thousands of metres (low risk)		
Threshold criteria	There are no criteria for fish eggs and larvae, though Popper et al (2014) provides a relative scale of risk. This scale assumes that a behavioural response is possible.	There are no criteria for fish eggs and larvae, though Popper et al (2014) provides a relative scale of risk. This scale assumes that larvae have similar sensitivity to noise as juvenile and adult fish and that recoverable injury and TTS are possible.	Popper et al (2014) is one of the very few studies on which to base threshold criteria. Such criteria are extrapolated from simulated pile driving signals that have a more rapid rise time and greater potential for trauma than pulses from a seismic source. As such, these are considered conservative.
Justification for threshold criteria	Popper et al (2014) cite many of the current references and studies on potential impacts of noise emissions on fish eggs and larvae and when compared to other studies (e.g., Day *et al*., 2016 for embryonic lobsters and Fields *et al*., 2019 for copepods), the threshold levels are similar. Popper et al (2014) suggest that injury to larvae resulting from seismic impulses may occur for sound exposures above 207 dB re 1uPa (PK) or above 210 dB re $1uPa^2.s$ (SEL_{24hr}). However, Popper et al (2014) suggest that recoverable injury and TTS is likely within tens of metres of a seismic source, which is generally less than the distance associated with their proposed mortal injury threshold, so there is some discrepancy. The threshold proposed for mortal injury is derived from pile driving impacts to fish and is likely to be conservative. The body of literature indicates that mortality and sub-lethal injury are limited to within tens of metres of seismic sources.		

STLM Results

The results of the STLM for the maximum horizontal distance (Rmax) are:

- Mortality or potential mortality;
  - Maximum-over-depth (MOD) PK (against the per pulse threshold of 207 dB PK) – 170 m.
  - Maximum seafloor PK (against the per pulse threshold of 207 dB PK) – 154 m.
- Recoverable injury and TTS – intermediate distance based on the distances above.
- Behavioural – intermediate distance based on the distances above.

Impact Assessment

The STLM results indicate that in the water column, plankton may experience mortality or potential mortality within a distance of 210 m of the sound pulse, while plankton at or near the seafloor may experience mortality or potential mortality within a distance of 191 m to 223 m of the sound pulse (depending on water depth). There is a low risk of plankton experiencing recoverable injury, TTS or behavioural impacts based on these distances and the Popper et al (2014) threshold values.

Any mortality of plankton as a result of the survey will have a negligible consequence because:

- The survey is a temporary activity, with active acquisition over 31 days.
- The survey lines run north to south, perpendicular to prevailing currents, which minimises the duration of exposure of individual organisms to seismic sound.
- The survey avoids the peak plankton population period that coincides with the Bonney Upwelling.
- The survey will be inconsequential when compared to natural mortality rates of plankton, fish eggs and larvae, which are generally very high. Tang et al (2014) notes that plankton mortality can exceed 50% per day in some species and commonly exceeds 10% per day. A review of mortality estimates by House and Zastrow (1993) found that the average mortality rate for marine fish larvae was equivalent to 21.3% per day.
- As noted in Section 5.5.1, SRL recruits in the Tasmanian fishery originate from larvae drifting from South Australia and western Victoria and occur over wide spatial scales. Hartmann et al (2013) states that larvae are not retained inshore on the continental shelf (i.e., most of the survey area) but rather, they live in oceanic waters and are transported over large distances. As such, it is expected that any impacts to SRL larvae released in the survey area will not affect future recruitment of SRL in the part of the fishery overlapped by the survey (and is unlikely to have measurable affects in other parts of the fishery). With SRL spawning occurring over a 6-month period (mid-May to mod-November), the survey (active for up to 31 days) temporally overlaps with <20% of the SRL spawning season.
- Recovery of most plankton populations will be rapid;
  - Richardson et al (2017) notes that zooplankton communities can begin to recover in number during the MSS, such that a continuous decline in zooplankton throughout the MSS is unlikely and parts of the survey area would be replenished with zooplankton as the survey progresses.
  - The hydrodynamics of Bass Strait are conducive to continual mixing and replenishment of plankton, noting the slower growth/replenishment rate of plankton in cooler temperate waters than warmer tropical waters. Taking this into consideration, the outcomes of the Richardson et al (2017) research hold, in that recovery of plankton populations are likely to be in the order of days post-MSS rather than weeks.
  - The Bonney Upwelling in the west, upwellings from the West Tasmania Canyons and the EAC from the east means will rapidly replenish plankton populations.

The impacts of localised increased plankton mortality in the area around the acoustic sources on food availability for plankton feeders is assessed as **negligible** because:

- The acquisition area is located 127 km southeast of the eastern extent of the 'Bonney Upwelling' KEF and the southwest corner of the acquisition area likely overlaps the unmapped upwelling associated with the 'West Tasmania Canyons' KEF. The Bonney Upwelling typically peaks in November and
- December and the West Tasmania Canyons upwelling typically peaks in late summer (February) (noting that the timing of both upwellings depends on a number of physical factors). The peaks for these upwellings means that the completion of the survey, meaning that large zooplankton populations that replenishment to plankton populations in and around the acquisition area will be enhanced by the upwelling events.
- The EMBA for impacts to plankton (the acquisition area and a radius of 210 m around it, equal to
- 2,904 km2) represents 0.08% of the West Tasmania Transition Area IMCRA and 7.13% of the Western Bass Strait Shelf Transition IMCRA provincial bioregions. These are low figures and the plankton circulating through the rest of the bioregion will quickly replenish any zooplankton that die. At this provincial bioregion level, plankton mortality will have no meaningful effects on regional ecology.
- The PBW 'foraging area (annual high use)' BIA, which is overlapped by the acquisition area, is vast. The acquisition area overlaps 8.4% of this BIA and the PBW 'known foraging area' BIA is similarly large, with the acquisition overlapping 1.7% of this BIA. It is therefore not likely that plankton mortality in the acquisition area represents a significant lost food resource for PBW, especially because the survey will be undertaken when the whales are not likely to be present in the area.

- The acquisition area overlaps 2.5% of the SRW 'known core range' BIA. It is not likely that plankton mortality in and around the acquisition area represents a significant lost food resource for the whales, especially because the survey will be undertaken when the whales are not likely to be present in the area.

The impacts of plankton mortality localised to an area around the acoustic sources on commercial fisheries of concern (the principal ones being SRL and giant crab) are assessed as **negligible** based on the results of the Day et al (2016) research, which found no significant difference in the abundance of bivalve larvae before and after a 3DMSS.

Demonstration of Acceptability

In accordance with Section 4 of NOPSEMA's EP decision making Guideline (GL1721, Rev 6, November 2019) and the methodology outlined in Chapter 6, Table 7.10 presents a demonstration of acceptability.

Table 7.10: Demonstration of acceptability for potential impacts to plankton

<table>
<tr><td>Statement of acceptability</td><td colspan="2">Impacts to plankton are localised, short-term, in line with natural variations in mortality, and do not result in long-term impacts to diversity and abundance at the population level.</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>ConocoPhillips' HSE Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>HSEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this survey. It is demonstrated that all the standards in the HSEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.</td></tr>
<tr><td>External context</td><td colspan="2">ConocoPhillips Australia has undertaken open and transparent communications with relevant persons and actively involved those known to have concerns with MSS, such as commercial fisheries associations.
Relevance to plankton: Commercial fisheries associations have raised concerns about the impacts of MSS on plankton, noting that papers they have read indicate mass mortality. These concerns have been addressed through ConocoPhillips Australia providing stakeholders with detailed responses to their concerns and mapping, which illustrates the overlap between the survey area and the fishing grid cells relevant to the fishery in question.</td></tr>
<tr><td>Legislative context</td><td colspan="2">There is no legislation relevant to the effects of underwater sound on plankton.</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice (listed in order of most to least recent) demonstrates that Best Practice Environmental Management (BPEM) is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry
(IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include:
• Considering sensitive locations and times of year for critical activities of species that are present.
• Using an MMO.
• Using soft-start procedures.
Relevance to plankton: no specific application.</td></tr>
</table>

	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)	This document provides guidelines regarding: • An exclusion zone for monitoring (500-m horizontal distance). • Pre-start observations in the exclusion zone (for at least 30 minutes). • Soft-start procedure. • Monitoring during periods of poor visibility and darkness. • Use of a passive acoustic monitoring (PAM) system. • Recording all monitoring data. With the exception of PAM systems, the EPS developed for this activity meet the requirements of this guideline (and is generally exceeded by meeting the more stringent requirements of the EPBC Act Policy Statement 2.1). **Relevance to plankton:** no specific application.
	Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities (Prideaux, 2017)	This document was developed to present the BPEM for marine noise-generating activities, including MSS. It includes 12 modules covering various species groups and what should be taken into consideration when undertaking EIA. **Relevance to plankton:** No specific application, though Section B.10.4 (fin-fish) notes that spawning locations should be considered.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The EPS developed for this activity and in the design of the survey in general take into account the four practices outlined in this guideline (see Section 3.7.4). **Relevance to plankton:** no specific application.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Noise (item 74) - the preparation of this EP meets the objectives of these guidelines because sensitive areas for marine life are identified, the survey is planned to avoid sensitive times of the year and soft-start and stop procedures are in place with marine mammals are sighted within 500 m of the sound source. **Relevance to plankton:** no specific application.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Section 8.2 (Planning and permitting) – consideration of fish spawning times. • Section 8.7 (Aquatic life) – soft-start procedures, use of MMOs, cetacean sighting and reporting.

		• Appendix 1 (Recommended mitigation measures for cetaceans during geophysical operations) - use of exclusion zone for monitoring and soft-start procedure. **Relevance to plankton:** no specific application.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008)	The EPS developed for this activity meet the requirements of this policy statement through the adoption of: Part A (standard management procedures) Part B (the use of MMOs). **Relevance to plankton:** no specific application
	Code of Environmental Practice (APPEA, 2008)	The EPS developed for this activity meet the requirements of this guideline with regard to geophysical surveys: • To reduce the impact on cetaceans and other marine life to ALARP and to an acceptable level. • To reduce the impacts to benthic communities to ALARP and to an acceptable level. **Relevance to plankton:** no specific application, considered part of marine life in general.
Environmental context	MNES	
	AMPs (Section 5.1.1)	There is a 444 km^2 overlap between the acquisition area and the Zeehan AMP (a 2.2% overlap). The acquisition and operational area avoids overlap with the Apollo AMP. Appendix 1 provides an assessment of the potential impacts of the activity on the management aims of the South-East Commonwealth Marine Reserves Network Management Plan 2013-23, which encapsulates the Zeehan AMP. MSS is permitted within the Multiple Use Zone of the Zeehan AMP. **Relevance to plankton:** no specific application. Plankton is not listed as a conservation value of the Zeehan AMP
	Wetlands of international importance (Section 5.1.4)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest Ramsar wetlands. **Relevance to plankton:** no specific application.
	TECs (Section 5.1.6)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest TECs. **Relevance to plankton**: no specific application.
	KEFs (Section 5.1.7)	The acquisition area overlaps 0.58% of the West Tasmania Canyons KEF, and therefore seismic sound will be generated within this KEF. **Relevance to plankton:** plankton are not listed as a value of the West Tasmania Canyons KEF, but the canyons are noted as a foraging area for PBW and humpback whales (they feed on plankton).

	NIWs (Section 5.1.8)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest NIWs. **Relevance to plankton:** no specific application.
	Nationally threatened and migratory species (Section 5.5)	The larval phase of many threatened and migratory fish species is likely to be a component of the zooplankton assemblage at various times of the year. This EIA demonstrates that impacts to larvae will be highly localised.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 & 5.1.11)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines. **Relevance to plankton:** no specific application.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Appendix 2 provides an assessment of the potential impacts of the activity on the management aims of threatened species plans. **Relevance to plankton:** the species' of most concern to the fisheries associations, being SRL and giant crab, have in place management arrangements for the Victorian SRL (VFA, 2017) and giant crab (VFA, 2010) fisheries (but not the Tasmanian equivalents). These management arrangements do not list underwater sound (or MSS specifically) as a threatening process to the fisheries. The survey does not impact on the management arrangements outlined in these plans (VFA, 2010; 2017).
ESD principles	The application of the ESD principles to plankton are outlined here.	
	Decision-making processes should effectively integrate both long- term and short-term economic, environmental, social and equitable considerations.	The timing of the activity has been selected to balance the requirements between spawning times of commercially important fish species, whale migration times and sea state considerations (see Figure 2.4).
	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.	The scientific literature cited throughout this section indicates mortality of plankton is likely only within tens of metres of the sound source and that plankton populations rapidly return to pre-impact levels.
	The present generation should ensure that the health, diversity and productivity of the	Impacts to plankton are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value and fish stocks for commercial fishing.

	environment is maintained or enhanced for the benefit of future generations.	
	The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	Impacts to plankton are assessed to be localised and temporary. There will not be a loss of plankton species diversity, and while plankton species abundance may be temporarily reduced, this abundance will quickly return.
	Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.

Impacts to Fish

Fish species known to occur within the survey area are listed and described in Section 5.5.4. In this section, fish includes elasmobranchs (sharks and rays) and fin-fish, unless otherwise noted.

Sensitivity to Sound

All fish studied to date are able to detect sound, with the main auditory organs in teleost (bony) fish being the otolithic organs of the inner ear (Carroll et al., 2017). Hearing in fish primarily involves the ability to sense acoustic particle motion via direct inertial stimulation of the otolithic organs or their equivalent. Many species also sense sound pressure using an indirect path of sound stimulation involving gas-filled chambers such as the swim bladder (Carroll et al., 2017).

The predominant frequency range of MSS sound is within the detectable hearing range of most fish.

There are substantial differences in auditory capabilities from one fish species to another, hence the use of anatomy to distinguish fish groups, as done by Popper et al (2014). Within these categories, two groups have an increased ability to hear.

- Fish with swim bladders close, but not intimately connected to the ear, can hear up to about 500 Hz, and are sensitive to both particle motion and sound pressure. In Australian waters, such fish species include:
  - Snappers, emperors, groupers and rock cods.
  - Some tuna species (Thunnus sp.).
- Fish with swim bladders mechanically linked to the ear are primarily sensitive to pressure, although they can still detect particle motion. These fishes have the widest hearing range, extending to several kilohertz, and are generally more sensitive to sound pressure than any of the other groups of fish (Hawkins and Popper, 2016). In Australian waters, such fish typically include some species from the following families:
  - Clupeidae (herrings, sardines, pilchards).
  - Gadidae (cods such as whiting).
  - Pomacentridae (damsel and clown fish).
  - Haemulidae (grunters and sweetlips).

Fish without a swim bladder include sharks (including whale sharks), some tuna species (Thunnus sp) and some mackerel species (Scomberomorus spp.) (Casper et al., 2012; Popper et al., 2014; Carroll et al., 2017). Prideaux (2017) notes that large sharks are attracted to low frequency pulsed sounds (generally 20-60 Hz) but not low frequency continuous sounds or high frequency (400-600 Hz) pulsed sounds.

Underwater noise levels significantly higher than ambient levels can have a negative impact on fish, ranging from physical injury or mortality, to temporary effects on hearing and behavioural disturbance effects.

The effects of underwater sound on fish within the vicinity of a seismic sound source array will vary depending on the size, age, sex and condition of the receptor among other physiological aspects, and the topography of the benthos, water depth, sound intensity and sound duration. The effect of noise on a receptor may be either physiological (e.g., injury or mortality) or behavioural, as described in the following sub-sections.

Sound-induced mortality in larval fish, where observed, has been in the range of 0.5 to 3 m around the source, in association with relatively high peak energy levels; however, damage may occur out to approximately 5 m (Payne et al., 2008). For example, Kostyuchenko (1973) reported fish egg mortality out to 0.5 m and only pathological effects (e.g., embryo curling, membrane perturbation and yolk displacement) at 5 m in a small percentage of anchovy eggs exposed to an estimated source level of 230 dB re 1 µPa. Matishov (1992) observed delamination of the retina in cod larvae within 1 m of a seismic source with a level of 250 dB re 1 µPa (PK-PK).In the USA, trials using seismic sound from acoustic sources as a method to reduce the survival of non-native lake trout embryos produced high mortalities of up to 100%, but only at close range (0.1 m). At distances of 2.7 m from the seismic source, mortalities did not differ from those of controls (Cox et al., 2012 as cited in NSW DPI, 2014).

Booman et al (1996) recorded the highest mortality rates of Norwegian fish eggs and larvae within 1.4 m and low or no mortality and infrequent pathology within 5 m of the seismic source. In contrast, Dalen and Knutsen (1987) exposed cod eggs, larvae and fry to a single seismic discharge with a source level of 220 dB re 1 µPa and no effects were observed at either 1 m or 5 m. A study by the Institute for Marine Resources and Ecosystem Studies (Bolle et al., 2012) also observed no statistically significant effect on the survival rate of common sole larvae exposed to piling noise at doses of a PK of 210 dB re 1 µPa and cumulative SEL dose of 206 dB re 1 µPa2.s.

An important study, although limited in scope, investigated the consequences that seismic-induced mortality of fish larvae may have at a population level (Sætre & Ona, 1996). The work was based on the observed mortality figures for larvae and fry at given distances in Booman et al (1996) for five species of fish (cod, saithe, herring, turbot, and plaice). As a worst-case situation, it was estimated that the number of larvae killed during a typical MSS (>10 days) was 0.45% of the total larvae population (Sætre & Ona, 1996). When compared with very high natural mortality rates for species (e.g., cod and herring eggs/larvae have a natural mortality of 5 to 15% per day), the potential loss associated with an MSS is negligible.

Physiological Impacts

Direct physical damage may occur to fish if they approach within a few metres (<5 m) of the seismic source (Gausland, 2000; McCauley et al., 2000a; Parvin et al., 2007).

Lethal effects of MSS on fish have not been reported, but those with a swim bladder closely connected to the inner ear are more susceptible than those without (McCauley, 1994). Fish with thin-walled, lightly damped and large swim bladders will be most susceptible to mechanical damage or trauma from seismic pulses. Other fish, including the elasmobranchs (sharks and rays), family Scombridae (mackerels and tuna) and many of the flatfish and flounder species do not possess a swim bladder and so are not susceptible to swim bladder-induced trauma (McCauley, 1994). Table 7.10 presents a summary from Carroll et al (2017) for investigations into the impacts of seismic acoustic source sound on fish, which supports the assertion that lethal effects of MSS on fish have not been observed. Note that this table has been edited by JASCO to revised sound units.

A study involving a 3DMSS in northern WA found no significant effects on the abundance or diversity on either site-attached or free roaming demersal species (Webster et al., 2018). Fish in this study were exposed to SELs of less than 187 dB re 1 µPa2s and impacts were examined through underwater visual consensus of the fish community, before and after the MSS. The underwater visual counts were combined with 10 years of historical monitoring data and no effects of seismic exposure were detected in terms of species richness and abundance (Webster et al., 2018).

Webster et al (2018) also note that substantial research concludes that there is little damage or limited evidence of physical injury to fish from MSS. The risk assessment undertaken by a panel of fisheries, acoustics and industry experts reported in the Webster et al (2018) report notes that in WA waters less than 250 m deep (as is the case with >90% the Sequoia survey area), risks to demersal finfish were rated as ranging from negligible to severe depending on water depth, fish resource and intensity of the sound source. Risks to pelagic finfish were assessed as negligible. Noting that the risk assessment was undertaken for waters adjacent to WA, they are just as likely to apply to waters of southern Australia given many of the species assessed are omnipresent around Australia.

Table 7.11: Summary of studies conducted on the effects of seismic surveys on fish mortality

Organism	Source	Source levels	Distance of receptor from source	Received levels	Results	Reference	Relevance to Sequoia 3DMSS
Pallid sturgeon (*Scaphirhynchus albus*) and on Paddlefish (Polyodon spathula)+	620 cui acoustic sources	Not relevant, not shown	0–33.75 m Control 160 m	206 – 231 PK 187 – 205 SEL (single shot)	No mortality or mortal injury that was significantly different between controls and the fish exposed to the highest sound energy. The results do not support the hypothesis that there would be mortality of fish exposed to the impulsive acoustic source sound, at least at peak received sound pressure levels as high as 231 dB re 1 µPa.	Popper et al (2016) C	Highly relevant, indicates the criteria applied in the STLM are highly conservative.
European seabass (*Dicentrarchus labrax*)	Playbacks (see spectrograms in Radford *et al*., 2016)	Not relevant	<1 m	158.39 PK (replica seismic)	Naïve fish showed elevated ventilation rates, indicating heightened stress, in response to impulsive additional noise (playbacks of recordings of pile-driving and seismic surveys). However, fish exposed to playbacks of pile-driving or seismic noise for 12 weeks no longer responded with an elevated ventilation rate to the same noise type. Fish exposed to long-term to playback of pile-driving noise also no longer responded to short-term playback of seismic noise. The lessened response after repeated exposure was likely driven by increased	Radford et al (2016) *, L	Not relevant to mortality. Results suggest that fish not accustomed to seismic sound will experience increased stress during exposure to a survey. This is acknowledged in the behaviour section of this EP.

Organism	Source	Source levels	Distance of receptor from source	Received levels	Results	Reference	Relevance to Sequoia 3DMSS
					tolerance or a change in hearing threshold.		
Rainbow trout (*Salmo gairdneri*)	130 cui acoustic sources	229 (estimated, and likely PK)	150–4,000 m	142 PK-PK at the cages (4 km) (M) 186 PK-PK at 150 m from acoustic sources (M)	No mortality observed.	Thomsen (2002) *, C, #	Not relevant to mortality as levels significantly lower than those in criteria.
Demersal fish, blue whiting and some pelagic fish	4,752 cui acoustic source array	222–250 PK	1–10, 150–300 m	200-210 (E)	No mortality observed.	Dalen & Knutsen (1987) *, C, #	Relevant – study with large commercial array.
Red snapper (*Lutjanus synagris*), Schoolmaster snapper (*Lutjanus apodus*), Atlantic spadefish (*Chaetodipterus faber*)	635 cui acoustic source array	196 PK	7 m horizontal at 5m depth. 2.5 m below array And 1 m horizontal distance	Not available	No mortality at any distances.	Boeger et al (2006) *, C, #	Relevant – study with small commercial array.
Sandeel (*Ammodytes marinus*)	3,090 cui acoustic source array	256.9 PK (vertical) 247.7 PK broadside	55–7,500 m	Sand eels within the near-field of the array on	No differences in mortality between control and experimental groups attributable to acoustic source exposure. Where mortalities occurred,	Hassel et al (2003; 2004) C	Relevant – study with similar sized commercial array to this survey.

Organism	Source	Source levels	Distance of receptor from source	Received levels	Results	Reference	Relevance to Sequoia 3DMSS
				the seafloor under tracklines	they were attributed to handling procedures (i.e., similar in control and experimental fish).		Track lines directly over habitat with no impact shown.
Twelve fish species	Single 20 cui acoustic source	223 PK-PK,	5–800 m	146-195 PK-PK (M)	No immediate mortality. No delayed mortality (up to 58 days) for one species.	McCauley et al (2003) *, C, #	Relevant, however this is the only study to have shown this, other studies examining the same thing have shown no damage for several other species (e.g., Popper *et al*., 2005 ; Song *et al*., 2008), see below.
Broad whitefish (*Coregonus nasus*), lake chub (*Couesius plumbeus*), Northern pike (*Esox pucius*)+	720 cui acoustic source array	Not specified , not relevant	13–17 m	Average mean of 207 PK (M) Mean SEL (single shot) 177 m (M)	No mortality of fish from the 3 species held for 24 hours after exposure.	Popper et al (2005) *, C[1] [1.] Caged outdoor tanks	Relevant – no mortality at close range. However, limited ability to compare to McCauley et al (2004) – different paradigm, species, acoustic source, and transmission loss environment.

Organism	Source	Source levels	Distance of receptor from source	Received levels	Results	Reference	Relevance to Sequoia 3DMSS
Juvenile sea bass (*Dicentrarchus labrax*)	Acoustic sources 2,500 cui array	Not shown	180–6,500 m	210 at 180 m (E) 204 at 800 m (E) 199 at 2,500 m (E)	No mortality up to 72 hours post exposure.	Santulli et al (1999) *, C	Relevant – real world study with a commercial seismic array.
Juvenile saithe (*Pollachius virens*) and cod (*Gadus morhua*), adult pollock (*Pollachius pollachius*) and mackerel (*Scomber scombrus*)	Acoustic sources	Not shown	109, 16 and 5.3 m	195, 210, 218 PK	No indication of mortality.	Wardle et al (2001) *, F, #	Highly relevant, indicates criteria applied to the STLM are highly conservative.

Source: modified from Carroll et al (2017).

Sound levels are reported as zero to peak (PK), peak-to-peak (PK-PK), root-mean-square SPL (units of dB re 1 µPa), or SEL (units of dB re 1 µPa2.s). However, the metric is not always evident from the literature.

E = estimated, M = measured.

** denotes a commercially important species.*

+ denotes freshwater species.

L = laboratory experiment (i.e., tank).

C = caged field experiment.

F = field experiment (uncaged). D = desktop study.

 # = no control.

In August 2020, the FRDC released the preliminary results of a Multiple Before-After Control-Impact (BACI) experiment that they funded to investigate the effects of a 3DMSS in eastern Bass Strait on Danish Seine catch rates (Fishwell Consulting, 2020). The key targets for this Danish Seine fishery in the areas of the MSS are flathead (Platycephalus sp.) and whiting (Sillago sp.). The research found that average catches of whiting at impact sites were 0.5% of those of the control sites. For flathead, zero catches comprised 2% of records in the control sites and 22% of records in the impact sites (Fishwell Consulting, 2020). In response to media reports about this study, the IAGC (2020) responded with the following information:

- This is a preliminary and incomplete report, with the research to be finalised in March 2021;
- It refers to changes in catch rates during Phase 1 of a 4-phase study (a 6-week period);
- It is based on a limited number of samples taken in a few specific locations (not the whole survey area) and is therefore not representative of the entire survey area;
- There is no evidence that the lowered catch rate would persist after the MSS or is indicative of population-level effects;
- Relative catch indices for both species in the years preceding the MSS were highly variable (temporally and spatially), and that relative catch index is a measure of catch per effort, not an absolute measure of abundance; and
- That fish are constantly detecting and responding to environmental stimuli and that movement away from sound is normal and consistent with previous research, but it does not indicate that the response is biologically significant (i.e., have a bearing on the long-term health, fecundity or survival of an individual fish or population).

Behavioural Impacts

Gausland (2000) postulates that while seismic acoustic source operation causes little direct physical damage to fish at distances greater than 1-2 m from the source, it is evident that fish respond to sounds emitted from acoustic sources, and that avoidance seems to be the primary response for all species.

Available evidence suggests that behavioural change for some fish species may occur, however this is thought to be localised and temporary, with displacement of pelagic or migratory fish populations having insignificant repercussions at a population level (McCauley, 1994). Behavioural changes such as startle or alarm responses are expected to be localised and temporary, with displacement of pelagic or migratory fish likely to have insignificant repercussions at a population level (McCauley, 1994; McCauley & Kent, 2012; Popper et al., 2015; Popper et al., 2007). The following studies support this:

- Przeslawski et al (2016b) found little evidence consistent with behavioural changes induced by a 2DMSS undertaken over part of the western Gippsland Basin in 2015. Gummy sharks were detected returning to the experimental zone during the period of seismic operations, and behaviour consistent with a possible response to the survey operations was restricted to flathead, which showed an increase in swimming speed during the survey period and change in diel movement patterns after the survey. The increased swimming speed may indicate a startle response, but if so, the range of movement was not sufficient to generate a significant difference in displacement (travel) across the monitored array.
- Streever et al (2016) indicates that it is possible that fish move away from seismic sources, thereby not being exposed to high levels of sound.
- Slotte et al (2004) examined potential effects on fish abundance to exposure to a seismic acoustic source array (source SPL of 222.6 dB re 1 µPa·m PK-PK) during a period of one month. The SPLs received by the fish were not measured. Acoustic surveys of the local distributions of various kinds of pelagic fish, including herring, blue whiting, and mesopelagic species, were conducted during the seismic surveys. There was no strong evidence of short-term horizontal distributional effects. With respect to vertical distribution, blue whiting and mesopelagics were distributed deeper (20 to 50 m) during the seismic survey compared to pre-exposure.

- Wardle et al (2001) used video and telemetry to make behavioural observations of marine fishes (primarily juvenile saithe, adult pollock, juvenile cod, and adult mackerel) inhabiting an inshore reef off Scotland before, during, and after exposure to discharges of a stationary acoustic source. The received SPLs ranged from about 195 to 218 dB re 1 µPa0-p. Pollock did not move away from the reef in response to the seismic acoustic source sound, and their diurnal rhythm did not appear to be affected. However, there was an indication of a slight effect on the long-term day-to-night movements of the pollock. Video camera observations indicated that fish exhibited startle responses ('C-starts') to all received levels. There were also indications of behavioural responses to visual stimuli. If the seismic source was visible to the fish, they fled from it. However, if the source was not visible to the fish, they often continued to move toward it.
- Trials of effects of nearby acoustic source operations on captive fish, undertaken by McCauley et al (2000) showed a generic fish 'alarm' response of swimming faster, swimming to the bottom, tightening school structure, or all three. From a review of trials and available published information, McCauley et al (2000) concluded the following effects on fish:
    - Demersal fish could be expected to begin to change their behaviour by increasing speed and swimming deeper in the water column;
    - As air gun level increases, fish would be expected to form compact schools probably near the bottom in continental shelf water depths (<200 m);
    - Eventually levels may be reached at which involuntarily startle responses occur in the form of the classic C-turn (involuntary flexing of the body and subsequent darting swim away from the source);
    - In deeper water (>200 m), any effects would be expected to lessen with increasing depth, as the acoustic source signal level dropped accordingly;
    - Startle responses may be generated by fish within 300 m and up to 2,000 m of an operating acoustic source array; and
    - Flight response could be expected up to several kilometres.
- The McCauley et al (2000) trials, as well as studies by Wardle et al (2001), Dalen et al (1996) and Gausland (2000), indicate the following:
- Fish generally show little evidence of increased stress from exposure to seismic signals unless restricted from moving away from the source; and
- Fish may become acclimatised to seismic signals over time.
- Prideaux (2017) notes that the behavioural response to an approaching noise source by pelagic fin-fish is that they tend to move downwards to eventually lie close to the seafloor or flee laterally, while site-attached fish may initially seek shelter in refuges or flee.
- Site-attached fish species that exhibit a high degree of site fidelity are more likely to be affected by MSS than larger more mobile roaming demersal species that have a greater ability to leave the affected area. Jones and McCormick (2002) report that coral reef fish frequently take refuge in the branches of corals or in holes in the reef matrix when showing a flight response. The impacts of seismic sound to such site-attached species can be broadly assessed using studies of reef fish, or studies where fish have been caged to prevent movement away from the sound source.
- Impacts to site-attached fish can be assessed through comparison with studies undertaken by Woodside at Scott Reef on tropical reef fish during the Maxima 3DMSS activities (Woodside, 2012a; b; c). The Scott Reef study identified the following impacts to site-attached reef fish:
    - No lethal or sub-lethal effects on fish were experienced. Behavioural responses were observed at close range with general movement from the water column to the seafloor, however normal feeding behaviour returned within 20 minutes of the survey vessel passing and when the vessel was beyond a distance of 1.5 km (Woodside, 2012a).
    - Fish exposed to acoustic pulses showed no structural abnormalities, tissue trauma or lesions, or auditory threshold changes (highest exposure level 190 dB re 1µPa2.s). However, a small number of

damaged hair cells (less than 1% of fish hearing capacity) were observed in fish exposed to acoustic noise (Woodside, 2012b).

- No significant decreases in the diversity and abundance of fish after the seismic survey were detected compared with the long-term temporal trend before the survey (Woodside, 2012c).
- The lack of significant impacts to fish species considered sensitive because of their site-fidelity requirements (i.e., being restricted to reef habitat and unable move far when the seismic sound approaches) indicates that pelagic fish able to swim away from disturbing noise are likely to be even less at risk of impacts from seismic sound.

In the proposed Sequoia survey area, there are few known habitats (e.g., reef) that would result in the presence of site-attached species (see Section 5.4.7).

As such, while lethal effects to fish from MSS have not been observed, sub-lethal effects have been reasonably well documented and the ecological effects of sub-lethal effects could expose some fish to increased mortality via increased predation through lowered fitness (Popper & Hastings, 2009) depending on the fishes' life history.

A summary of the potential impacts of low-frequency seismic sound on fish is presented in Figure 7.3.

Limited research has been conducted on responses from elasmobranchs (sharks and rays, including juveniles) to MSS (as highlighted in Figure 7.3). 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 acoustical pressure (Myrberg, 2001). Elasmobranchs sense sound via the inner ear and organs and as they lack a swim bladder it is thought that they are only capable of detecting the particle motion component of acoustic stimuli (Myrberg, 2001).

In addition to particle motion, elasmobranchs are also sensitive to low frequency sound between 40 and 800 Hz (Myrberg, 2001). This range overlaps with MSS sound frequencies. However, sharks do not appear to be attracted by continuous signals or higher frequency sounds that presumably they cannot hear (Popper & Løkkeborg, 2008). 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. 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. For the purposes of this EIA , sharks are included in the same group as fish without swim bladders and for the reasons outlined above, along with the fact that the Recovery Plan for the White Shark (DSEWPC, 2013b) does not list anthropogenic sound as a threat to this species.

Thresholds adopted for the STLM

Table 7.12 presents the exposure criteria for the different groups of fish, adapted from Popper et al (2014), and relative risk (high, moderate or low) to fish at three distances from the source (near (N), intermediate (I) and far (F)). In general, any adverse effects of seismic sound on fish behaviour depends on the species, the state of the individuals exposed, and other factors.

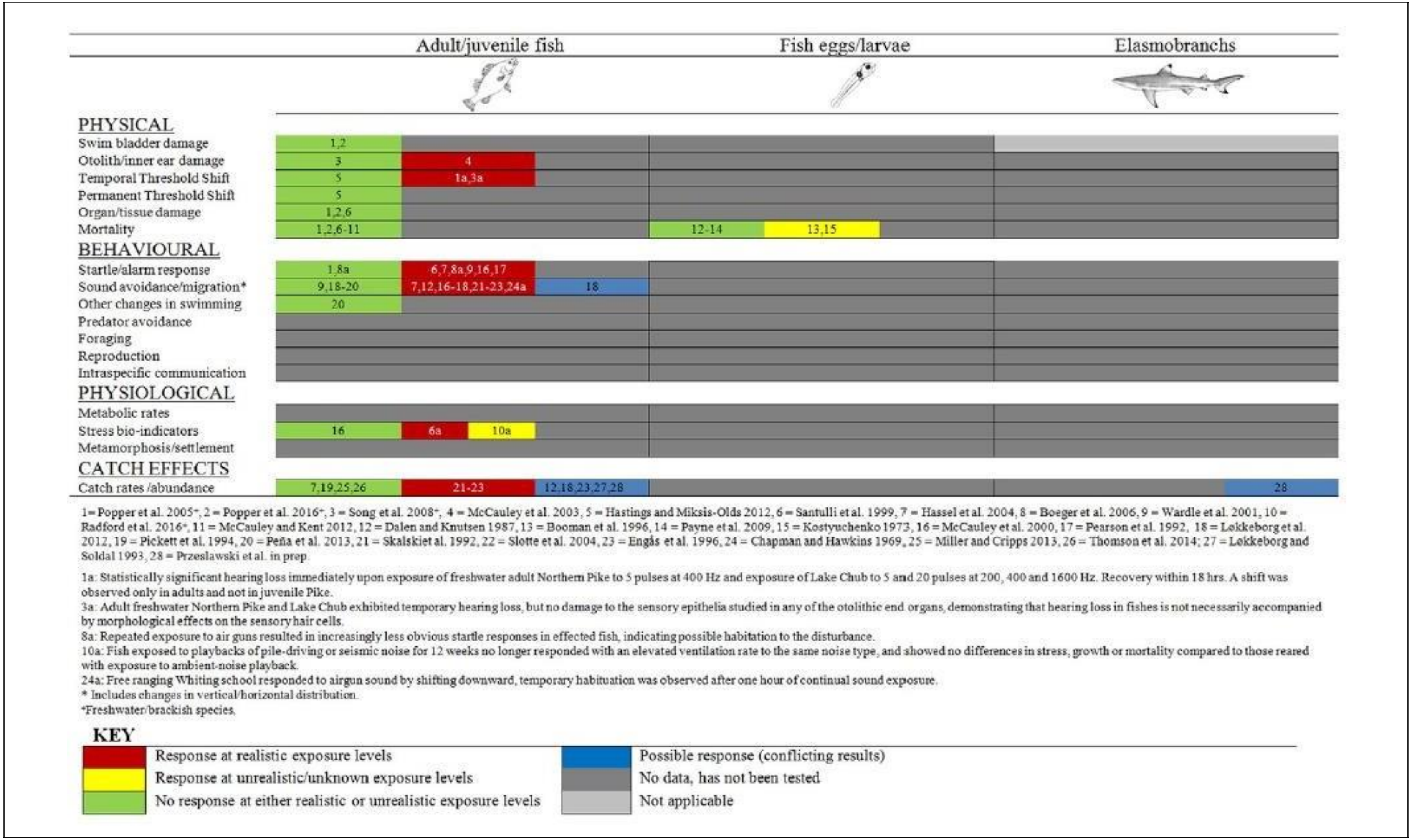
Table 7.12: Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts for fish

	Mortality/potential mortal injury		Recoverable injury		TTS	
	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs
Fish with no swim bladder (including sharks) (particle motion detection)						
Threshold value	213 dB PK	219 dB SEL_{24h}	213 dB PK	216 dB SEL_{24h}	No criteria	186 dB SEL_{24h}
Fish with swim bladder - not involved in hearing (particle motion detection)						
Threshold value	207 dB PK	210 dB SEL_{24h}	207 dB PK	203 dB SEL_{24h}	No criteria	186 dB SEL_{24h}
Threshold criteria	No studies to date have demonstrated direct mortality of adult fish in response to seismic acoustic source arrays, even at close proximity (within 1-7 m, DFO (2004), Boeger et al (2006), Popper et al (2014). Popper et al (2014) conclude that for fish, there are few data on the physical effects of seismic acoustic sources and of these, none have shown mortality. It is common industry practice to apply the Popper et al (2014) exposure guidelines for EIA.		The effects of change in pressure (barotrauma that results in tissue injury) can result in injury. Recoverable injuries include fin hematomas, capillary dilation and loss of sensory hair cells. Popper et al (2014) note that full recovery from these injuries is possible.		Sound exposure guidelines proposed in Popper et al (2014) indicate that TTS may occur at SEL_{24hr} levels >186 dB re 1 $uPa^{2}\cdot s$. The report summarises that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18-24 hours. Consequently, a 24-hour period is used to define cumulative impact for SEL, which is similar to that applied to mammals by Southall et al (2007) and NMFS (2016).	
Justification for threshold criteria	The Popper et al (2014) work is referenced for the adoption of threshold criteria because these thresholds were based on results of the Working Group on the Effects of Sound on Fish and Turtles (formed in 2006, which continued the work of a NOAA panel two years earlier). The American National Standards Institute (ANSI) accredited the report prepared by the working group, and it is therefore suitable for adoption elsewhere.					
Fish with swim bladder - involved in hearing (primarily pressure detection)						
Threshold value	207 dB PK	207 dB SEL_{24h}	207 dB PK	203 dB SEL_{24h}	No criteria	186 dB SEL_{24h}

Threshold criteria	The distance to sound levels associated with mortality and potential mortal injury to fish based on Popper et al (2014) using the SEL_{24hr} metric, are smaller than those estimated using the PK-based metric. Therefore, in line with the criteria in Popper et al (2014), the PK metric should be used to assess these impacts.	The distance to sound levels associated with recoverable injury on fish based on Popper et al (2014) using the SEL_{24hr} metric, are bigger than those estimated using the PK-based metric. Therefore, in line with the criteria in Popper et al (2014), the SEL_{24hr} metric should be used to assess these impacts.	There is no per pulse criteria for TTS, as such the SEL24hr metric is used to assess these impacts to fish. Modelled ranges to TTS are based on unweighted sound energy accumulated over 24 hours. However, fish lack the ability to detect many of the distant impulses that occur during this 24-hour period and so the ranges are likely to be conservative. The majority of sound energy contributing to potential TTS effects will be received when the survey vessel is at very close range to the fish (Popper, 2018).
Behaviour			
It is currently impossible to determine single value thresholds for the onset of behavioural reactions to fish. Popper et al (2014) propose broad response and effect categories. For all three groups of fish, the behavioural criteria are described as a quantitative relative risk per Popper et al (2014), as noted below			
Fish group	Near (tens of metres)	Intermediate (hundreds of metres)	Far (thousands of metres)
Fish with no swim bladder (including sharks)	High	Moderate	Low
Fish with swim bladder - not involved in hearing	High	Moderate	Low
Fish with swim bladder - involved in hearing	High	High	Moderate

* Note – given that the threshold criteria is a dual criteria (per pulse vs 24 hr), the largest distance resulting from either SEL or PK has been applied to this EIA

Figure 7.4: Summary of potential impacts of low-frequency seismic sound on marine fish



STLM Results

Table 7.13 presents the STLM results for the per-pulse effects criteria of sound levels associated with mortality and potential mortal injury for fish.

Table 7.13: Maximum horizontal distances from the source array to modelled maximum-over-depth (MOD) and seafloor peak pressure level thresholds (PK) from three single-impulse modelled sites for fish

	Mortality/potential mortal injury		Recoverable injury		TTS	
	Per pulse	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**
Group 1 - Fish with no swim bladder (including sharks)						
Threshold value	213 dB PK	219 dB SEL_{24h}	213 dB PK	216 dB SEL_{24h}	No criteria	186 dB SEL_{24h}
Site A (61 m) – seafloor only	80 m seafloor	Seafloor Scenario 1: Not reached Scenario 2: Not reached	As per mortality/ potential mortal injury	Seafloor Scenario 1: Not reached Scenario 2: Not reached	N/A	Seafloor Scenario 1: 2.36 km Scenario 2: 2.4 km
Site 1 (103 m) – seafloor only	81 m seafloor					
Site 2 (69 m) – seafloor only	77 m seafloor					
Site 3 (102 m) – water column	70 m MOD	MOD Scenario 1: 80 m Scenario 2: 80 m		MOD Scenario 1: 80 m Scenario 2: 80 m		MOD Scenario 1: 2.55 km Scenario 2: 2.52 km
Site 6 (798 m) – water column	60 m MOD					
Site 7 (606 m) – water column	60 m MOD					
Site 10 (106 m) – water column	60 m MOD					
Group II - Fish with swim bladder – not involved in hearing & Group III - Fish with swim bladder – involved in hearing						
Threshold value	207 dB PK	210 dB SEL_{24h}	207 dB PK	203 dB SEL_{24h}	No criteria	186 dB SEL_{24h}
Site A (61 m) – seafloor only	147 m seafloor	Seafloor Scenario 1: Not reached Scenario 2: Not reached	As per mortality/ potential mortal injury	Seafloor Scenario 1: Not reached Scenario 2: Not reached	N/A	Seafloor Scenario 1: 2.36 km Scenario 2: 2.4 km
Site 1 (103 m) – seafloor only	153 m seafloor					
Site 2 (69 m) – seafloor only	154 m seafloor					
Site 3 (102 m) – water column	170 m MOD	MOD Scenario 1: 80 m Scenario 2: 80 m		MOD Scenario 1: 90 m Scenario 2: 80 m		MOD Scenario 1: 2.55 km Scenario 2: 2.52 km
Site 6 (798 m) – water column	130 m MOD					
Site 7 (606 m) – water column	130 m MOD					
Site 10 (106 m) – water column	140 m MOD					

** Distances represent the perpendicular distance from the closest survey line to the relevant isopleth*

Table 7.14 indicates that the maximum distance to sound levels associated with mortality and potential mortal injury on fish using the per-pulse metric may occur up to:

- In the water column - a maximum distance of 60 m (for fish with no swim bladder) to 170 m (for fish with a swim bladder).
- At the seafloor – a maximum distance of 81 m (for fish with no swim bladder) to 154 m (for fish with a swim bladder).

Table 7.14 also indicates that using the multiple pulse metric (SEL24hr) (which assumes fish remain stationary for 24 hours):

- The distance to sound levels associated with mortality and potential mortal injury may occur up to a maximum distance of 80 m from the source array in the water column;
- Recoverable injury may occur up to a maximum distance of 80 m (for fish with no swim bladder) to 90 m (for fish with a swim bladder) from the source array in the water column; and
- TTS may occur up to a maximum distance of between 2.52 km and 2.55 km from the source array.

Impact Assessment

Impacts to fish as a result of the Sequoia 3DMSS will have a **negligible** consequence based on the following:

- The sound at any one location will be localised and temporary.
- The likelihood of fish experiencing TTS is low, as the accepted threshold assumes an individual fish remains within the range of the acoustic sources for a continuous 24-hour period. Fish will generally exhibit avoidance behaviour before this occurs and there are no site-attached species likely to be present.
- The survey will not result in permanent destruction or modification of marine habitat.
- There are no recorded seasonal aggregations of fin-fish or elasmobranchs in or around the survey area.
- Fish, including sharks, are omnipresent throughout the survey area and Bass Strait in general. Most fish present in the open ocean swim large distances, and any distance they swim to avoid the sound source is likely to be insignificant (in terms of energy expenditure) in the course of their normal movements.
    - Only the white shark has a BIA that is overlapped by the survey; the acquisition area represents 1.0% of the shark's 'known distribution' BIA (or 1.3% with the 2.55 km distance to TTS applied as a buffer around the acquisition area). The survey area does not overlap the white shark's foraging BIA (the nearest being 23 km to the east) or breeding BIA (the nearest being 260 km to the east).
- Mortality of fish (both immediate and delayed) is considered highly unlikely based on no documented cases of fish mortality upon exposure to seismic acoustic source sound under experimental or field operating conditions. Free-swimming fish can detect seismic sound and move away from it to avoid injury.
- Behavioural impacts are likely to be temporary and localised, with fish likely to return to pre-disturbance behaviour soon after the intensity of the sound source reduces (i.e., the vessel moves away). Many fish species move over large distances. Popper (2018) suggests that if the sound of a seismic source becomes too loud then the fish will move away from the source. If the fish moves away, the amount of energy to which it is exposed is likely to be one or a few seismic pulses, which would not be loud enough to result in any effect other than the behavioural response of avoidance (Popper, 2018).
- The bathymetry of the seafloor in the survey area indicates the absence of seafloor features such as rocky reefs or volcanic mounts, meaning there are unlikely to be fish species with restricted ranges due to their habitat preferences. As such, temporary displacement of site-attached species or those with an affinity for a particular habitat (such as rocky reefs) are highly unlikely.
- The short distances from the sound source associated with injury and mortality of fish are unlikely to affect predator-prey dynamic (for fish-feeding species such as seals, dolphins, whales, penguins and other seabirds), due to the vast expanse of similar habitat and prey available in the region. Like the fish,

their predators are also likely to exhibit avoidance behaviour around the seismic source. This means that both fish and their predators are not likely to be present around the operating seismic source, resulting in no net loss of feeding opportunities.

- The potential impacts of the survey to the threatened fish species listed and described in Section 5.5.4 are either unlikely to occur (because of habitat preferences) or likely to be minor (as outlined in Table 7.14).

Table 7.14: Potential impacts to threatened fish species from seismic sound

Species/group	Potential impacts
Freshwater	Generally live too close to the shoreline and only for a very limited time of the year (for spawning) to be impacted by seismic sound generated in central Bass Strait.
Pipefish, seahorses and seadragons	Generally live in reef or seagrass habitats in shallow waters close to the shore, or among rafts of seaweed in the open ocean. These rafts of seaweed are generally close to the sea surface, outside of area of sound exposure (beneath the acoustic sources). In general, their shallow water habitat means they are located too far from the survey area to be impacted by seismic sound.
Oceanic	
Elasmobranchs	
Great white shark	As previously noted, shark species generally do not possess a swim bladder and are therefore less prone to the effects of seismic sound. In and around the survey area, these species are transitory as they move between foraging grounds (such as seal colonies near islands) and breeding grounds. The survey area does not represent key habitat or provide geographically limited habitat for any of these species. Sharks generally have wide ranging habitats and are known to avoid sudden sound increases. The conservation advice or management plans for these species do not list sound as a threatening process and there are no management actions relating to underwater sound from seismic surveys. These factors combined mean that the Sequoia 3DMSS is not inconsistent with these management plans.
Grey nurse shark (east coast population)	
Shortfin mako shark	
Porbeagle shark	
School shark	
Scalloped hammerhead	
Whale shark	
Fin-fish	
Black rockcod	This species inhabits caves, gutters and crevices generally to depths of 50 m. These water depths are shallower than those of the survey area. The black rockcod is present only in the outer parts of the hydrocarbon spill EMBA and thus will not be affected by seismic sound.
Spotted handfish	This species inhabits waters to depths of 60 m, but generally in waters only up to 10 m deep and is known only from sites in the Derwent Estuary (northern Tasmania). These water depths are shallower than those of the survey area. As such, this species is unlikely to occur in the survey area and therefore not be impacted by the seismic sound. Underwater sound is not listed as a threat in this species approved conservation advice.

Ziebell's handfish	This species is known only from eastern and southern Tasmania, in the outer parts of the spill EMBA. As such, this species is unlikely to be impacted by the seismic sound.
Harrison's dogfish	This species is known only from the eastern parts of the spill EMBA. As such, this species is unlikely to be impacted by the seismic sound.
Southern dogfish	This species is not recorded in the survey area (records are for the spill EMBA), though its habitat preferences mean it may occur in the area. This is a highly mobile species that is likely to respond to seismic sound through a startle/alarm response.
Orange roughy	This is a highly mobile species that is likely to respond to seismic sound through a startle/alarm response.
Blue warehou	This is a highly mobile species that is likely to respond to seismic sound through a startle/alarm response.
Southern bluefin tuna	This is a highly mobile species that is likely to respond to seismic sound through a startle/alarm response. The timing of their breeding in the northern Indian Ocean from October to March means they are unlikely to be present in or around the survey area from August to October, and thus not impacted by the seismic sound.

Impacts to commercial fin-fish fisheries as a result of the survey will have a **negligible** consequence because:

- SESS (Gillnet, Hook and Trap sector) -
  - Shark biology, specifically the absence of a swim bladder, makes them less susceptible to underwater sound than fish species with a swim bladder.
  - Other fin-fish caught in this fishery are likely to exhibit behavioural responses such as startle/alarm, but not move away from the area. As such, the abundance of target fish is not likely to significantly change post-survey compared to pre-survey.
  - The acquisition area overlaps 0.21% of the fishery, and catch from the proposed operational area
  - represents ~1% of the fishery's annual catch (averaged over the last ten years).
  - Applying a 2.55 km buffer around the acquisition area to represent the largest TTS SEL24hr value results in 0.27% of the fishery being affected. Applying a 170 m buffer around the acquisition area to represent the largest distance to mortality/potential mortality in the water column results in 0.21% of the fishery being affected.
  - The short distances to effect, the short duration of the survey, the very small area of the fishery affected and the low susceptibility of sharks to seismic sound make it unlikely that there will be loss of catch as a result of the Sequoia 3DMSS.
- SESS (Commonwealth Trawl Sector, otterboard trawl) –
  - Shark biology, specifically the absence of a swim bladder, makes them less susceptible to underwater sound than fish species with a swim bladder.
  - The acquisition area overlaps 0.26% of the fishery, and catch from the proposed operational area represents ~1% of the fishery's annual catch (averaged over the last ten years).
  - Applying a 2.55 km buffer around the acquisition area to represent the largest TTS SEL24hr value results in 0.32% of the fishery being affected. Applying a 170 m buffer around the acquisition area to represent the largest distance to mortality/potential mortality in the water column results in 0.26% of the fishery being affected.

- The short distances to effect, the short duration of the survey, the very small area of the fishery affected and the low susceptibility of fin-fish to seismic sound make it unlikely that there will be loss of catch as a result of the survey.

Demonstration of Acceptability

In accordance with Section 4 of NOPSEMA's EP decision making Guideline (GL1721, Rev 6, November 2019) and the methodology outlined in Chapter 6, Table 7.15 presents a demonstration of acceptability.

Table 7.15: Demonstration of acceptability for potential impacts to fish

<table>
<tr><td>Statement of acceptability</td><td colspan="2">• There is no long-term reduction of fish diversity and abundance in the survey area.
• The survey is not inconsistent with the management actions of threatened fish species management plans/conservation advice.
• Commercial fisheries operators are no worse off financially as a result of the survey.</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>ConocoPhillips' HSE Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>HSEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the HSEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.</td></tr>
<tr><td>External context (stakeholder engagement)</td><td colspan="2">ConocoPhillips Australia has undertaken open and transparent communications with all relevant persons, and actively involved those known to have concerns with MSS, such as commercial fisheries associations.
Relevance to fish: The ASBTIA raised concerns about the impacts of MSS on southern bluefin tuna. ConocoPhillips Australia responded in detail, noting that fishing effort for southern bluefin tuna does not extend into the proposed Sequoia survey area.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound to fish align with the requirements of:
• EPBC Act 1999 (Cth).
  • EPBC Policy Statement 1.1 (Significance Guidelines).
  • EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales).
• OPGGS Act 2006 (Cth).
  • Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seafloor (and other matters)…to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.
Relevance to fish: Implementation of soft-starts in accordance with the EPBC Policy Statement 2.1 will provide fish with the opportunity to move away from the sound source before it reaches levels that cause TTS.</td></tr>
<tr><td>Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice (listed in order of most to least recent) demonstrates that BPEM is being implemented.</td></tr>
</table>

	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include: • Considering sensitive locations and times of year for critical activities of species that are present. • Using an MMO. • Using soft-start procedures. • **Relevance to fish:** no specific application
	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)	This document provides guidelines regarding: • An exclusion zone for monitoring (500-m horizontal distance). • Pre-start observations in the exclusion zone (for at least 30 minutes). • Soft-start procedure. • Monitoring during periods of poor visibility and darkness. • Use of a passive acoustic monitoring (PAM) system. • Recording all monitoring data. With the exception of PAM systems, the EPS developed for this activity meets the requirements of this guideline (and is generally exceeded by meeting the more stringent requirements of the EPBC Act Policy Statement 2.1). **Relevance to fish:** no application.
	Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities (Prideaux, 2017)	This document was developed to present the BPEM for marine noise-generating activities, including MSS. It includes 12 modules covering various species groups and what should be taken into consideration when undertaking EIA. **Relevance to fish:** Section B.10 of the guideline specifically discusses fin-fish and Section B.11 discusses elasmobranchs. The EIA assessment criteria listed in Section B.10.4 and B.11.4 have been considered in this EP.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The EPS developed for this activity and in the design of the survey in general take into account the four practices outlined in this guideline (see Section 3.7.4). **Relevance to fish:** no specific application.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group,	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Noise (item 74). The preparation of this EP meets the objectives of these guidelines because sensitive areas for marine life are identified, the survey is planned to

	2015)	avoid sensitive times of the year and soft-start and stop procedures are in place for marine mammals sighted within 500 m of the sound source. **Relevance to fish:** no specific application.
	Environmental Manual for Worldwide Geophysical	The EPS developed for this activity meet the requirements of these guidelines with regard to:
	Operations (IAGC, 2013)	• Section 8.2 (Planning and permitting) – consideration of fish spawning times. • Section 8.7 (Aquatic life) – soft-start procedures, use of MMOs, cetacean sighting and reporting. • Appendix 1 (Recommended mitigation measures for cetaceans during geophysical operations) – use of exclusion zone for monitoring and soft-start procedure. **Relevance to fish:** no specific application.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008)	The EPS developed for this activity meet the requirements of this policy statement through the adoption of: • Part A (standard management procedures) • Part B (the use of MMOs). **Relevance to fish:** no specific application, however, implementing soft-starts will provide fish with the opportunity to move away from the sound source before it reaches levels that cause TTS.
	Code of Environmental Practice (APPEA, 2008)	The EPS developed for this activity meet the requirements of this guideline with regard to geophysical surveys: • To reduce the impact on cetaceans and other marine life to ALARP and to an acceptable level. • To reduce the impacts to benthic communities to ALARP and to an acceptable level. **Relevance to fish:** no specific application, considered part of marine life in general.
Environmental context	MNES	
	AMPs (Section 5.1.1)	There is a 444 km^2 overlap between the acquisition area and the Zeehan AMP (a 2.2% overlap). The acquisition and operational area avoids overlap with the Apollo AMP. Appendix 1 provides an assessment of the potential impacts of the activity on the management aims of the South-East Commonwealth Marine Reserves Network Management Plan 2013-23, which encapsulates the Zeehan AMP. MSS is permitted within the Multiple Use Zone of the Zeehan AMP. **Relevance to fish:** no specific application. Fin-fish are not

		listed as a conservation value of the Zeehan AMP.
	Wetlands of international importance (Section 5.1.4)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest Ramsar wetlands. **Relevance to fish:** no specific application. Fish in these wetlands will not be affected by the seismic sound.
	TECs (Section 5.1.6)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest TECs. **Relevance to fish:** no specific application. Fish in these TECs will not be affected by the seismic sound
	KEFs (Section 5.1.7)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest KEFs. Relevance to fish: no specific application. Fish in these KEFs will not be affected by the seismic sound
	NIWs (Section 5.1.8)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest NIWs. **Relevance to fish:** no specific application. Fish in these NIWs will not be affected by the seismic sound
	Nationally threatened and migratory species (Section 5.5)	Table 7.14 addresses the potential impacts to threatened fish species that may occur in the survey area. The MSS will not have a 'significant' impact on threatened fish species when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), which are: • Lead to a long-term decrease in the size of a population – No. • Reduce the area of occupancy of the species – No. • Fragment an existing population into two or more populations – No. • Adversely affect habitat critical to the survival of a species – No. • Disrupt the breeding cycle of a population – No. • Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline – No. • Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat – No. • Introduce disease that may cause the species to decline – No. Interfere with the recovery of the species - No.

	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 & 5.1.11)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines. **Relevance to fish:** no specific application. Fish in these marine parks will not be affected by the seismic sound
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Appendix 2 provides an assessment of the potential impacts of the survey on the management aims of threatened species plans. Table 7.14 lists the threatened fish species known or likely to occur within the survey area (and spill EMBA, which accounts for the underwater sound EMBA), and notes that the survey is not inconsistent with the management aims outlined in those plans and that seismic sound is not listed as a threatening process.
ESD principles	The application of the ESD principles to **fish** are outlined here.	
	A. Decision-making processes should effectively integrate both long-term and short- term economic, environmental, social and equitable considerations.	The timing of the activity has been selected to balance the requirements between spawning times of commercially important fish species, whale migration times and sea state considerations (see Figure 2.4).
	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.	The scientific literature cited throughout this section indicates mortality of fish is likely only within several metres of the sound source. Fish will detect the sound and move away before effects such as TTS and PTS are likely.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future	Impacts to fish are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value and fish stocks for commercial fishing.

	generations.	
	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	Impacts to fish are assessed to be localised and temporary. There will not be a loss of fish species diversity and abundance, with fish returning to the survey area soon after the sound moves away.
	E. Improved valuation, pricing and incentive mechanismsshould be promoted.	Not relevant.

Impacts to Marine Invertebrates – Molluscs, Sponges and Corals

This section presents the most recent research regarding the impacts of seismic sound on molluscs, sponges and corals. Molluscs are distinguished by three features, these being the presence of a mantle (a cavity used for breathing and excretion), a radula (a 'rasping' tongue, except for bivalves) and the structure of the nervous system. Molluscs include scallops, abalone, oysters, clams, mussels, limpets, squids, octopus and cuttlefish.

Molluscs recorded in the survey area include the giant squid, Gould's squid and pale octopus (see Section 5.5.5 and Appendix 12). Commercial scallops (Pecten fumatus) may also be present in the survey area, but are not commercially fished in this area.

Marine invertebrates also include sponges and corals (and crustaceans, discussed in the subsequent section). The STLM report notes that the PK sound level at the seafloor directly underneath the seismic source was estimated at all modelled sites and compared to the no effect sound level of 226 dB re 1 uPa PK for sponges and corals from Heyward et al (2018); this threshold was reached at 4 m from a single modelled site.

Sensitivity to Sound

The potential impacts of seismic sound on molluscs has not been well studied until very recently.

Prideaux (2017) notes that very little is known about the effects of anthropogenic noise on marine invertebrates, despite their ecological and economic importance. Invertebrates detect sound by sensing either the 'particle motion' (Przeslawski et al., 2016a;b; Carroll et al., 2017), through other external and

internal physiological structures such as hairs, statocysts and muscles; or 'pressure' component (or both) of a sound field in the marine environment. Invertebrate statocysts are the mechanosensory organ equivalent to the inner ear of humans and are responsible for the detection of gravity, position and movement (Day et al., 2020). Because they lack gas-filled bladders, marine invertebrates are unable to detect the pressure changes associated with sound waves (Carroll et al., 2017; Parry & Gason, 2006). Similarly, Prideaux (2017) notes that marine invertebrates are sensitive to the particle motion component of sound more so than the pressure wave, meaning they are well suited to detecting the low frequency vibrations, which they use to identify predators and prey.

However, all cephalopods (as well as some bivalves, echinoderms and crustaceans) have a sac-like structure called a statocyst, which includes a mineralised mass (statolith) and associated sensory hairs (Carroll et al., 2017). Cephalopods have epidermal hair cells that help them to detect particle motion in their immediate vicinity (Kaifu et al., 2008). Decapods have similar sensory setae on their body (Popper et al., 2001) and antennae that may be used to detect low-frequency vibrations (Montgomery et al., 2006).

The statocyst organs, found in a wide range of invertebrates, are utilised by animals to maintain their equilibrium and orientation and to direct their movements through the water. Their functions include the detection of gravitational forces and linear accelerations. Although there is little information available on the functioning of these sensory organs, it has been suggested that marine invertebrates are sensitive to low-frequency sounds and that this sensitivity is not directly linked to sound pressure but to particle motion detection (André et al., 2016; Edmonds et al., 2016; Robert & Breithaupt, 2016). The statocysts may play a key role in controlling the behaviour responses of invertebrates to a wide range of stimuli.

There has recently been a number of comprehensive reviews of seismic noise impacts to invertebrates (de Soto, 2016; Carroll et al., 2017; Edmonds et al., 2016), and reviews that have focused generally on behavioural impacts (e.g., Tidau & Briffa, 2016).

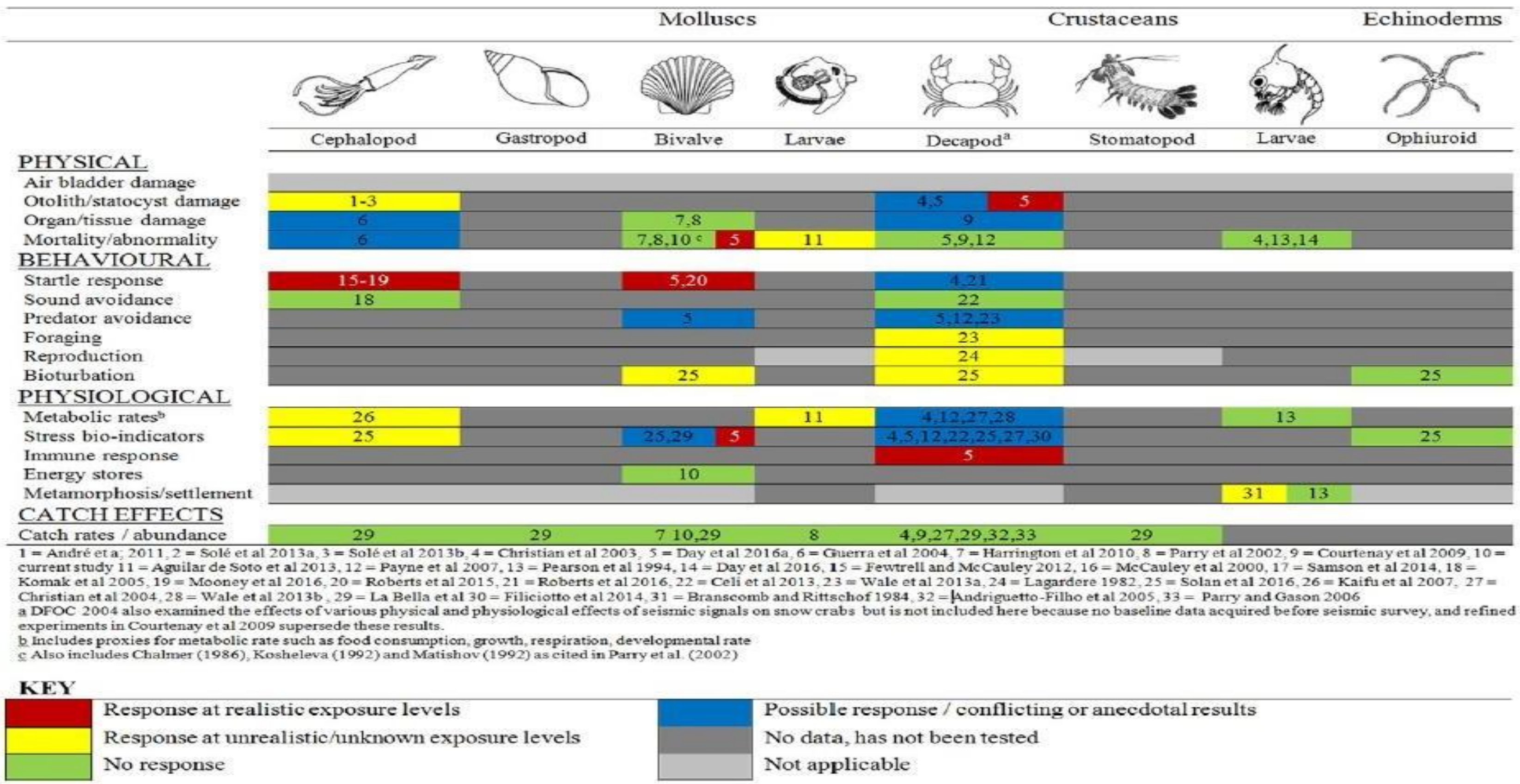
Larval stages are often considered more sensitive to stressors than adult stages, but exposure to seismic sound reveals no differences in larval mortality or abundance for fish (Popper et al., 2014), crabs (Pearson et al., 1994) or scallops (Carroll et al., 2017).

Some impacts have been observed within a few metres of acoustic sources for some species (see 'plankton' earlier), and some stages have been shown not to be impacted (Day et al., 2016). Impacts to larvae have been identified at intense and lengthy periods of exposure to low-frequency sound. Tank experiments by Aguilar de Soto et al (2013) showed evidence of morphological abnormalities in early stage scallop larvae from simulated acoustic source signals. The lengthy exposure period of 3 second shot intervals for an exposure duration of 90 hours, 1 m distance from sound source is not realistic in an actual survey. Again, the exposure period of a consistent peak sound level is not a realistic representation of an actual seismic survey. Acoustic studies conducted in laboratory tanks are difficult to interpret, as the sound field is often very distorted (Parvulescu, 1967; Rogers et al., 2016).

There is, however, no evidence of population level impacts on invertebrates from seismic sound. 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 persistence 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 (2016a) and Przeslawski et al (2016b). Przeslawski et al (2016b) 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.

A summary of the potential impacts of low-frequency sound on various responses of marine invertebrates is presented in Figure 7.5 (from Carroll et al., 2017).

Figure 7.5: A summary of the potential impacts of low-frequency sound on various responses of marine invertebrates



Impacts are classified according to the sound exposure treatments as:

- Realistic (i.e., short bursts of low frequency sound at a distance of <1–2 m); or
- Unknown/unrealistic (i.e., long duration and/or short distance of <2 m to sound source, nearfield sound exposure in aquaria).

There are significant differences between seismic studies regarding sound exposure and the environment in which studies were conducted.

Source: Carroll et al (2017

Sensitivity to Sound – Cephalopod-specific

Cephalopods are capable of 'hearing' seismic surveys (Samson et al., 2016). Mooney et al (2012) notes that early anecdotal reports suggested that cephalopods might detect sounds because squid were attracted to 600 Hz tones and cuttlefish (Sepia officinalis) elicited startle responses to 180 Hz stimuli. It was thought that squid might be debilitated by the acoustic intensity of foraging odontocete (toothed whale and dolphin) echolocation clicks, though subsequent laboratory experiments demonstrated that squid do not exhibit anti-predator responses in the presence of odontocete echolocation clicks, indicating that they cannot detect the ultrasonic pressure component of a sound field.

Squid are not known to utilise sound for communication, with their primary communication system considered to be visually based. In situ exposure of caged squid (Sepioteuthis australis) to impulsive noise from air guns induced behavioural alarm responses such as jetting (Fewtrell & McCauley, 2012). Though results from this small handful of studies suggest adverse effects, noise sources and cephalopod species are diverse, and little is known regarding how longfin squid (Doryteuthis pealeii) or other cephalopod species may behaviourally respond to anthropogenic noise.

A range of cephalopod responses to seismic sound has been observed, including escape and startle type behaviour in relation to loud low frequency sounds (McMauley et al., 2000b, Fewtrell & McCauley, 2012; Samson et al., 2016). Octopus however have shown only changes in respiratory rates during exposures to low frequency sound (Kaifu et al., 2008).

Anatomically, squid have complex statocysts that are considered to serve primarily as vestibular and acceleration detectors (Mooney et al., 2012). Behavioural experiments confirmed that squid (Loligo vulgaris), octopus (Octopus vulgaris), and S. officinalis can detect acceleration stimuli from 1 to 100 Hz, presumably by using the statocyst organ as an accelerometer and that they can detect the low-frequency particle-motion component of a sound field (Mooney et al., 2012). Squid appear to only sense acoustic particle motion (the back-and-forth vibratory component of sound), with particle acceleration likely being the most relevant metric (Jones et al., 2020). Cephalopods detect particle acceleration via paired statocyst organs in the head, which contain a calcium-carbonate 'statolith' sensitive to linear acceleration. The ecological functions of squid and other cephalopods' hearing abilities are unknown. It is thought that cephalopods may utilise sound to assess the 'auditory scene' of their natural environment, orienting to and extracting information from their environment by segregating discrete components of natural soundscapes, which is thought to be a basal function of hearing. Squid may also utilise sound to detect the presence of nearby predators, especially when vision is impeded (Jones et al., 2020).

Any impacts of aquatic noise on cephalopods have yet to be established and are poorly understood. Ambient and anthropogenic ocean noise are substantial at lower frequencies where squid are sensitive, suggesting that they will be susceptible to masking or other physiological or behavioural impacts of anthropogenic noise, such as MSS. Statocyst or lateral line hair cells could be impacted by sound energy (either long duration or brief, high-intensity noise). Hair cell damage and related temporary hearing loss has been demonstrated in fish, so it follows that this could also be the case for squid given they have a lateral line analogue. However, cephalopods that are very mobile and have the ability to move away from areas where sound levels might have the capacity to cause physiological damage.

Sensitivity to Sound – Scallop-specific

Several international studies have been conducted into the effects of MSS on scallops. However, the applicability of these laboratory assessments to in situ seismic surveying is unclear, due in part to the exposure regime. Acoustic studies conducted in laboratory tanks are difficult to interpret, as the sound field is often very distorted (Parvulescu, 1967; Rogers et al., 2016; Slabbekoorn, 2016).

The most recent Australian studies (summarised in the following pages) have focussed on the molluscs of key commercial fishing value, the Bass Strait commercial scallop (Pecten fumatus). This has included studies conducted by Parry et al (2002), Harrington et al (2010), Day et al (2016a;b) and Przeslawski et al (2016a), and the summary of Przeslawski et al (2016a) in Przeslawski et al (2016b). The Parry et al (2002) and Harrington et al (2010) studies had experimental design issues (Carroll et al., 2017) that complicates the comparison of results, however they were opportunistic and still contribute useful information. Parry et al (2002) is not considered as relevant as the scallops were suspended in nets during exposure, and as such, were not subject to the ground-borne vibrations they would experience if in their natural habitat (i.e., partially buried in sandy sediments).

The Australian research is summarised below.

TAFI 2010 Bass Strait study

The Tasmanian Aquaculture and Fisheries Institute (TAFI) was commissioned by AFMA (as reported in Harrington et al., 2010) to undertake a before-after-control-impact (BACI) in situ survey to determine if short-term impacts of a MSS on adult scallops in eastern Bass Strait (north of Flinders Island) could be detected. The 2DMSS was run for the Geological Survey of Victoria between February and April 2010, using a single acoustic source array with a volume of 4,130 cui and operating pressure of 2,000 psi. Part of the survey was conducted over a known commercial scallop bed. Scallop dredging was undertaken about 6 weeks prior to the MSS and 8 weeks after the conclusion of the MSS. Scallops were collected by means of dredging in order to assess the abundance of live and dead scallops within the impacted and control sites.

Animals collected in the surveys were separated into one of four shell categories;

- Live scallops;
- Clappers (very new dead scallops with two shell halves still joined together);
- New dead shells; and
- Old dead shells.

Sub-lethal impacts were investigated by examining changes in roe and meat condition within each of the areas sampled. The results of this study were:

- Live scallops were the most abundant shell category identified in all sample locations during both the before and after surveys.
- There were no statistical differences in live scallop abundances in any of the stratum before and after seismic surveying, as would have been expected if MSS had a lethal effect on scallop survivorship.
- The length frequency distribution of all shell categories remained unchanged within the impacted and semi-impacted survey stratum after seismic surveying
- Greater than 90% of scallops caught from all survey strata during both surveys were classified as normal meats.

The study concluded that there was no evidence of a short-term (<2 months) impact on the survival or health of adult commercial scallops in this fishery. The report also concludes that there were no statistical differences in live scallop abundances in any of the stratum before and after seismic surveying (as would have been expected if seismic surveying had a lethal effect on scallop survivorship) and there was no apparent increase in dead shell categories before and after seismic surveying (Harrington et al., 2010).

GA-FRDC 2015 Bass Strait study

The Geoscience Australia (GA)-Fisheries Research Development Corporation (FRDC) study detailed in Przeslawski et al (2016a;b) (noting that Przeslawski et al (2016b) supersedes Przeslawski et al (2016a)), focused on potential short-term impacts of MSS on scallops in the Gippsland Basin. This study was carried out by GA in collaboration with the Australian Maritime College in response to concerns from the fishing industry about an April 2015 MSS in the Gippsland Basin. The study aimed to acquire baseline data that might be useful in quantifying the potential impacts of seismic operations on marine organisms and their habitats. From March to June 2015, the 2DMSS took place (2,530 cui source array, pressure of 2,000 psi), and in conjunction several field experiments were conducted to investigate the potential impacts of acoustic source operations on scallops and other marine invertebrates in the Gippsland Basin. The experimental components included:

- Sound monitoring with moored hydrophones – four stations;
- Sound modelling using both field-based and theoretical approaches;
- Seafloor image analysis from autonomous underwater vehicle (AUVs); and
- Analysis of scallops collected from dredging.

Each component incorporated control (> 10 km from seismic survey) and experimental (0–1 km from seismic survey) zones, and data was acquired both before and two months after the seismic survey where possible. Two methods were used to assess scallop condition in response to the seismic survey; dredging (using a commercial box dredge) and the use of AUV to quantify scallop condition in situ.

All live scallops were photographed to quantify size, and at least ten ten animals (if available) from each dredge were opened and photographed to examine various metrics of scallop condition. Samples were frozen for analysis of fatty acids and sterols to identify potential depletion of energy reserves due to excessive summing activity in response to the seismic source. The AUV imagery showed:

- There was no interaction between zones (experimental, control) and time (short-term, long-term) on commercial scallop types (live, clapper, dead shell, unknown), indicating that no long-term effects attributable to the MSS were detected on commercial scallops. It is noted though that short-term or moderate effects could not be tested due to the lack of AUV data before the MSS.
- There were negligible dead doughboy scallops (clappers and shells) detected in the experimental zone during short- or long-term survey, indicating an absence of adverse impacts of the MSS.
- The dredging results indicated that:
  - The abundance of live scallops and recently dead scallop shells were not significantly different among zone or time.
  - There was no effect of zone or time on commercial scallop shell assemblages, nor any interactions.
  - There was no detectable impact due to the MSS on commercial scallop shell size (growth), adductor muscle diameter, gonad size or gonad stage.
  - There was a significant effect of zone, with scallops in the control zone showing smaller shells, adductor muscles and gonads than in the experimental zone. This relationship existed before and after the survey.
  - Commercial scallops showed no differences in fatty acids, sterols or the ratio of fatty acids to sterols among zone or time.
  - There is no clear evidence of adverse effects on scallops due to this survey, although in the study area assessed, commercial scallops (P. fumatus) were present but not abundant.
- There were no detectable impacts of the MSS on the abundance of live scallops, catch of live or dead scallops or gonad condition.

Table 7.16 taken from Przeslawski et al., 2016b) summarises the studies and results of the investigations into the impacts of MSS on scallops, while this section provides a more in-depth discussion of the findings from these recent studies.

Due to the high variance among sites, small or sub-lethal changes resulting from acoustic exposure may have been obscured, but it was argued that detection of large effects such as mass mortalities would have been detected. They recommended that future studies should focus efforts on the long-term or physiological effects of MSS on scallops and other invertebrates, rather than short-term gross effects such as mortality.

Sound monitoring for the experiment only involved sound pressure measurements and were limited to a maximum recording amplitude of 165 dB re 1 µPa. Recordings were chosen to avoid clipping and the highest reported SEL recorded by the hydrophones was 146 dB re 1 µPa2.s at 51 m water depth, at a distance of 1.4 km from the acoustic sources. Received sound exposure levels were used to calculate particle velocity at various frequencies assuming planar wave propagation. The highest predicted particle velocity at the seafloor at 100 m range was 171 dB re 1 nms-1 (354 mms-1) in the third-octave-band centred at 40 Hz.

UTAS-FRDC 2014 Tasmanian study

In the University of Tasmania (UTAS)-FRDC field experimental (manipulative) study reported by Day et al (2016a), sample populations of scallops (20 individuals in each cohort) were exposed to the same seismic source parameters and similar exposure conditions during 2013, 2014 and 2015.

The research program involved exposure of cohorts of scallops to multiple seismic acoustic source pulses in sandy substrate in 10-12 m water depths off the coast of Tasmania. The exposed scallops and control lobsters (no exposure) were examined during subsequent analyses undertaken at 0, 14, and 120 days post-exposure. Exposure experiments were undertaken in:

- July 2013 (45 cui acoustic source, 2,000 psi);
- July 2014 (150 cui acoustic source, 1,300 psi and 2,000 psi); and
- February 2015 (150 cui acoustic source, 2,000 psi).

The acoustic source was towed at approximately 5 m depth from a distance of 1 km away from the scallop enclosure and at a speed of approximately 3-4 nm per hour (approximately 5.5-7.4 km/hr) and the shot interval was 11.6 seconds. The maximum calculated exposures were 212 dB re 1 µPa PK-PK, a per-pulse SEL of 190 dB re 1 µPa2.s, an accumulated SEL of 199 dB re 1 µPa2.s and maximum peak magnitude of ground acceleration of 68 ms-2. However, this was likely an outlier.

Captive scallops were subject to multiple passes from the MSS source at close range; zero passes (control specimens), one, two and four passes. A summary of the results and conclusions for the commercial scallop is as follows:

- Exposures did not result in immediate mass mortalities, and overall mortality rates in all three experiments were at the low end of the range of naturally occurring mortality rates in the wild (documented as ranging between 11-51%, with a 6-year mean of 38%). Gwyther and McShane (1988) recorded natural mortality rates in scallops in Port Phillip Bay of up to 40%.
- Repeated exposures resulted in increased mortality rates with time post-exposure when compared with control specimens.
- After 120 days, the following mortalities were recorded for the 0-pass, 1-pass, 2-pass and 4-pass treatments:
- 2013 experiment - mortalities of 3.8%, 8.9%, 10.3% and 13.3% were recorded.
- 2014 experiment - mortalities of 3.6%, 11.3%, 16% and 17.5% were recorded.
- 2015 experiment - complete mortality of all control and exposed scallops occurred by day 120.
- Most mortalities were recorded 120 days following multiple passes of the seismic source, indicating that exposures may have a chronic effect on scallops.
- Haemolymph biochemistry was also impacted up to 120 days post-exposure.
- Scallop behaviour was altered by exposure to air gun signals, with a decrease in classic behaviours (positioning, mantle irrigation and swimming) and increase in novel behaviours. Exposure did not elicit energetically expensive behaviours such as swimming or extensive valve closure.
- Scallop reflexes were affected, with exposure resulting in faster recessing in sediments and some specimens in one experiment showing a possible reduced ability to right itself following exposure.

- Additional measurements were made measuring adductor muscle mass; shell length, width and height; and whole animal mass, wet tissue mass and shell mass. None of these measurements showed any statistical difference between control and exposure level.

The results indicate that exposure to seismic acoustic source impulses may result in the mortality of some scallops as well as some impaired reflexes and immunity response if the seismic source passes in close proximity or directly overhead. Day et al (2016a) also indicated that exposure, particularly repeated exposure, did result in significantly increased mortality compared to unexposed controls.

The authors of Day et al (2016a) rejected the hypothesis that 'exposure to seismic acoustic sources causes immediate mass mortality, defined as an increase in mortality rate of sufficient proportion to affect population size significantly'.

The experimental mortality rates at 120 days' post-seismic acoustic source exposure were between 9.4% and 20%. These are towards the low end of what might be expected from natural mortality rates (Day et al., 2016a). Even the highest levels of mortality recorded, 17.5% and 20% suffered by 4-pass treatments from the 2014 and 2015 experiments, were assessed by the authors to be modest compared to naturally occurring mortality rates in scallops (Day et al., 2016a).

Thresholds for STLM

The Day et al (2016a) study is one of the first to report persistent physiological effects and increased mortality for benthic invertebrates from exposure to an acoustic source. However, the science around which metrics relate to a potential effect, and the relationship therefore to impact, is an area needing further research. Prideaux (2017) states that there are no dose-response curves identifying levels of impact onset to marine invertebrates, so there are no data about thresholds of pressure or particle motion initiating noise impacts.

NOPSEMA has publicly stated that the seafloor levels derived from Day et al (2016a) should be used to assist in the assessment of potential impacts on scallops in the absence of definitive established thresholds.

It is not clear from the Day et al (2016a) experiment whether the effects observed resulted from the particle motion to which the animals were exposed, or whether it was exposure to sound pressure that resulted in the effects. This complicates the analysis in terms of presenting a metric for application in an impact assessment.

Additionally, cumulative metrics like the SEL used in many studies must be treated with caution, particularly when considering more than one pulse. During a real MSS there may be short periods of high sound exposure interspersed with longer periods of much reduced exposure. Attempts to estimate an average exposure level may result in false conclusions about the effects of sound exposure. Recent studies have provided quantitative data to define the levels of impulsive sound that result in the onset of physical injury to fish (e.g., Halvorsen et al., 211, 2012; Casper et al., 2013). From these studies, the investigators were able to reject the hypothesis (referred to as the "equal energy hypothesis") that the same type and severity of injury would occur for the same total cumulative energy level of exposure (SEL) regardless of how that was reached (e.g., through many low-energy impulsive sounds or fewer high-energy impulsive sounds). The way the energy is delivered, in terms of both the duty cycle (the proportion of time during which sound is present) and the energy within the individual pulses of sound, will influence the effects of sound exposure, whether these effects are in terms of injury or behavioural responses.

Table 7.16: Summary of studies investigating the effects of MSS on scallops

Study	Species	Type of Study	Sound Source	Duration of sound exposure	Responses measured	Key Findings	Study Strengths	Study Limitations
Przeslawski et al. 2016 (GA-FRDC study)	*Pecten fumatus* (Commercial scallop), *Mimachlamys asperrima* (Doughboy scallop)	Field (observational)	Airgun array (2530 cubic inches, 16 airguns)	9-day seismic operations (shots every 18.75m)	Abundance (live, dead), gonad stage, meat condition, size, fatty acid and sterol profiles	No short- or long-term changes in measured responses due to sound exposure	Field conditions, *in situ* scallops monitored throughout experiment, sound pressure measured and modelled	Low sample sizes or missing data before seismic surveys
Day et al. 2016 (UTAS-FRDC study)	*Pecten fumatus*	Field (manipulative)	Single airgun (45 and 150 cubic inches) *	1, 2 and 4 airgun passes, each pass having between 51–167 shots every 11.6 seconds	Mortality, haemolymph biochemistry, haemocyte counts, righting reflect, recessing rate, condition indices	Long-term mortality effects, short-term haemolymph effects, delay in righting reflex and increase in recessing reflex after sound exposure	Sound pressure and motion accurately measured, field conditions during exposure, multiple metrics measured	Scallops handled and long-term effects measured suspended in captivity (lantern nets), mechanism of effects remains unknown
Aguilar de Soto 2015	*Pecten novaezelandiae* (New Zealand scallop) (larvae)	Lab	Recording of airgun array	Pulse every 3 seconds for 90 hours	Developmental stage, abnormality rate	Delayed development and higher abnormality rate in larvae exposed to seismic noise	Only study to examine scallop larvae	Acoustic conditions in small tanks make extrapolations to field conditions challenging, sound exposure durations are unrealistic
Harrington et al. 2010	*Pecten fumatus*	Field (observational)	Airgun array (4130 cubic inches)	2-week seismic operations (shots every 5 seconds)	Abundance (live, dead), size, gonad stage, meat condition	No short-term changes in measured responses due to sound exposure	Field conditions, *in situ* scallop exposure	Long-term effects not included, control 3.5 km from seismic operations
Parry et al. 2002	*Pecten fumatus*	Field (manipulative)	Airgun array (3642 cubic inch, 24 airguns)	4-day seismic operations (shots every 18.75m)	Mortality, adductor muscle strength	No immediate changes in measured responses due to sound exposure	Field conditions	Scallops not in contact with substrate, only immediate effects considered (17 days after seismic survey complete)

* The estimated cumulative sound exposure levels received by test animals in Day et al. (2016a) were considered similar to that of a large commercial seismic array passing at ~ 30 to 524 m for the 45 and 150 in³ sources. The magnitude from the ground borne motion from the 150 in³ air gun emulated that measured for a 3130 in³ array at around 100-200 m.

Source: Przeslawski et al (2016b

Based on Jasco's expert advice, the key sound parameter for the assessment of potential impacts on benthic molluscs is likely to be associated with particle motion exposure combined with a cumulative property (e.g., proportional to the total energy received, time above a threshold, or number and duty cycle of exposures). The scientific literature does not present a sound level associated with no impact for molluscs, and as particle motion is likely the more relevant metric, particle acceleration from the seismic source has been presented for comparing to the results from Day et al (2016b). The maximum particle acceleration assessed for scallops was 37.57 ms-2, which is considered appropriate for bivalves.

Table 7.17 presents the thresholds used for the marine invertebrates EIA.

Table 7.17: STLM thresholds for marine invertebrates

Group	Threshold	Criteria
Molluscs – octopus and squid	Behavioural Startle response - inking (Fewtrell & McCauley, 2012)	162 dB re 1 µPa^2.s
Molluscs – bivalves (e.g., scallops, abalone)	Mortality/mortal injury Maximum particle acceleration (Day *et al*., 2016a;b) threshold associated with chronic effects that could result in mortality during the weeks and months following exposure	37.57 ms^{-2}
Sponges and corals	Mortality/mortal injury No impact – no detectable effect on soft tissues or skeletal integrity or mortality (Heyward *et al*., 2018)	226 dB re 1 µPa PK

STLM Results

Table 7.18 presents the modelled results for the maximum and 95% distances for per-pulse SPL metrics relevant to molluscs in the water column (squid and octopus). This modelling indicates that the furthest distance to effect (i.e., startle response that results in inking) is 3.56 km from the sound source (with a range of 2.14 km to 3.56 km. There is no clear correlation between water depth and distance to effect.

Table 7.18: Maximum (Rmax) and 95% (R95%) horizontal distances (in km) from the source array to modelled maximum- over-depth (water column) per-pulse SEL isopleths from modelled single impulse sites relevant to molluscs in the water column

SPL (L_p; dB re 1 µPa)	Site 1 (103 m)		Site 2 (69 m)		Site 3 (102 m)		Site 4 (115 m)		Site 5 (118 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
162	3.06	2.46	3.56	2.51	2.98	2.41	2.96	2.3	3.12	2.45
	Site 6 (798 m)		**Site 7 (606 m)**		**Site 8 (299 m)**		**Site 9 (125 m)**		**Site 10 (106 m)**	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
	2.14	1.69	2.22	1.69	3.34	2.14	2.64	2.1	3.08	2.4

Red = highest distance to threshold, green = lowest distance to threshold

Figure 7.6 shows modelled maximum particle acceleration as a function of horizontal range in four perpendicular directions from the centre of the 3,480 cui sound source at two modelled sites (Site A and Site 1, in water depths of 61 m and 103 m, respectively). The modelling considered a resolution of 10 m, and a receiver positioned 5 cm off the seafloor. The maximum distance to a particle acceleration 37.57 ms-2 (to compare with results presented in Day et al (2016a)) occurs at maximum range of 1.5 m for Site A and is not reached at Site 1.

Figure 7.6: Peak particle acceleration magnitude at the seafloor as a function of horizontal range from the centre of the 3,480 cui sound source along four directions

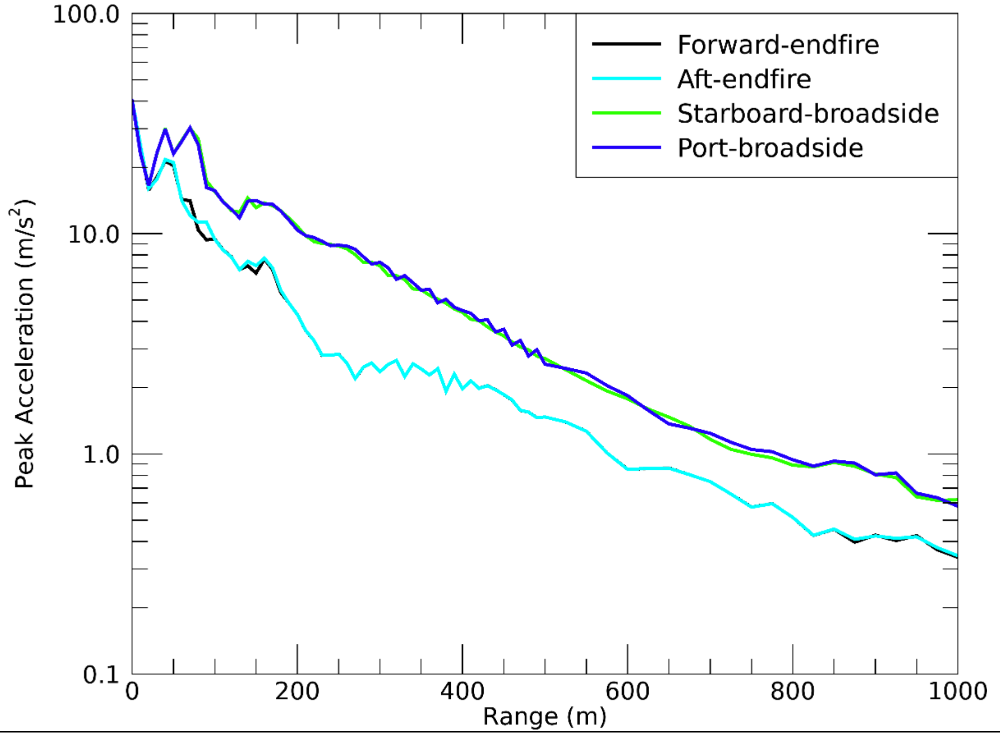
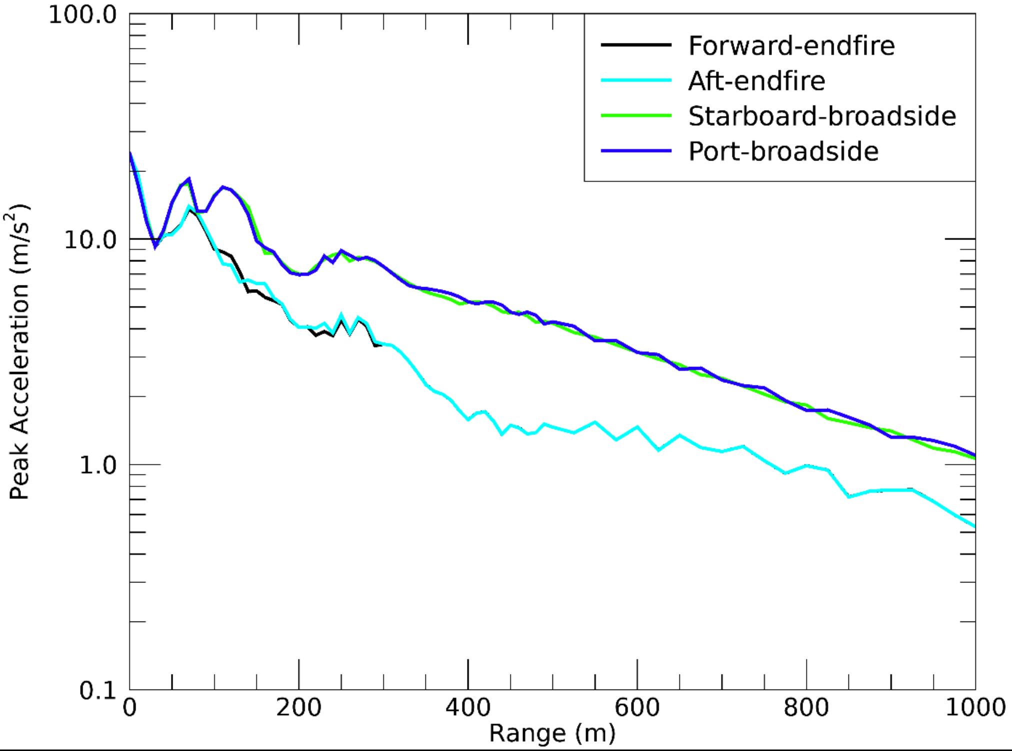
	Site A (61 m water depth)
	Site 1 (103 m water depth)

Table 7.19 presents the results for the maximum distances to PK and PK-PK thresholds calculated for three of the modelled single impulse sites at the seafloor. These thresholds use the less relevant pressure metric (as compared with particle motion) and therefore are of lower reliability for predicting impacts to benthic invertebrates. For the purposes of comparison with less conservative thresholds, the 212-213 dB re 1 uPa

PK-PK thresholds are listed in Table 7.19to indicate the distance to no effect (Day et al., 2016a; 2017; 2019).

These results indicate that the distance to no effect ranges from 138 m to 156 m from each seismic pulse, depending on water depth and the metric applied.

For sponges and corals, the no effect distance is reached within 4 m of each sound pulse at the seafloor.

Table 7.19: Maximum horizontal distances from the seismic source to modelled seafloor PK and PK-PK pressure levels from single impulse sites relevant to benthic invertebrates

PK-PK (L_{PK-PK}; dB re 1 µPa) (bivalves)	Distance R_{max} (m)		
	Site A (61 m)	Site 1 (103 m)	Site 2 (69 m)
213[a, b, c]	140	138	144
212[b, c]	152	154	156
PK (L_{PK-PK}; dB re 1 µPa) (sponges & corals)	**Site A (61 m)**	**Site 1 (103 m)**	**Site 2 (69 m)**
226	4	*	*
Key			
a	Day et al (2019) – lobster, maximum single impulse exposure measured		
b	Day et al (2016a) – lobster and scallops, maximum single impulse exposure measured		
c	Day et al (2017) – scallops, maximum single impulse exposure measured		
*	Sound level not reached		

Impact Assessment

Impacts to molluscs as a result of the Sequoia 3DMSS are outlined below.

- The sound at any one location will be localised and temporary.
- Octopus and squid –
  - The startle response (inking) may occur within 2.22 km to 3.56 km of the sound source, assuming that the source of the sound is sudden. Beyond the initial startle, octopus and squid are likely to disperse from the sound source and therefore not be subject to additional sound levels that result in physiological impacts.
  - The implementation of soft-start procedures means that sound from the seismic source array will gradually ramp up, providing marine invertebrates with the opportunity to move away from the sound if they can.
  - The environmental consequence to octopus and squid is assessed as **negligible**.
- Fisheries-specific impact assessment -
  - There is little to no fishing for octopus in the survey area, with the acquisition area overlapping 0.24% of the Tasmanian octopus fishery (or 0.7% of the fishery with a 3.56 km buffer applied to the acquisition area).
  - There has been no squid fishing in the survey area since March 2017.
  - It is understood that octopus fishing is most active between March and July and that octopus eggs are generally observed in traps from April to June. Squid fishing is generally undertaken during February. With the MSS taking place from September to October, impacts to octopus fishing and spawning will be avoided.
  - The business consequence to the octopus and squid fisheries is assessed as negligible.
- Bivalves (e.g., scallops and abalone) –

- Using the particle motion threshold (the most relevant metric given that scallops are attached to the seafloor), physiological impacts to commercial scallops (in the form of increased stress levels and therefore a low risk of mortality in the long-term, but no mass mortality) are restricted to a distance of no greater than 1.5 m from each seismic impulse location at the seafloor.
- The scientific literature (e.g., Harrington et al., 2010; Przeslawski et al., 2016a;b; Day et al., 2016) indicates that MSS does not result in immediate mass mortality, and that there are no short- or long-term changes in measured responses to sound, but that low levels of mortality may occur, along with impaired reflexes. Measured mortality rates in some experiments are within the ranges of natural mortality rates.
- In the context of the wide availability of suitable habitat for scallops in Bass Strait (sandy sediments) and the bioregion in general, the potential impacts of the MSS are considered negligible.

- Fisheries-specific impact assessment -
  - There has been no commercial scallop fishing for scallops in or in the immediate vicinity of the survey area for at least 30 years. As such, the business consequence to these fisheries is negligible.
  - Most abalone fishing is restricted to waters less than 30 m deep in areas around the King Island coastline. The distance between the acquisition area and the 30 m bathymetric contour (and the WRARA) is 20 km. At this distance, the STLM indicates there will be no effects to abalone and therefore, the business consequence to this fishery is negligible.
- Sponges and corals –
  - Where present through the survey area (such as the canyons), sponges and corals will not be impacted beyond 4 m from the sound pulse at the seafloor. Sponges and corals do not have hearing structures that can be impacted by underwater sound, but their soft tissues or skeletal integrity may be affected. This, combined with the small portion of the survey area occupied by the aggregations of sponges and corals in the canyons, and the excise area that overlaps some of the canyons, means the environmental consequence to this group is assessed as negligible.

Demonstration of Acceptability

In accordance with Section 4 of NOPSEMA's EP decision making Guideline (GL1721, Rev 6, November 2019) and the methodology outlined in Chapter 6, Table 7.20 presents a demonstration of acceptability.

Table 7.20: Demonstration of acceptability for potential impacts to molluscs

Statement of acceptability	• Impacts to molluscs, sponges and corals are localised and temporary, with no mass mortality attributable to the MSS. • There are no impacts to the sustainability of the mollusc fisheries.	
Internal context	Policy compliance	ConocoPhillips HSE Policy objectives are met through implementation of this EP.
	HSEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the HSEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
External context (stakeholder engagement)	ConocoPhillips Australia has undertaken open and transparent communications with relevant persons, and actively involved those known to have concerns with MSS. **Relevance to molluscs, sponges and corals:** Fishing industry associations have not raised concerns regarding the impacts of MSS on molluscs.	

<table>
<tr><td>Legislative context</td><td colspan="2">The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of:
• EPBC Act 1999 (Cth).
  • EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales).
• OPGGS Act 2006 (Cth).
  • Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seafloor (and other matters)…to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.
Relevance to molluscs, sponges and corals: Implementation of soft-starts in accordance with the EPBC Policy Statement 2.1 will provide invertebrates in the water column (e.g., octopus and squid) with the opportunity to move away from intense sound. Soft starts will have no benefit for benthic invertebrates as they are not as mobile as free-swimming species.</td></tr>
<tr><td>Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice (listed in order of most to least recent) demonstrates that BPEM is being implemented.</td></tr>
<tr><td></td><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include:
• Considering sensitive locations and times of year for critical activities of species that are present.
• Using an MMO.
• Using soft-start procedures.
Relevance to molluscs, sponges and corals: Implementation of soft-starts will provide invertebrates in the water column (e.g., octopus and squid) with the opportunity to move away from sound intense sound.</td></tr>
<tr><td></td><td>Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)</td><td>This document provides guidelines regarding:
• An exclusion zone for monitoring (500-m horizontal distance).
• Pre-start observations in the exclusion zone (for at least 30 minutes).
• Soft-start procedure.
• Monitoring during periods of poor visibility and darkness.
• Use of a passive acoustic monitoring (PAM) system.
• Recording all monitoring data.
With the exception of PAM systems, the EPS that COP Sequoia has developed for this activity meets the requirements of this guideline (and is generally exceeded by meeting the more stringent requirements</td></tr>
</table>

		of the EPBC Act Policy Statement 2.1). **Relevance to molluscs, sponges and corals:** Implementation of soft-starts will provide invertebrates in the water column (e.g., octopus and squid) with the opportunity to move away from sound intense sound.
	Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities (Prideaux, 2017)	This document was developed to present the BPEM for marine noise-generating activities, including MSS. It includes 12 modules covering various species groups and what should be taken into consideration when undertaking EIA. **Relevance to molluscs, sponges and corals:** Section B.12 of the guideline specifically discusses marine invertebrates. The EIA assessment criteria listed in Section B.12.4 have been considered in this EP.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The EPS developed for this activity and in the design of the survey in general take into account the four practices outlined in this guideline (see Section 3.7.4). Relevance to molluscs, sponges and corals: no specific application.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Noise (item 74) – the preparation of this EP meets the objectives of these guidelines because sensitive areas for marine life are identified, the survey is planned to avoid sensitive times of the year and soft-start and stop procedures are in place for marine mammals sighted within 500 m of the sound source. **Relevance to molluscs, sponges and corals:** Implementation of soft-starts will provide invertebrates in the water column (e.g., octopus and squid) with the opportunity to move away from sound intense sound.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Section 8.2 (Planning and permitting) – consideration of fish spawning times. • Section 8.7 (Aquatic life) – soft-start procedures, use of MMOs, cetacean sighting and reporting. • Appendix 1 (Recommended mitigation measures for cetaceans during geophysical operations) - use of exclusion zone for monitoring and soft-start procedure. **Relevance to molluscs, sponges and corals:** Implementation of soft-starts will provide invertebrates

		in the water column (e.g., octopus and squid) with the opportunity to move away from sound intense sound.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008)	The EPS developed for this activity meet the requirements of this policy statement through the adoption of: • Part A (standard management procedures) • Part B (the use of MMOs). **Relevance to molluscs, sponges and corals:** Implementation of soft-starts will provide invertebrates in the water column (e.g., octopus and squid) with the opportunity to move away from sound intense sound.
	Code of Environmental Practice (APPEA, 2008)	The EPS developed for this activity meet the requirements of this guideline with regard to geophysical surveys: • To reduce the impact on cetaceans and other marine life to ALARP and to an acceptable level. • To reduce the impacts to benthic communities to ALARP and to an acceptable level. **Relevance to molluscs, sponges and corals:** no specific application, considered part of marine life in general.
Environmental Context	MNES	
	AMPs (Section 5.1.1)	There is a 444 km2 overlap between the acquisition area and the Zeehan AMP (a 2.2% overlap). The acquisition and operational area avoids overlap with the Apollo AMP. Appendix 1 provides an assessment of the potential impacts of the activity on the management aims of the South-East Commonwealth Marine Reserves Network Management Plan 2013-23, which encapsulates the Zeehan AMP. MSS is permitted within the Multiple Use Zone of the Zeehan AMP. Relevance to molluscs, sponges and corals: sponges and corals are an important feature of the Zeehan AMP within the canyons. The acquisition area does not intersect the portion of the AMP dissected by canyons.
	Wetlands of international importance (Section 5.1.4)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest Ramsar wetlands. Relevance to molluscs, sponges and corals: no specific application. Marine invertebrates in these wetlands will not be affected by the seismic sound.

	TECs (Section 5.1.5)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest TECs. Relevance to molluscs, sponges and corals: no specific application. Marine invertebrates in these TECs will not be affected by the seismic sound.
	KEFs (Section 5.1.7)	Sponges and corals are known to be an important feature of the West Tasmania Canyons KEF. The acquisition area overlaps 0.58% of this KEF, and only a small portion of six of the 72 canyons comprising this KEF. The STLM indicates sponges and corals will not be impacted beyond 4 m from the sound pulse at the seafloor. Relevance to molluscs, sponges and corals: given the small distance to no effect to sponges and corals from seismic pulses at the seafloor, the environmental consequence to sponges and corals in the West Tasmania Canyons KEF is assessed as negligible.
	NIWs (Section 5.1.8)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest NIWs. **Relevance to molluscs, sponges and corals:** no specific application. Marine invertebrates in these NIWs will not be affected by the seismic sound.
	Nationally threatened and migratory species (Section 5.5)	The EPBC PMST search does not include any threatened or migratory marine invertebrates in the survey area. Relevance to molluscs, sponges and corals: no specific application.
	Other Matters	
	State marine parks (Sections 5.1.9, 5.1.10 & 5.1.11)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines. **Relevance to molluscs, sponges and corals:** no specific application. Marine invertebrates in these marine parks will not be affected by the seismic sound.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	The EPBC PMST search does not include any threatened or migratory marine invertebrates in the survey area. Relevance to molluscs, sponges and corals: no specific application.
ESD principles	The application of the ESD principles to molluscs, sponges and corals are outlined	
	A. Decision-making processes should effectively integrate both long-term and short-term	The timing of the survey has been selected to balance the requirements between commercial fishing activity, spawning times of commercially important species, whale migration times and sea state considerations (see Figure 2.4).

	economic, environmental, social and equitable considerations.	Impacts to molluscs, sponges and corals have been determined as negligible.
	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.	The scientific literature cited throughout this section indicates mortality of marine invertebrates is likely only within several metres of the sound source. Free-swimming marine invertebrates will detect the sound and respond with behaviour such as inking and movement away from the sound source. For largely immobile benthic invertebrates, a low level of stress that is unlikely to lead to mortality is likely to result within a very short distance of the sound source. The EIA indicates there are no threats of serious or irreversible environmental damage.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Impacts to marine invertebrates are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value and stocks for commercial fishing.
	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	Impacts to marine invertebrates are assessed to be localised and temporary. There will not be a loss of species diversity and abundance as a result of the MSS.
	E. Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.

Impacts to Marine Invertebrates – Crustaceans

This section assesses impacts to crustaceans, which belong to the Arthropoda phylum. Crustaceans possess an exoskeleton that they moult to grow. Their bodies are composed of segments grouped into three parts: the cephalon (head), thorax and the pleon (abdomen). Crustaceans are distinguished from other arthropods by the possession of biramous (two-parted) limbs and by their larval forms. Most aquatic crustaceans are free-living, though some are sessile. Crustaceans include rock lobsters, prawns, crabs, and barnacles, as listed in Section 5.5.1.

There are no threatened crustacean species in the survey area, but SRL and giant crabs are commercially fished in small parts of the survey area (see Section 5.7.5).

Sensitivity to Sound

Experiments on lobsters indicates that the statocyst (a mechano-sensory organ responsible for detecting gravity, body positioning and movement) is sensitive to sound and particle motion. The statocyst controls the righting response in lobsters that plays a vital role in the ability to escape predators (Day et al., 2019).

Specific studies examining the effect of seismic survey signals on crustaceans, including larval stages, are relatively rare, though recent Australian studies (e.g., Day et al., 2019; Carroll et al., 2017; Day et al., 2016a; Przeslawski et al., 2016a;b;), have aimed to narrow the knowledge gap. These are being supplemented by global research, including ongoing projects such as Canadian Healthy Oceans Network Project 2.1.4 ('Anthropogenic Noise In The Ocean Soundscape: Effects On Fishes And Invertebrates').

The following studies conducted outside Australia, but considered in the recent review papers, are highly relevant in establishing possible impacts to crustaceans present in the proposed Sequoia survey area:

- Morris et al (2017) undertook field studies in 2015 and 2016 into the effects of 2DMSS on the snow crab (Chionoecetes opilio) fishery of the shelf and slope habitats of Atlantic Canada, using treatment and control sites in a multi-year BACI approach. As with the Victorian and Tasmanian giant crab fisheries in Bass Strait, snow crab fishers in Canada were concerned about the potential impacts of MSS on their target species. The study found that no interface waves that would increase particle motion at the seafloor were detected and concluded that if MSS effects on snow crabs do occur, they are smaller than changes related to natural spatial and temporal variation.
- Wale et al (2013) undertook controlled tank-based experiments and showed that noise from lower-level sources, such as ships, altered behaviour in the shallow water European shore crab (Cancer maenus) by disrupting feeding, slowing reaction time to threats, and hastening turn-over times for crabs placed on their backs.
- Payne et al (2007) conducted a pilot study of the effects of exposure to seismic sound on various health endpoints of the American lobster (Homarus americanus). Adult lobsters were exposed either 20 to 200 times to 202 dB re 1µPap-p or 50 times to 227 dB re 1µPap-p, and then monitored for changes to survival, food consumption, turnover rate, serum protein level, serum enzyme levels, and serum calcium level. Lobsters were exposed to seismic pulses at very close range to the source (~2 m). The SEL that the lobster were exposed to was not described in the report but can be estimated to be up to 207 dB re 1 µPa2·s. Observations were made over a period of a few days to several months and found that:
  - Results indicated no effects on delayed mortality or damage to the mechanosensory systems associated with animal equilibrium and posture (as assessed by turnover rate).
  - There was a decrease in the levels of serum protein, particular serum enzymes and serum calcium in the haemolymph of animals exposed to seismic sound. Statistically significant differences were noted in serum protein at 12 days post-exposure, serum enzymes at 5 days post-exposure, and serum calcium at 12 days post-exposure. Serum enzymes are valuable in detecting major organ damage whereby enzymes leak into the blood upon cellular rupture. Within this study two enzymes, Aspartate transaminase (AST) and Creatine kinase (CK), were not elevated in seismic-exposed animals, reflecting the absence of major cellular rupture or necrosis being affected by seismic sound, including high exposure conditions. Similar results were obtained in studies with snow crabs (Christian et al., 2003). However, there was evidence of decreased serum enzymes in some trials, indicating the possibility of hemodilution or uptake of excess water by the animals. A similar decrease in serum protein and calcium was noted in some trials indicating a potential for disturbance to osmoregulation (i.e., the process by which the body regulates the osmotic pressure of any organisms' fluids in order to keep the homeostasis of the organisms' water level constant).

Altogether, the results suggest a potential for osmo-regulatory disturbance in lobsters exposed to seismic.

- During the histological analysis conducted 4 months post-exposure, no structural differences in hepatopancreatic tissues were noted, which would denote cell or tissue rupture, necrosis or inflammation. There was also no evidence of tissue necrosis or inflammation in the ovaries. However, histology identified elevated deposits of carbohydrates, thought to be glycogen, in the hepatopancreas of seismic-exposed animals. Such abnormal accumulations are believed to be due to disturbance in cellular processes connected with synthesis and secretion, however, the report concludes that further research is required to assess whether this particular observation is due to organ stress. These studies are noted as being exploratory in nature, with the authors cautioning against over-interpretation.

- A pilot study on snow crabs (C. opilio) (Christian et al., 2003; 2004) exposed captive adult male snow crabs, egg-carrying female snow crabs, and fertilised snow crab eggs to variable SPLs (191–221 dB re 1 µPa0-p) and SELs (<130–187 dB re 1 µPa2·s) under controlled field experimental conditions. The crabs were exposed to 200 discharges over a 33-minute period and found that:
  - Neither acute nor chronic (12 weeks post-exposure) mortality was observed for the adult crabs.
  - There was a significant difference in the development rate noted between the exposed and unexposed fertilised eggs/embryos in this study with the egg mass exposed to seismic energy demonstrating a higher proportion of less-developed eggs than the unexposed mass. However, this experiment was performed on eggs stripped from a single berried female and cultured in a laboratory for six weeks prior to exposure and eighteen weeks following exposure. Subsequent work on larvae that had been exposed to seismic array signals as embryos but were allowed to hatch normally without being stripped from berried females did not suffer any negative effects (Payne et al., 2008).
  - Stress indicators in the haemolymph of adult male snow crabs were monitored immediately after exposure of the animals to seismic survey sound (Christian et al., 2003; 2004) and at various intervals after exposure. No significant acute or chronic differences between exposed and unexposed animals in terms of the stress indicators (e.g., proteins, enzymes, cell type count) were observed.
- Christian et al (2003) also investigated the behavioural effects of exposure to seismic survey sound on snow crabs. Caged animals on the ocean bottom at a depth of 50 m were monitored with a remote video camera during exposure to seismic sound and did not exhibit any overt startle response during the exposure period. Eight animals were equipped with ultrasonic tags, released, and monitored for multiple days prior to exposure and after exposure. None of the tagged animals left the immediate area after exposure to the seismic survey sound. Five animals were captured in the snow crab commercial fishery the following year, one at the release location, one 35 km from the release location, and three at intermediate distances from the release location.
- In 2003, a collaborative study was conducted in the southern Gulf of St. Lawrence, Canada, to investigate the effects of exposure to sound from a commercial seismic survey on egg-bearing female snow crabs (DFO, 2004). Caged animals were placed on the ocean bottom at a location within the survey area and at a location outside of the survey area. The maximum received SPL was ~195 dB re 1 µPa0-p. The crabs were exposed for 132 hours of the survey, equivalent to thousands of seismic shots of varying received SPLs. The animals were retrieved and transferred to laboratories for analyses. Neither acute nor chronic lethal or sub-lethal injury to the female crabs or crab embryos was indicated. DFO (2004) reported that some exposed individuals had short-term soiling of gills, antennules and statocysts, bruising of the hepatopancreas and ovary, and detached outer membranes of oocytes. However, they were found to be completely cleaned of sediment when sampled five months later and any differences could not be conclusively linked to exposure to seismic survey sound.
- In a field study, Pearson et al (1994) exposed Stage II larvae of the dungeness crab (Cancer magister) to single discharges from a seven-acoustic source array and compared their mortality and development

rates with those of unexposed larvae. For immediate and long-term survival and time to molt, this study did not reveal any statistically significant differences between the exposed and unexposed larvae, even those exposed within 1 m of the seismic source (with a mean sound pressure as high as 231 dB re 1 µPa).

- Morris et al (2017) undertook a study into the effects of 2D MSS on the snow crab fishery. Snow crab harvesters in Atlantic Canada contend that seismic noise from widespread hydrocarbon exploration has strong negative effects on catch rates. This study repeated a BACI study 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 (North Atlantic Ocean) of Newfoundland, Canada. The results did not support the contention that MSS 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 this study, the results do suggest that if seismic effects on snow crab harvests do exist, they are smaller than changes related to natural spatial and temporal variation.
- Parry and Gason (2006) undertook a statistical analysis of catch per unit effort (CPUE) data collected over nearly 30 years in the Victorian SRL fishery (in southwest Victoria) that showed no influence of historical 2D and 3D MSS activity. Analyses looked at short-term (weekly) and long-term variations (up to 7 years) in CPUE to determine whether changes were correlated with the MSS. The surveys occurred in water depths ranging from 10 m to 150 m. The study included surveys occurring during the SRL spawning period as well as during the lobster fishing season and so would have interacted with adult lobsters and larvae in the same way that the proposed Sequoia 3DMSS may. This study found no evidence that catch rates were affected in the weeks or years following the surveys, however Day et al (2016a) suggest that catch rates would have had to decrease by around 50% for this study to detect a result.

The following information summarises recent Australian research into the effects of MSS on crustaceans.

FRDC Study (2016)

In order to further understand interactions between MSS and marine invertebrates, the Commonwealth Government's Fisheries Research Development Corporation [FRDC], Origin Energy Ltd and the CarbonNet Project contributed funding to a research program assessing the impact of MSS on SRL (and commercial scallops). This program study was undertaken by researchers from the Institute for Marine and Antarctic Studies (IMAS) at the University of Tasmania (Day et al., 2016a). Information from this report as it relates to SRL is provided herein.

The research program involved exposure of cohorts of SRL to multiple seismic acoustic source pulses at two sites (sandy substrate and limestone rock platform), both in 10-12 m water depths off the southern Tasmanian coast. The exposed lobsters were captive and control lobsters (no exposure) were also examined during subsequent analyses undertaken at 0-, 14-, and 120-days post-exposure. Exposure experiments were undertaken in July 2013 (45 cui acoustic source, 2,000 psi), July 2014 (150 cui acoustic source, 1,300 psi and 2,000 psi) and February 2015 (150 cui acoustic source, 2,000 psi). The acoustic source was towed at approximately 5 m depth from a distance of 1 km away and at a speed of approximately 5.5-7.4 km/hr with a shot interval of 11.6 seconds. The seismic source circled in close proximity to the lobster pots. The maximum calculated exposures were 212 dB re 1 µPaPK-PK, a per-pulse SEL of 190 dB re 1 µPa2.s, an accumulated SEL of 199 dB re 1 µPa2.s and maximum peak magnitude of ground acceleration of 68 ms-2 (this was likely to be an outlier).

While a regression of particle acceleration versus range for the single 150 cui acoustic source used in the study (minimum range of 6 m) showed that acceleration at 10 and 100 m range were typically 26 and 5 ms-2, respectively, Day et al (2016a) describes findings related to seismic exposure of egg-bearing female spiny lobsters and subsequent larval development, which concludes:

- Exposure to seismic sound did not result in any mortalities of adult lobsters, even at close proximity.

- 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.
- 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.
- The ability of exposed lobsters, and one cohort of control lobsters, to right themselves, a complex reflex, was compromised in the long term (120 days post-exposure) in three of the four experiments. This response was linked to damage to sensory hairs of the statocyst, the primary mechano-sensory and balance organ in lobsters.
- Tail extension, a simple behavioural reflex response, showed reduction in exposed lobsters in one of the four experiments. However, it is unclear how significant this finding is, as the warm summer water conditions during this particular experiment may be a contributing factor.
- Haemolymph (blood) biochemistry showed little effects on metabolic and respiratory stress, or vitality following exposure.
- Haemocyte count (indicative of immune response function) in exposed lobsters showed a long-term decline to 120 days post-exposure. However, haemocyte counts subsequently recovered to double the number of haemocytes in control lobsters at 365 days post-exposure, which may indicate a possible immune response to pathogens.
- Seismic exposure did not cause any immediate mass mortality. The authors rejected the hypothesis that 'exposure to seismic acoustic sources causes immediate mass mortality, defined as an increase in mortality rate of sufficient proportion to affect population size significantly'. Not considering when both the control and exposed groups suffered mass mortality, the experimental mortality rates at 120 days' post-seismic acoustic source exposure were between 9.4% and 20%. These fall towards the low end of what might be expected from natural mortality rates. Even the highest levels of mortality recorded, 17.5% and 20% suffered by 4-pass treatments from the 2014 and 2015 experiments, were assessed by the authors to be modest compared to naturally occurring mortality rates.

Overall, no direct lethal effects to adult lobsters or impacts to embryos were observed and impacts were limited to statocyst condition, behavioural reflexes and immune response functions in adult lobsters. Day et al (2016a) note that these effects could have some effect on longer-term survivability.

However, Day et al (2016a) also report that lobsters used for the 2014 experiments, which were collected from the Crayfish Point Reserve in the Derwent Estuary near Taroona, were found to have pre-existing damage to statocysts, likely resulting from prolonged exposure to shipping traffic noise in shallow water at this location. The lobster population at Crayfish Point Reserve has been subject to long-term monitoring. The population is thought to be at carrying capacity (Kordjazi et al., 2015) and survival rates within this reserve have been estimated through capture and release studies at around 95% (Green & Gardner, 2009).

The abundance of SRL within the Crayfish Point Reserve can reasonably be ascribed to the exclusion of the lobster fishery since 1971. Lobster populations within marine protected areas have consistently been found to demonstrate higher biomass and higher abundance of larger size classes than lobster populations subject to fishing pressure (Barret et al., 2009a;b; Young et al., 2016). Barret et al (2009) suggested that exploitation had reduced SRL biomass in the fishery adjacent to the Maria Island marine protected area, east coast Tasmania, to <10% of natural values, with consequent severe ecological effects on rocky reef ecosystems (Ling et al., 2009, Ling & Johnson, 2012).

Thus whilst the ecological effects of damaged statocysts in the SRL has not been the subject of dedicated experimental studies, long-term monitoring of the lobster population with damaged statocysts at Cray Point

Reserve indicates that any population-level survivability effects are not significant and, importantly, ecological effects are likely to be negligible relative to the effect of fishing mortality.

On the basis of these studies, the following broad conclusions can be drawn about impacts to SRL exposed to MSS:

- Mortality of adult lobsters is unlikely;
- Increased mortality, delayed development or abnormal development to the egg mass carried by any
- 'berried' females, if present, or larvae produced from those eggs, is highly unlikely;
- Changes to heamolymph biochemistry, an indicator of acute or chronic metabolic stress, in adult lobsters in close proximity to the acoustic source are unlikely;
- Damage to statocysts in adult lobsters in close proximity to the acoustic source is likely, and it is not known whether a significantly damaged statocyst or impaired reflexes might disadvantage the growth or survival of lobsters in the wild;
- Statocyst damage is known to exist in wild SRL populations that have very high survival rates and are near carrying capacity;
- Changes to haemocyte count, an indicator of immune response function, in adult lobsters in close proximity to the acoustic source is likely; and
- Increased probability of mortality, delayed development or abnormal development of crustacean larvae in the water column is only possible at very close range.

In response to the Day et al (2016a) findings about the effects of MSS on SRL, the IAGC asked several of its members who are expert in seismic sound and fisheries to examine the findings. These members were Prof. James Pierson (Uni of Maryland), Prof. Julie Kiester (Uni of Washington), Prof. Susan Menden-Deur (Uni of Rhode Island), Prof. Chuck Greene (Cornell Uni), Dr. Kelly Benoit-Bird (Monterey Bay Area Research Institute), Tim Stanton (Woods Hole Oceanographic Institution), Prof. Mark Benfield (Uni of Louisiana) and Dr. Jerry F Payne (retired Fisheries and Oceans Canada scientist and present scientist emeritus). The following review findings introduce a high level of uncertainty about the results:

- The average turnover rates in exposed lobster (the time taken to right themselves from ventrum-up) was a matter of seconds compared to unexposed individuals. As such, concern about ecological and fisheries impacts should be approached with caution.
- The water depth for the experiment (10-12 m) and the distance between the sound source and the seafloor (5-7 m) is not representative of the majority of MSS (and is not representative of the Sequoia MSS, where there will be no less than 60 m of water between the acoustic source array and the seafloor). The complexity of sound acoustics in shallow waters means caution should be applied when interpreting these results in deeper waters.
- The potential effects to SRL fisheries implied from the study contradicts the findings of the field study conducted in Victoria between 1978 and 2004 (Parry & Gason, 2006), which found there was no evidence of a lower catch rate in the weeks or years following MSS (see earlier point).

CarbonNet Study (2018)

As previously described, in early 2018, the CarbonNet Project undertook the Pelican 3DMSS in waters 15 m to 35 m deep located between 1 km and 13 km from the Gippsland shoreline in Victoria. Underwater sound and its potential impact on the marine environment was a key issue raised by stakeholders, particularly the commercial fishing industry. In response, and among other actions, CarbonNet undertook SRL surveys before and after the MSS to ascertain whether any differences in abundance could be attributed to the MSS. The design of the survey was overseen by an independent Advisory Panel to provide advice on the survey methodology and interpretation of the survey results and its implications.

Ten sites (in areas of reef) were monitored, including six sites within the acquisition area and four reference sites located more than 15 km to the northeast. At all sites, more SRL were retrieved during the post-MSS assessment (4 months after the MSS), with 81 individuals trapped during the pre-MSS assessment compared to 122 trapped post-MSS. This increase in numbers post-MSS was most likely due to seasonal effects rather than any impact of the MSS (CarbonNet, 2018). These results indicate no effect of the MSS on lobster abundance.

IMAS & CMST Study (2019)

Subsequent to the Day et al (2016a) study, Day et al (2019) undertook additional work to determine whether SRL with pre-existing damage to their mechanosensory statocyst organs as a result of exposure to anthropogenic sound, incur further damage from exposure to MSS. This is relevant to the Sequoia acquisition area because of the existing anthropogenic sound in the acquisition area (e.g., vessel movements) and the potential for other MSS to take place near the Sequoia survey area around the same time.

For this study, SRL collected from a site subject to high levels of anthropogenic noise (a high shipping traffic lane used by cargo vessels and cruise ships, as well as pumping stations) were exposed to an equivalent seismic air gun signal regime as the Day et al (2016a) study of lobsters, which was from an area of minimal anthropogenic sound ('noise-naïve' lobsters). Following exposure, both control and exposed treatments were found to have damage to the statocyst equivalent to that of noise-naïve lobsters following seismic exposure, leading to the conclusion that the damage was both pre-existing and not exacerbated by seismic exposure. Additional to the lack of further damage following MSS exposure, no disruption to the righting reflex was observed, demonstrating the lobster's ability to cope with or adapt to the mechanosensory damage (Day et al., 2020).

The lobsters from the high shipping site showed a pre-existing level of statocyst damage equivalent to that of lobsters exposed to the seismic signals. These lobsters also demonstrated a resilience to further damage, with exposure to seismic sound not increasing the level of cell loss in the statocyst hairs (Day et al., 2020). There were also no significant differences in the time taken to right themselves (from 'belly up' to 'belly down') between the control and exposed lobsters from the shipping site, though righting time was slower and more variable than the lobsters at the control site.

Western Australian Department of Primary Industries and Regional Development (2018) risk workshop

The WA Department of Primary Industries and Regional Development (DPIRD) undertook a risk assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia to gain a contemporary understanding of MSS related risks to these fauna groups (Webster et al., 2018). With regard to crustaceans, the DPIRD risk assessment relied on many of the same scientific studies referenced in this EP (e.g., Day et al., 2016, Carroll et al., 2017; Parry & Gason, 2006; Payne et al., 2007). For lobsters, the risk rating for an airgun array sized between 2,000 and 4,5000 cui (as is the case for the Sequoia 3DMSS) was 'moderate' in water depths of 100 m and 'moderate' for water depths >250 m. This risk rating was based on multiplying a consequence rating of 'moderate' (meaning the risk was acceptable) with a likelihood of 'unlikely' (meaning the consequence may occur but only in exceptional circumstances).

Thresholds for STLM

The background information relating to STLM thresholds presented in 'Impacts to Marine Invertebrates (molluscs)' applies equally here for crustaceans.

Table 7.21 presents the threshold used for the crustaceans STLM.

Table 7.21: STLM thresholds for crustaceans

Group	Threshold	Criteria
Crustaceans	No mortality or damage to mechano-sensory systems (Payne *et al*., 2008)	202 dB re 1 µPa PK-PK

STLM Results

The background information relating to STLM thresholds presented in 'Impacts to Marine Invertebrates (molluscs)' also applies to crustaceans.

Table 7.22 presents the results for the maximum horizontal distance from the seismic source to modelled seafloor PK-PK pressure levels from three single impulse sites relevant to crustaceans (i.e., SRL and giant crab). This indicates that the maximum no-effect distance for SRL is 414 m (varying from 324 m to 414 m depending on water depth).

Table 7.22: Maximum horizontal distances from the seismic source to modelled seafloor PK-PK pressure levels from single impulse sites relevant to crustaceans

PK-PK (L_{PK-PK}; dB re 1 µPa)	Distance R_{max} (m)		
	Site A (61 m)	Site 1 (103 m)	Site 2 (69 m)
202	324	340	414

Impact Assessment

Crustaceans present within 414 m of each seismic impulse at the seafloor may experience:

- Damage to statocysts and changes in reflexes;
- Increased metabolic stress;
- Changes to haemocyte count, an indicator of immune response function;
- Increased probability of mortality; and
- Delayed development or abnormal development of larvae.

Impacts to crustaceans up to 414 m from the sound source will have a minor consequence because:

- There are limited areas of suitable seafloor habitat (e.g., rocky reef) for SRL in the survey area, with bathymetric data indicating an absence of reefs, meaning that impacts at a population level are not likely to occur.
- The area of suitable habitat for giant crabs (upper parts of the shelf slope) is limited to the southwest corner of the survey area, or <2% of the acquisition area. Given the abundance of similar habitat available around the continental shelf (extending from the Otway region south around Tasmania and north to near the Victorian/NSW border), impacts at a population level will be negligible. The excise of the 140-300 m water depth region (and 'no-effect' buffer distance of 425 m for the 140 m contour and 455 m for the 300 m contour) effectively means that areas commercially fished for giant crabs have been removed from the acquisition area, along with the area in which effects to giant crabs may extend to. This means that impacts to adult giant crabs are not likely to occur.
- SRL spawning occurs between late winter and early spring (i.e., between August and September) and drift as plankton for up to six weeks before first settlement (see Section 5.5.2) (up to about mid-November). Giant crab carry eggs for approximately 4 months with eggs hatching in the October/November period and are dispersed over about 50 days before settling. The timing of the Sequoia 3DMSS may overlap with the spawning period and/or the plankton drifting phase for SRL and giant crab. Impacts to plankton are considered earlier and indicate that crustaceans in the drifting planktonic phase are not likely to be impacted by the survey unless within 210 m of the active sound source.
- Mass mortality will not occur.

The fisheries-specific impact assessment for the Victorian and Tasmanian SRL and giant crab fisheries is presented in Table 7.23.

Table 7.23: Victorian and Tasmanian SRL and giant crab impact assessment

Southern Rock Lobster	Giant crab
Victorian fishery	
The socio-economic consequence of the Sequoia 3DMSS to the Victorian SRL fishery is assessed as minor because: **Temporal** • The survey overlaps the closed fishing season for female SRL. • The survey overlaps only a short period of the fishing season for male SRL (up to 15 September), so the temporal overlap with the fishing season is small. **Spatial** • The acquisition area overlaps 1.76% of the Victorian fishery. The operational area was re-designed to avoid the K16 and L16 fishing grid cells. • Applying the 414 m distance to effect around the acquisition area means there is a 1.84% overlap with the fishery. • The acquisition area is located 6.2 km south of the 'Big Reef' structure (using the 50 m contour as a proxy for the deepest part of the reef) that is known to be an important SRL fishing ground. This is well beyond the 414 m distance to no effect. ◦ The 'Big Reef' is also 3.2 km from the end of the run out lines, also well beyond the 414 m distance to no effect. • Using the 50 m contour as a proxy for the deepest part of the reef, line turns will avoid the 'Big Reef' reef by about 200 m. The sound source will not be active during the turns, so seismic sound will not reach the reef during line turns. • Catch • The percentage of catch (as an average for the last 10 years) potentially affected by the operational area is 5.2% (valued at about $1.28 million), spread over up to 33 licences. • The research presented in this section indicates that mortality of SRL from the survey is not likely to occur. • The research presented in this section indicates that short- and long-term impacts to SRL fishing catch rates are not likely to occur.	The socio-economic consequence of the Sequoia 3DMSS to the Victorian giant crab fishery is assessed as minor because: **Temporal** • The survey overlaps the closed fishing season for female crabs. • The survey overlaps only a short period of the fishing season for male crabs (up to 15 September), so the temporal overlap with the fishing season is small. **Spatial** • The acquisition area overlaps 1.76% of the Victorian fishery. • The acquisition area overlap of waters 140-300 m deep (water depths favoured by the fishery) is zero percent. **Catch** • The percentage of catch (as an average for the last 10 years) potentially affected by the operational area is 16.3% (valued at about $161,000) spread over up to 11 licences. The excised part of the acquisition area means that the overlap with catch is reduced to zero or nearly zero. • The research presented in this section indicates that mortality of crabs from the survey is not likely to occur. • The research presented in this section indicates that short- and long-term impacts to crab fishing catch rates are not likely to occur.
Southern Rock Lobster	**Giant crab**

<table>
<tr><th colspan="2">Victorian fishery</th></tr>
<tr><td>The socio-economic consequence of the Sequoia 3DMSS to the Tasmanian SRL fishery is assessed as minor because:
Temporal
• The survey overlaps the closed fishing season for female SRL (1 May to 15 November).
• The survey cannot avoid the fishing season for male crabs (open all year).
Spatial
• The acquisition area overlaps 1.11% of the Tasmanian fishery.
• The operational area was re-designed to avoid the 4C2B, 4C2F, 4C2J and 4C2N fishing grid cells.
Catch
• The percentage of catch (as an average for the last 10 years) potentially affected by the operational area is <1% (valued at about $238,000), spread over up to 194 licences.
• The research presented in this section indicates that mortality of SRL from the survey is not likely to occur.
• The research presented in this section indicates that short- and long-term impacts to SRL fishing catch rates are not likely to occur.
• Most catch comes from waters <100 m deep (which is restricted to 9.08% of the acquisition area).
The acquisition area is located over 20 km west of nearshore areas of the west coast of King Island that are known to be important shallow water SRL fishing grounds. This is well beyond the 414 m distance to no effect.</td>
<td>The socio-economic consequence of the Sequoia 3DMSS to the Tasmanian giant crab fishery is assessed as minor because:
Temporal
• The survey overlaps the closed fishing season for female crabs.
• The survey cannot avoid the fishing season for male crabs (open all year).
Spatial
• The acquisition area overlaps 1.11% of the Tasmanian fishery.
• The operational area was re-designed to avoid the 4C2B, 4C2F, 4C2J and 4C2N fishing grid cells.
• The water depths favoured by this fishery (140-300 m deep) have been excised from the acquisition area, plus a ‘no-effect’ buffer applied to these water depths.
Catch
• The percentage of catch (as an average for the last 10 years) potentially affected by the operational area is 39% (valued at about $737,000) spread over an unknown number of licensees. The excised area means that the overlap with catch is reduced to zero or nearly zero.
• The research presented in this section indicates that mortality of crabs from the survey is not likely to occur.
The research presented in this section indicates that short- and long-term impacts to crab fishing catch rates are not likely to occur.</td></tr>
</table>

Demonstration of Acceptability

In accordance with Section 4 of NOPSEMA’s EP decision making Guideline (GL1721, Rev 6, November 2019) and the methodology outlined in Chapter 6, Table 7.24 presents a demonstration of acceptability.

Table 7.24: Demonstration of acceptability for potential impacts to crustaceans

<table>
<tr><td>Statement of acceptability</td><td colspan="2">• Impacts to crustaceans are localised and temporary, with no mass mortality reported subsequent to the MSS.
• There are no impacts to the sustainability of the SRL and giant crab fisheries.</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>ConocoPhillips HSE Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>HSEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the HSEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.</td></tr>
<tr><td>External context (stakeholder engagement)</td><td colspan="2">ConocoPhillips Australia has undertaken open and transparent communications with relevant persons, and actively involved those known to have concerns with MSS (e.g., TSIC, SIV and DPIPWE).
Relevance to crustaceans: Fishing industry associations including TSIC and SIV have raised concerns regarding the impacts of MSS on commercial catch targets such as SRL and giant crab. Engagement with commercial fisheries associations and fishers is summarised in Chapter 4 and their concerns are addressed in the EIA in this section. The area of giant crab fishing was excised from the acquisition area as a result of consultation with TSIC and DPIPWE.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of:
• EPBC Act 1999 (Cth).
    • EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales).
• OPGGS Act 2006 (Cth).
    • Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seafloor (and other matters) to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.
Relevance to crustaceans: Implementation of soft-starts in accordance with the EPBC Policy Statement 2.1 will not provide significant benefit for crustaceans living on the seafloor as they are not as fast moving as free-swimming demersal or pelagic species.</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice (listed in order of most to least recent) demonstrates that BPEM is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry
(IOGP-IPIECA, 2020)</td><td>• The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include:
• Considering sensitive locations and times of year for critical activities of species that are present.
• Using an MMO.
• Using soft-start procedures.
Relevance to crustaceans: no specific application</td></tr>
</table>

	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)	This document provides guidelines regarding: • An exclusion zone for monitoring (500-m horizontal distance). • Pre-start observations in the exclusion zone (for at least 30 minutes). • Soft-start procedure. • Monitoring during periods of poor visibility and darkness. • Use of a passive acoustic monitoring (PAM) system. • Recording all monitoring data. With the exception of PAM systems, the EPS that ConocoPhillips Australia has developed for this activity meets the requirements of this guideline (and is generally exceeded by meeting the more stringent requirements of the EPBC Act Policy Statement 2.1). **Relevance to crustaceans:** no specific application.
	Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities (Prideaux, 2017)	This document was developed to present the BPEM for marine noise-generating activities, including MSS. It includes 12 modules covering various species groups and what should be taken into consideration when undertaking EIA. **Relevance to crustaceans:** Section B.12 of the guideline specifically discusses marine invertebrates. The EIA assessment criteria listed in Section B.12.4 have been considered in this EP.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The EPS developed for this activity and in the design of the survey in general take into account the four practices outlined in this guideline (see Section 3.7.4). **Relevance to crustaceans:** no specific application.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Noise (item 74) - the preparation of this EP meets the objectives of these guidelines because sensitive areas for marine life are identified, the survey is planned to avoid sensitive times of the year and soft-start and stop procedures are in place for marine mammals sighted within 500 m of the sound source. **Relevance to crustaceans:** no specific application.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Section 8.2 (Planning and permitting) – consideration of fish spawning times. • Section 8.7 (Aquatic life) – soft-start procedures, use

		of MMOs, cetacean sighting and reporting. • Appendix 1 (Recommended mitigation measures for cetaceans during geophysical operations) - use of exclusion zone for monitoring and soft-start procedure. **Relevance to crustaceans:** no specific application
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008)	The EPS developed for this activity meet the requirements of this policy statement through the adoption of: • Part A (standard management procedures) • Part B (the use of MMOs). **Relevance to crustaceans:** no specific application.
	Code of Environmental Practice (APPEA, 2008)	The EPS developed for this activity meet the requirements of this guideline with regard to geophysical surveys: • To reduce the impact on cetaceans and other marine life to ALARP and to an acceptable level. • To reduce the impacts to benthic communities to ALARP and to an acceptable level. **Relevance to crustaceans:** no specific application, considered part of marine life in general.
Environmental context	MNES	
	AMPs (Section 5.1.1)	There is a 444 km2 overlap between the acquisition area and the Zeehan AMP. The acquisition and operational areas avoid overlap with the Apollo AMP. Appendix 1 provides an assessment of the potential impacts of the activity on the management aims of the South-East Commonwealth Marine Reserves Network Management Plan 2013-23, which encapsulates the Boags AMP. MSS is permitted within the AMP, which is wholly designated as a Multiple Use Zone. **Relevance to crustaceans**: no specific application. Crustaceans are not listed as a conservation value of the Zeehan AMP, though DNP (2013) notes the presence of rocky limestone seafloor that is important for giant crab.
	Wetlands of international importance (Section 5.1.4)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest Ramsar wetlands. **Relevance to crustaceans**: no specific application. Marine invertebrates in these wetlands will not be affected by the seismic sound.

	TECs (Section 5.1.5)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest TECs. **Relevance to crustaceans**: no specific application. Marine invertebrates in these TECs will not be affected by the seismic sound
	KEFs (Section 5.1.7)	Giant crabs are fished from the canyons that form part of the West Tasmania Canyons KEF. The acquisition area overlaps 0.58% of this KEF, and only a small portion of six of the 72 canyons comprising this KEF. Giant crabs are not listed as a conservation value of the canyons. **Relevance to crustaceans:** given the short distance to no effect to crustaceans from seismic sound, the environmental consequence to giant crab in the West Tasmania Canyons KEF is assessed as negligible.
	NIWs (Section 5.1.8)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest NIWs. **Relevance to crustaceans:** no specific application. Marine invertebrates in these NIWs will not be affected by the seismic sound
	Nationally threatened and migratory species (Section 5.5)	The EPBC PMST search does not include any threatened or migratory marine invertebrates in the survey area. **Relevance to crustaceans:** no specific application.
	Other Matters	
	State marine parks (Sections 5.1.9, 5.1.10 & 5.1.11)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines. **Relevance to crustaceans:** no specific application. Marine invertebrates in these marine parks will not be affected by the seismic sound.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	The EPBC PMST search does not include any threatened or migratory marine invertebrates in the survey area. **Relevance to crustaceans:** no specific application.
ESD principles	The application of the ESD principles to **crustaceans** are outlined here.	
	A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	The timing of the survey has been selected to balance the requirements between peak fishing activity, spawning times of commercially important species, whale migration times and sea state considerations (see Figure 2.4). Impacts to crustaceans have been

		determined as minor.
	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	The scientific literature cited throughout this section indicates that mortality and mass mortality of crustaceans is unlikely as a result of MSS. A low level of stress that is unlikely to lead to mortality is likely to result within a short distance of the sound source. The EIA indicates there are no threats of serious or irreversible environmental damage.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Impacts to crustaceans are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value and stocks for commercial fishing.
	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	Impacts to crustaceans are assessed to be localised and temporary. There will not be a loss of species diversity and abundance as a result of the MSS.
	E. Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.

Impacts to Cetaceans

Cetaceans (the group of marine mammals including whales, dolphins and porpoises) evolved from terrestrial mammals and share basic hearing anatomy and physiology with their terrestrial ancestors. Marine mammals, however, have broader hearing frequency ranges due to the much higher sound speed underwater compared to in air.

Sound is very important to cetaceans for effective hunting, navigation and communication:

- Mysticetes (baleen whales, including species such as humpback and blue whales) - hear better at lower frequencies (Wartzok & Keeten, 1999; Mooney et al., 2012) and communicate at low frequencies (20 Hz to approximately 5 kHz) using predominantly tonal type calls. In the sound modelling, these are referred to as low-frequency cetaceans (LFC).
- Odontocetes (beaked whales, including species such as killer whales, sperm whales and dolphins) - hear best at higher frequencies and communicate using both tonal signals (up to approximately 30 kHz) and echolocation clicks (peak frequencies range from approximately 40 – 130 kHz), which they also use for hunting and navigation (Au et al., 2000). In the sound modelling, these are referred to as mid-frequency cetaceans (MFC).
- Other odontocetes (porpoises, dwarf and pygmy sperm whales, river dolphins and other species generally not known to occur in the survey area) – generally produce narrow band, high-frequency echolocation signals. In the sound modelling, these are referred to as high-frequency cetaceans (HFC).

In the evolutionary process, mysticetes and potentially odontocetes increased their ability to receive sound through the skull and both modified their middle ear structures to increase the amplitude of low-frequency sounds in particular (Ketten, 1992; Cranford & Krysl, 2015).

The type and scale of the effect on cetaceans to seismic sounds will depend on a number of factors including the level of exposure, the physical environment, the location of the animal in relation to the sound source, how long the animal is exposed to the sound, the exposure history, how often the sound repeats (repetition period) and the ambient sound level. The context of the exposure plays a critical and complex role in the way an animal might respond (Gomez et al., 2016; Southall 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 (Richard et al., 1995).

Sensitivity to Sound - Physiological impacts

Physiological impacts such as physical damage to the auditory apparatus (e.g., loss of hair cells or permanently fatigued hair cell receptors), can occur in marine mammals, including cetaceans, when they are exposed to intense or moderately intense sound levels and could cause permanent or temporary loss of hearing sensitivity. While the loss of hearing sensitivity is usually strongest in the frequency range of the emitted noise, it is not limited to the frequency bands where the noise occurs but can affect a broader hearing range. This is because animals perceive sound structured by a set of auditory bandwidth filters that proportionately increase in width with frequency.

A TTS is hearing loss from which an animal recovers, usually within a day at most, whereas PTS is hearing loss from which an animal does not recover (permanent hair cell or receptor damage). The severity of TTS is expressed as the duration of hearing impairment and the magnitude of the shift in hearing sensitivity relative to pre-exposure sensitivity, in decibles (dB). TTS occurs at lower exposure levels than PTS. The cumulative effects of repeated TTS, especially if the animal receives another sound exposure near or above the TTS threshold before recovering from the previous sensitivity shift, could cause PTS. If the sound is intense enough, an animal could succumb to PTS without first experiencing TTS (Weilgart, 2007). Though the relationship between the onset of TTS and the onset of PTS is not fully understood, a specific amount of TTS can be used to predict sound levels that are likely to result in PTS. For example, in establishing PTS thresholds, Southall et al (2007) assume that PTS occurs with 40 dB of TTS. While there are results from TTS and PTS studies on odontocetes exposed to impulsive sounds (Finneran, 2016), there is no data for mysticetes.

Gotz et al (2009) notes that there is no conclusive evidence linking MSS with cetacean mortality.

For MSS in Australian waters, the EPBC Act Policy Statement 2.1 determines suitable exclusion zones with an unweighted per-pulse SEL threshold of 160 dB re 1 µPa2·s (DEWHA, 2008). This threshold value is used in the policy to determine whale exclusion zones where MSS must lower their acoustic power output, or shut down completely, in order to prevent significant exposure to sound levels that could induce TTS. So:

- If it is demonstrated that SELs from air gun pulses fall below 160 dB re 1 µPa2·s at <1 km, a reduced 1 km 'low-power' exclusion zone can be adopted.
- If it is demonstrated that SELs from air gun pulses are greater than 160 dB re 1 µPa2·s at <1 km, the survey must operate with a 2 km exclusion zone (applicable to this survey, as the distance to per-pulse SEL ranges from 2.8 km to 4.4 km, depending on water depth).

The 160 dB re 1 µPa2·s threshold minimises the likelihood of TTS in mysticetes and large odontocetes according to the policy background paper. 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.

Sensitivity to Sound – Behavioural impacts

A secondary concern arising from sound generation is the potential non-physiological effects on cetaceans including:

- Increased stress levels;
- Disruption to underwater acoustic cues;
- Masking;
- Behavioural changes; and
- Displacement.

These aspects are discussed further in this section.

Behavioural responses to underwater sound are difficult to determine because animals vary widely in their response type and strength, and the same species exposed to the same sound may react differently (Nowacek et al., 2004; Gomez et al., 2016; Southall et al., 2016). Dunlop et al (2017) notes that establishing a simple dose–response relationship between a behavioural response and noise exposure levels in marine mammals has proved elusive, with this relationship considered to be an over-simplification because of the complexity of the behavioural responses.

An individual’s response to a stimulus is influenced by the context in which the animal receives the stimulus and how relevant the individual perceives the stimulus to be. A number of biological and environmental factors can affect an 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 and 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 & Radford, 2011). Some cetaceans might also respond acoustically to seismic survey noise in a range of ways, including by increasing the amplitude of their calls (Lombard effect), changing their spectral (frequency content) or temporal vocalisation properties, and in some cases, cease vocalising (McDonald et al., 1995; Parks et al., 2007; Di lorio & Clark, 2010; Castellote et al., 2012; Hotchkin & Park, 2013; Blackwell et al., 2015). Masking can also occur (Erbe et al., 2015).

The BRAHSS (Behavioural Response of Australian Humpback whales to Seismic Surveys) project conducted studies at Peregian Beach, Qld, and Dongara, WA, to better understand the behavioural responses of humpback whales to noise from the operation of seismic air gun arrays (20 cui and 140 cui arrays) (Cato et al., 2013). Results from the experiments are published in Dunlop et al (2015;2016;2017) and Godwin et al (2016), together with concurrent studies of the effects of vessel noise on humpback whale communications (Dunlop, 2016). The BRAHSS Project found:

- In most exposure scenarios, a distance increase from the sound source was observed and interpreted as potential avoidance.
- No difference in the 'avoidance' response to either ‘ramp-up’ or the constant source producing sounds at a higher level than early ramp-up stages. In fact, a small number of groups showed inspection behaviour of the source during both treatment scenarios.
- ‘Control’ groups also responded, which suggested that the presence of the survey vessel alone had some effect on the behaviour of the whales. Despite this, the majority of groups appeared to avoid the survey vessel at distances greater than the radius of most injury-based mitigation zones.
- Significant responses to the air guns occurred when the source was within about 3 km and the received level was greater than about 140 re. 1 µPa2s. Humpback whale groups responded more to the smaller source (which was closer) than to the larger source, indicating that proximity to the source (rather than simply source level) is also important.
- The results of this study are consistent with previous studies with humpback whales in different behavioural contexts. Feeding humpback whales, for example, responded at ranges up to 3 km from the source, at levels of 150–169 dB re 1 µPa (Malme et al., 1985). Resting female humpback whales with

calves displayed avoidance reactions at 140 dB re 1 µPa, though other cohorts reacted at higher levels (157– 164 dB re 1 µPa; McCauley et al., 2003).

Small odontocetes responded to acoustic source sounds by moving laterally away from the sound, showing the strongest lateral spatial avoidance, compared to mysticetes and killer whales that showed more localised spatial avoidance. Other larger odontocetes studied included long-finned pilot whales (Globicephala melas) which only changed their orientation in response to sound exposure, while sperm whales did not significantly avoid the sound (Stone & Tasker, 2006).

Southall et al (2007) extensively reviewed marine mammal behavioural responses to sounds as documented in the literature. Their review found that most marine mammals exhibit varying responses between an SPL of 140 and 180 dB re 1 µPa, but a lack of convergence in the data from multiple studies prevented them from suggesting explicit criteria. The causes for variation between studies included lack of control groups, imprecise measurements, inconsistent metrics, and context dependency of responses including the animal's activity state.

The behavioural impacts of MSS on particular cetacean species or groups are summarised here.

Pygmy blue whales. There are very few peer-reviewed papers that examine the responses of blue or PBW to MSS. The only study that specifically examines responses was that from Di lorio and Clark (2010), who found that blue whales increased their discrete, audible calls during a seismic survey.

- The Blue Whale Study has undertaken numerous MSS along the Bonney coast (southeast South Australia/southwest Victoria) between 1998 and 2012. The Blue Whale Study has used aerial surveys to assess distribution and migration movements of marine mammals, with particular attention to great whales, in Bass Strait and the Otway Basin. Aerial surveys of PBW distributions during MSS have observed the following:
- In February 2011, during the blue whale peak migration period, aerial surveys (conducted by Origin) observed only a single PBW within the Astrolabe 3DMSS (Otway Basin), and eight PBW within a 10 km buffer area around the survey area. The total number of PBW sightings during the February 2011 aerial surveys was 51, of which 42 were located outside the 10 km buffer around the Astrolabe study area. Blue whales continued feeding behaviour at a distance of approximately 30 km from the seismic vessel, irrespective of the seismic operations.
- Morrice et al (2004) stress that the proximity of whales to seismic vessels must be interpreted in the context of their pressing need to consume tonnes of food per day. PBW may need to feed into their zone of acoustic discomfort if the only krill available is in proximity to a seismic vessel. Blue whales have been sighted within approximately 2.4 km of an active seismic source array and cow and calf pairs, which are considered the most sensitive of whale aggregations, were recorded within 7.1 km (Morrice et al., 2004).
- In December 2003, Santos carried out a 2DMSS (3,150 cui sound source) in EPP32 west of Kangaroo Island (SA) where blue whales were observed. Some of the whales approached as close as 2.4 km to the operating seismic vessel, feeding on dense krill swarms.
- During an MSS in VIC/P51 in November 2003, blue whales were sighted near krill swarms approximately 18 km from the seismic vessel and left the area as the vessel approached closer. It is unknown if the approach of the vessel triggered the whales to move from the area.
- During November-December 2002, Santos conducted 2D and 3DMSS in VIC/P51 and VIC/P52 (3,150 cui sound source) with no PBW sightings within 60 km of the operating seismic vessel.
- During the 1999-2000 season, Woodside conducted a 3DMSS in VIC/P43 (2,250 cui sound source). During aerial surveys, no blue whales were sighted within 90 km of the operating seismic vessel, despite abundant krill surface swarms in the area.

Southern right whales. The whole of Bass Strait is recognised as a 'known core range' BIA for SRW (see Figure 5.30). All species of large whales, except Bryde's whale, are known to have populations that migrate from winter breeding grounds in the tropics to summer feeding grounds in the Antarctic (Kasamatsu & Joyce, 1995; Kasamatsu et al., 2000). In common with other large whales that feed within Antarctic waters during the Austral summer, the SRW has evolved within, and annually enters, an environment with a ubiquitous natural source of low frequency sound. Gordon et al (2003) report on the movements of a single SRW based on analysing data from an array of seismometers mounted on the seafloor during an MSS (using a source array with a total capacity of 1,600 cui and a source level of 215 dB re:1 µPa peak-to-peak @ 1 m over a 10-60 Hz band). This study found that the whale was tracked moving at a speed of about 10 km/hr on a course converging with that of the survey vessel. At a range of 10 km from the seismic vessel, the whale stopped vocalising and remained silent for an hour before resuming calling at a range of 10 km. Its track then diverged from that of the seismic vessel by about 80° and from its original course by about 120°. This avoidance of the seismic vessel may indicate that blue whales are more sensitive to air gun noise than humpback whales.

Humpback whales. Humpback whales have not been observed to be significantly displaced from their migratory pathways as a result of seismic sound, with the most consistent observed response to seismic activity being an alteration of course and swimming speed (McCauley et al., 2000a). Cows with young calves may have greater susceptibility to acoustic disturbance (McCauley et al., 2000a). The BRAHSS experiment found that in most exposure scenarios, a distance increase from the sound source was observed and interpreted as potential avoidance from the seismic source.

Dolphins. The oceanic dolphins that may be encountered during the survey (such as the bottlenose dolphin

T. truncatus and common dolphin D. delphis) have very broad distributions and habitat requirements. Both of these species are known to ride the bow waves of vessels (Bannister et al., 1996, Perrin, 1998; Ross, 2006; Hawkins and Gartside, 2009; Barkaszi et al., 2012; Barry et al., 2012). Bow riding of seismic vessels is also a common occurrence, though likely to occur less frequently when the source is operating.

Thresholds adopted for the STLM

A summary of the threshold criteria used to assess impacts of underwater sound for each of the cetacean functional hearing groups is presented in Table 7.25.

Table 7.25: Sound level threshold criteria for impairment and behavioural impacts in cetaceans

	Impairment – PTS		Impairment – TTS		Behavioural	
	Per pulse	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**
LFC (mysticetes – e.g., PBW, SRW and humpback whales)						
Threshold value	219 dB PK	183 dB SEL_{24h}	213 dB PK	168 dB SEL_{24h}	160 dB SPL	No definition of SEL exposure criteria for cetacean behaviour (NOAA, 2019)
MFC (some odontocetes – e.g., toothed whales and dolphins)						
Threshold value	230 dB PK	185 dB SEL_{24h}	224 dB PK	170 dB SEL_{24h}	160 dB SPL	As above
HFC (odontocetes – e.g., porpoises)						
Threshold value	202 dB PK	155 dB SEL_{24h}	196 dB PK	140 dB SEL_{24h}	160 dB SPL	As above

	Impairment – PTS		Impairment – TTS		Behavioural	
	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs
Threshold criteria	PTS is considered injurious in marine mammals but there are no published data on the sound levels that cause PTS. The EIA evaluates dual metric criterion requiring consideration of both PK and accumulated SEL. PTS onset thresholds for marine mammals have not been directly measured, but the NFMS (2018) criteria incorporate the best available science to estimate PTS onset in marine mammals from sound energy (SEL_{24h}) or very loud, instantaneous peak sound pressure levels (PK) through extrapolation from available TTS onset measurements.		TTS onset is often defined as a threshold shift of 6 dB above the normal hearing threshold (Southall *et al.*, 2007; 2019). In marine mammals, the onset level and growth of TTS is frequency specific and depends on the temporal pattern, duty cycle and the hearing test frequency of the fatiguing stimuli. There is considerable individual difference in all TTS-related parameters between subjects and species tested to date.		NMFS currently used a step function with a 50% probability of inducing behavioural responses at an SPL of 160 dB re 1 µPa to assess behavioural impacts. This threshold value was derived from the responses of migrating baleen whales to an acoustic source sound (Malme *et al*., 1983;1984). An extensive review of behavioural responses to sound was undertaken by Southall et al (2007) which found varying responses for most marine mammals between an SPL of 140 and 180 dB re 1 µPa. There is no SEL_{24h} metric for behavioural responses in high-frequency cetaceans, so per pulse SPL of 160 dB re 1 µPA is used to assess these impacts (as it is for all cetaceans).	
Justification for threshold criteria	The TTS and PTS threshold are from NFMS (2018), which is the most current, globally recognised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing. The thresholds and weighting functions are identical to those in Southall et al (2019). Given that it is difficult to determine thresholds for behavioural response in individual cetaceans due to their varied responses (Nowacek *et al*., 2004; Gomez *et al*., 2016; Southall *et al*., 2016), which are also influenced by biological and environmental factors such as age, sex, health and activity at the time of exposure, the behavioural disturbance threshold criteria applied is the current NMFS criterion for marine mammals. This summarises the most recent scientific literature on the impacts of sound on marine mammal hearing, and is therefore considered the most relevant to use for this EIA.					

STLM Results

Table 7.26 presents the STLM predicted maximum horizontal distance from the source array to the modelled maximum-over-depth peak pressure level (PK) thresholds. It is important to note that these results do not factor in mitigation measures (such as ramp up of the sound source prior to starting acquisition along each survey line).

Table 7.26: Maximum (Rmax) horizontal distance from the source array to modelled maximum-over-depth peak pressure level (PK) thresholds for cetaceans

	Impairment – PTS		Impairment – TTS		Behavioural	
	Per pulse*	Over 24 hrs^	Per pulse*	Over 24 hrs^	Per pulse#	Over 24 hrs^
LFC						
Distance R_{max}	30 m	1.18 km	70 m	56.6 km	11.1 km	Not measurable
MFC						
Distance R_{max}	Not reached	Not reached	Not reached	80 m	11.1 km	Not measurable
HFC						
Distance R_{max}	340 m	80 m	600 m	320 m	11.1 km	Not measurable

** Highest figure of the 4 sites modelled.*
 # Highest figure of the 10 sites modelled.
^ Highest figure of the 2 sites modelled.

The results in Table 7.26 predict the following effects to cetaceans:

- Behaviour – the maximum distance at which the behavioural response criterion of 160 dB re 1 µPa could be exceeded by SPL is 11.1 km (relevant to LFC, MFC and HFC).
- TTS – only likely to occur in close proximity to the operating acoustic source array, with the peak pressure criteria exceeded at a maximum horizontal distance of 70 m for LFC, and 600 m for HFC, while the peak pressure criteria for MFC was not reached.
- The distances to TTS using the 24-hour metric (ranging from 80 m for MFC, 320 m for HFC and 56.6 km for LFC) are not likely to be triggered because whales will not remain in the one location for this duration of time.
- PTS – only likely to occur in very close proximity to the operating acoustic source array based on the criteria applied (NMFS, 2018). This is a dual metric criterion, requiring consideration of both PK and accumulated SEL. The peak pressure criteria were exceeded at a maximum horizontal distance of 30 m for LFC, and 340 m for HFC, while the peak pressure criteria for MFC was not reached.
- The distances to PTS using the 24-hour metric (ranging from 80 m for HFC to 1.18 km for LFC) are not likely to be triggered because whales will not remain in the one location for this duration of time.

Impact Assessment

The potential impacts to threatened cetaceans that are known to migrate through the proposed survey area based on the timing of 1st August to 31st October are outlined in Table 7.27.

Table 7.27: Potential impacts to threatened and migratory cetaceans recorded in the survey area

Species or group	Impact assessment for survey window
LFC	
PBW	Very low likelihood of presence. The timing of the window has been selected primarily to avoid temporal and spatial overlap with this species, which is largely aligned to the timing of krill aggregations that result from the Bonney Upwelling. Absence of temporal overlap avoids impacts to migration foraging. As such, the consequence of the MSS on PBW is assessed as **negligible**.
SRW	The survey temporally overlaps part of the SRW's migration season (May to October). Spatially, there is likely to be little to no overlap with migration. Although Figure 5.30 illustrates that the acquisition area overlaps the 'known core range' BIA for this species (1.75% overlap), there is little data to support the notion that this area is important for migration or foraging. Applying a 11.1 km buffer for the distance to behavioural effects to the acquisition area, this increases to a 2.5% overlap. Masking of communications and avoidance behaviour may be exhibited if SRW are present nearby. This avoidance behaviour or impaired ability to communicate may add tens of kilometres to their migration. Such a marginal increase is not considered likely to significantly affect the metabolic demands of individuals whose migrations occur over thousands of kilometres. The acquisition area is distant from the species' BIAs of biological significance such as migration, feeding and breeding: • 'Known migration areas' BIA along the Victorian coast (34 km to the north); • 'Connecting habitat' BIA on the King Island coast (17 km east) and the King Island coast (76 km west); and • 'Aggregation' BIA in southwest Victoria (90 km northwest), a known calving and nursery ground. These areas are beyond the 11.1 km distance to behavioural effect (and TTS and PTS). As such, the survey is assessed to have a **minor** consequence on SRW.
Humpback whale	Temporally, there is a short period of overlap with the first half of the humpback whale southern migration (October to December). Spatially, there is a low probability of overlap given their preference for migrating along the edge of the continental shelf (in water depths of about 200 m). The acquisition area overlaps 0.2% of the humpback whale's 'core range' BIA in eastern and southeast Australia. Applying a 11.1 km buffer for the distance to behavioural effects to the acquisition area, this increases to a 0.5% overlap. The acquisition area is located 490 km from the nearest 'feeding' BIA in southern NSW, so the survey will not have an impact on important feeding grounds. Assuming the 'core range' BIA relates mostly to migrating habitat (as opposed to feeding, breeding and resting), the most likely impact is avoidance behaviour or impaired ability to communicate, which may add tens of kilometres to their migration. Such a marginal increase is not considered likely to significantly affect the metabolic demands of individuals whose migrations occur over thousands of kilometres. As such, the survey is assessed to have a **minor** consequence on humpback whales.

Sei whale	Temporally, the survey partly overlaps with the sei whale's southern migration (October to December). Spatially, sei whales prefer deep oceanic waters. Waters >150 m deep occur only in the southwest corner of the survey area, representing 9% of the acquisition area. There are no BIAs for this species in Australian waters. Behavioural effects may occur in or around the deep waters of the southwest part of the acquisition area, extending to an area of 11.1 km from the sound source. The survey is assessed to have a **minor** consequence on this species.
Fin whale	Temporally, the survey overlaps with the end of the northern migration (mid-May to mid-September). Spatially, fin whale habitat preferences around Australia are poorly understood and there are no BIAs. If present at the time of the survey, the most likely impact is avoidance behaviour or masking of communications, which may add tens of kilometres to their migration. Such a marginal increase is not considered likely to significantly affect the metabolic demands of individuals whose migrations occur over thousands of kilometres. The survey is assessed to have a **negligible** consequence on this species.
Pygmy right whale	Little is known about the migration of pygmy right whales in Australian waters, both spatially and temporally. They are known to have a circumpolar distribution in the Southern Hemisphere. If present at the time of the survey, the most likely impact is avoidance behaviour or masking of communications, which may add tens of kilometres to their migration. Such a marginal increase is not considered likely to significantly affect the metabolic demands of individuals whose migrations occur over thousands of kilometres. The survey is assessed to have a **negligible** consequence on this species.
Antarctic minke whale	Little is known about the populations of Antarctic minke whales in Australian waters, both spatially and temporally, though they are known to migrate between their summer feeding grounds in Antarctica and their tropical water breeding grounds in winter. While there are records of this species in the survey area, it is to the west of the presumed migration pathway along the east coast of Tasmania and the Australian mainland. If present at the time of the survey, the most likely impact is avoidance behaviour or masking of communications, which may add tens of kilometres to their migration. Such a marginal increase is not considered likely to significantly affect the metabolic demands of individuals whose migrations occur over thousands of kilometres. The survey is assessed to have a **negligible** consequence on this species.
MFC	
Sperm whale	Sperm whales are generally uncommon in waters <300 m deep, which means they are unlikely to migrate through >90% of the acquisition area. Timing of their presence in the Otway region is largely unknown. The STLM indicates that the per-pulse threshold for TTS is 80 m and PTS will not be reached (TTS for the 24-hour metric is unlikely to be relevant as whales will not remain in the one location for that period of time, and the survey vessel is not stationary). If present in the acquisition area at the time of the survey, the most likely impact is avoidance behaviour, which may add several kilometres to their migration path. The survey is assessed to have a **negligible** consequence on this species.

Dusky dolphin	There is insubstantial information about this species' population, distribution and abundance in Australian waters to determine impacts. The STLM indicates that the per-pulse threshold for TTS is 80 m and PTS will not be reached (TTS for the 24-hour metric is unlikely to be relevant, for the same reason noted above). If present in the acquisition area at the time of the survey, the most likely impact is avoidance behaviour, which may add several kilometres to their migration path. The survey is assessed to have a **negligible** consequence on this species
Killer whale	Temporally, sightings of killer whales off the Victorian coast peak in June/July. Spatially, they have been observed along the continental slope and shelf, with recognised key localities around islands south of Tasmania. The STLM indicates that the per-pulse threshold for TTS is 80 m and PTS will not be reached (TTS for the 24-hour metric is unlikely to be relevant, for the same reason noted above). If present in the acquisition area at the time of the survey, the most likely impact is avoidance behaviour, which may add several kilometres to their migration path. The survey is assessed to have a **negligible** consequence on this species.
HFC	
There are no threatened or migratory HFC known to occur or potentially occurring within the survey area. This, combined with the results of the STLM, indicates that the survey will have a **negligible** consequence on this cetacean group.	

In general, impacts to cetaceans from the MSS are possible without mitigation. However, with the implementation of EPBC Policy Statement 2.1 (which discourages whales from being in the vicinity of the sound source), it is unlikely that TTS or PTS onset will occur.

To determine whether the Sequoia 3DMSS is consistent with the conservation management plans/advice statements for the threatened and migratory species of most relevance to this MSS (PBW, SRW and humpback whales), an assessment against these plans is presented in Table 7.28.

Table 7.28: Assessment of potential impacts to the aims of the threatened and migratory cetacean management plans

Plan	Relevant aim/objective	Assessment
PBW		
Conservation Management Plan for the Blue Whale (*Balaenoptera musculus*) 2015-2025 (DSEWPC, 2011)	Assess and address anthropogenic noise.	The EIA in this EP is consistent with this conservation objective.
SRW		
Conservation Management Plan for the Southern Right Whale (*Eubalaena australis*) 2011-2021 (DSEWPC, 2012)	Anthropogenic threats are demonstrably minimised.	The EIA in this EP demonstrates that anthropogenic threats are considered and minimised wherever possible.
	Assess and address anthropogenic noise (shipping, industrial and seismic).	The EIA in this EP is consistent with this conservation objective.
Humpback whale		

Conservation Advice for the Humpback Whale (*Megaptera novaeangliae*) (TSSC, 2015d)	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.	The EPS adopt the EPBC Policy Statement 2.1 as a control. The MSS is not being undertaken in or near mapped calving, resting or foraging areas, or in a confined migratory pathway.
	Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified, a noise management plan should be developed.	Not relevant, as noted above.
	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)	STLM for this MSS has been undertaken and presented in this chapter.
	Assess impacts of increasing anthropogenic threats and undertake a risk assessment to determine the increased exposure of these expanding populations to entanglement, ship strike and acoustic noise.	The EIA in this EP is consistent with this conservation and management action.
Sei whale		
Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015b)	Once the spatial and temporal distribution (including BIAs) of sei whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.	There is no BIA for this species in Australian waters. Table 7.24 presents the potential impacts to this species.
Fin whale		
Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015c)	Once the spatial and temporal distribution (including BIAs) of fin whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.	There is no BIA for this species in Australian waters. Table 7.24 presents the potential impacts to this species.

The Sequoia 3DMSS will not have a 'significant' impact on critically endangered or vulnerable cetacean species (see Section 5.5.6) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013) below:

- Lead to a long-term decrease in the size of a population.
- Reduce the area of occupancy of the species.

- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a 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 a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species.

Demonstration of Acceptability

In accordance with Section 4 of NOPSEMA's EP decision making Guideline (GL1721, Rev 6, November 2019) and the methodology outlined in Chapter 6, Table 7.29 presents a demonstration of acceptability.

Table 7.29: Demonstration of acceptability for potential impacts to cetaceans

<table>
<tr><td>Statement of acceptability</td><td colspan="2">• Cetaceans are not injured or displaced from foraging, aggregation and breeding grounds or migratory routes.
• The survey is not inconsistent with the aims of cetacean conservation management plans and conservation advice.</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>ConocoPhillips HSE Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>HSEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the HSEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.</td></tr>
<tr><td>External context (stakeholder engagement)</td><td colspan="2">ConocoPhillips Australia has undertaken open and transparent communications with relevant persons, and actively involved those known to have concerns with MSS.

Relevance to cetaceans: During the public exhibition phase of the EP, there was concern expressed by members of the public about impacts to cetaceans, though these concerns were largely absent in earlier consultation with relevant persons. ConocoPhillips Australia believes these concerns are largely addressed with the proposed timing of the survey (to temporally avoid PBW and largely spatially avoids the presence of SRW) and the implementation of routine controls (such as the use of MMOs).</td></tr>
</table>

<table>
<tr><td>Legislative context</td><td colspan="2">The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of:
• EPBC Act 1999 (Cth).
  ◦ Section 229, 229A – all cetaceans are protected in Australian waters, and it is an offence to kill, injure or interfere with a cetacean.
  ◦ EPBC Policy Statement 1.1 (Significance Guidelines).
  ◦ EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales).
• OPGGS Act 2006 (Cth).
  ◦ Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seafloor (and other matters) to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.
Relevance to cetaceans: Implementation of EPBC Policy Statement 2.1 using MMOs allows operations to be responsible to cetacean sightings, minimising the risk of TTS and PTS.</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice (listed in order of most to least recent) demonstrates that BPEM is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include:
• Considering sensitive locations and times of year for critical activities of species that are present.
• Using an MMO.
• Using soft-start procedures.
Relevance to cetaceans: these considerations have been factored into the EIA and into the EPS. MMOs will be used and the EPBC Act Policy Statement 2.1 (which specific soft-start procedures) will be implemented by the MMOs.</td></tr>
</table>

	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)	This document provides guidelines regarding: • An exclusion zone for monitoring (500-m horizontal distance). • Pre-start observations in the exclusion zone (for at least 30 minutes). • Soft-start procedure. • Monitoring during periods of poor visibility and darkness. • Use of a passive acoustic monitoring (PAM) system. • Recording all monitoring data. **Relevance to cetaceans:** With the exception of PAM systems, the EPS that COP Sequoia has developed for this activity meets the requirements of this guideline (and is generally exceeded by meeting the more stringent requirements of the EPBC Act Policy Statement 2.1). Implementation of soft-starts will provide cetaceans with the opportunity to move away from sound before it can cause TTS or PTS.
	Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities (Prideaux, 2017)	This document was developed to present the BPEM for marine noise-generating activities, including MSS. It includes 12 modules covering various species groups and what should be taken into consideration when undertaking EIA. **Relevance to cetaceans:** Section B.4 of the guideline specifically discusses mysticetes (Sections B.1 to B.3 discuss inshore and offshore odontocetes and beaked whales, but are not so relevant to the Sequoia 3DMSS area). The EIA assessment criteria listed in Section B.4.4 have been considered in this EP and the listed TTS and PTS thresholds are the same as those used for the STLM.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The EPS developed for this activity and in the design of the survey in general take into account the four practices outlined in this guideline (see Section 3.7.4). **Relevance to cetaceans:** no specific application.

	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS developed for this activity meet the requirements of these guidelines with regard to: Noise (item 74) – the preparation of this EP meets the objectives of these guidelines because sensitive areas for marine life are identified, the survey is planned to avoid sensitive times of the year and soft-start and stop procedures are in place for marine mammals sighted within 500 m of the sound source.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Section 8.7 (Aquatic life) – soft-start procedures, use of MMOs, cetacean sighting and reporting. Appendix 1 (Recommended mitigation measures for cetaceans during geophysical operations) – use of exclusion zone for monitoring and soft-start procedure.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008)	The EPS developed for this activity meet the requirements of this policy statement through the adoption of: • Part A (standard management procedures). • Part B (the use of MMOs). With the implementation of EPBC Act Policy Statement 2.1 by experienced MMOs to alert cetaceans to the onset of sound disturbance (e.g., soft starts) and shut downs when there are sightings, behavioural effects (i.e., temporary avoidance) is likely to be the single largest effect on cetaceans, and thus would be limited to the duration of the survey depending on migration season for individual whale species.
	Code of Environmental Practice (APPEA, 2008)	The EPS developed for this activity meet the requirements of this guideline with regard to geophysical surveys: To reduce the impact on cetaceans and other marine life to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.1.1)	There is a 444 km^2 overlap between the acquisition area and the Zeehan AMP (a 2.2% overlap). The acquisition and operational area avoids overlap with the Apollo AMP. Appendix 1 provides an assessment of the potential impacts of the activity on the management aims of the South-East Commonwealth Marine Reserves Network Management Plan 2013-23, which encapsulates the Zeehan AMP. MSS is permitted within the AMP, which is wholly designated as a Multiple Use Zone. Relevance to cetaceans: The Zeehan AMP states lists PBW and humpback cetaceans in its key values (the AMP provides an important migration area for these species). As previously

		noted, the timing of the survey has been designed primarily to avoid temporal overlap with PBW migration and foraging, hile the deeper waters that the humpback whales prefer to migrate along are outside the portion of the AMP intersected by the acquisition area. The Apollo AMP is noted as having value as important migration habitat for the blue, fin, sei and humpback whales. No seismic acquisition will take place within the Apollo AMP, and the closest distance between the park and active seismic lines is 8.5 km, meaning that sound that may result in behavioural impacts to all cetacean groups may extend about 2.6 km into the park. The survey has been timed to minimise temporal overlap with threatened whale species.
	Wetlands of international importance (Section 5.1.4)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest Ramsar wetlands. **Relevance to cetaceans**: no specific application. Cetaceans do not live in these wetlands.
	TECs (Section 5.1.5)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest TECs. **Relevance to cetaceans**: no specific application. The TECs are not recognised areas for cetacean feeding, breeding, resting or migration.
	KEFs (Section 5.1.7)	The acquisition area overlaps 0.58% of the West Tasmania Canyons KEF and only a small area of six of the 72 canyons intersected. This KEF is noted as being important for PBW and humpback whale foraging. The Bonney Upwelling KEF is located 127 km to the northwest of the acquisition area. This seasonal KEF is an important foraging area for PBW and humpback whales. **Relevance to cetaceans**: the Sequoia 3DMSS has been timed to avoid the plankton blooms associated with the Bonney Upwelling (and associated growth in krill populations and whale feeding events). The small intersection between the acquisition area and the West Tasmania Canyons KEF (0.58%) overlap) and the timing of the survey means that there will be no overlap with PBW or humpback whale foraging.
	NIWs (Section 5.1.8)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest NIWs. **Relevance to cetaceans**: no specific application. Cetaceans do not live in these wetlands.
	Nationally threatened and migratory species (Section 5.5)	Impacts to cetaceans will be within acceptable levels through the implementation of EPBC Act Policy Statement 2.1 (e.g., soft starts will alert cetaceans to the start-up of the acoustic sources, while power downs and shut downs will avoid impacts when cetaceans are sighted as too close to the source). The survey will not have a 'significant' impact on critically

		endangered or vulnerable cetacean species) when assessed against the EPBC Act Significant Impact Guidelines 1.1 (DoE, 2013), previously listed. The Conservation Advice documents and Recovery Plans for each of the threatened cetacean species lists anthropogenic noise and acoustic disturbance as a threat (see Table 7.25). The EIA presented in this EP (along with the controls nominated) satisfies the requirements of these advice documents and plans. Cetaceans are omnipresent throughout the South-east Marine Bioregion. There is no limiting habitat restricting these species to migrating, foraging, breeding or resting specifically within the proposed survey area.
	Other Matters	
	State marine parks (Sections 5.1.9, 5.1.10 & 5.1.11)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines. **Relevance to cetaceans:** SRW use the shallow waters of nearby coastlines for migration (which overlap many state marine parks). Seismic sound will not extend to these parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Appendix 2 provides an assessment of the potential impacts of the activity on the management aims of threatened species plans. Relevant cetacean plans are: • Conservation Management Plan for the Blue Whale (DoE, 2015). • Conservation Management Plan for the SRW (DSEWPaC, 2012). • Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015xx). • Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015xx). Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015xx).
ESD principles	The application of the ESD principles to **cetaceans** are outlined here.	
	A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	The timing of the survey has been selected to balance the requirements between peak whale migration and foraging seasons, commercial fishing activity and sea state considerations (see Figure 2.4). EPBC Act policy Statement 2.1 states that when planning MSS, areas and times known to be important for migration should be avoided. The timing of the proposed survey aims to do exactly this.
	B. If there are threats of	The scientific literature cited throughout this section indicates the PTS in cetaceans is likely only within close

	serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	proximity to the sound source, with TTS possible over slightly longer distances. TTS and PTS are unlikely to occur due to the implementation of EPBC Act Policy Statement 2.1. Behavioural impacts, which extend up to distances of 11.1 km from the sound source, will not lead to serious or irreversible damage to cetaceans.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Impacts to cetaceans are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value.
	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	Impacts to cetaceans are assessed to be localised and temporary. There will not be a loss of species diversity and abundance as a result of the MSS.
	E. Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.

Impacts to Pinnipeds

Pinnipeds (seals and sea lions) produce sounds over a generally lower and more restricted bandwidth (generally from 100 Hz to several tens of kHz) than cetaceans. Their sounds are used primarily in critical social and reproductive interactions (Southall et al., 2007). Most pinniped species have peak sensitivities between 1 and 20 kHz (NRC, 2003).

Pinnipeds are divided into two groups:

- Otariid pinnipeds – fur seals and sea lions (‘eared’ seals, using foreflippers for propulsion). This is the group of most relevance to this activity (see Section 5.5.7).
- Phocid pinnipeds – true seals (‘earless’ species).

Sensitivity to Sound

Pinnipeds may tolerate seismic pulses of high intensity and may be able to approach operating seismic vessels to a close range because their hearing is poor in low frequencies (McCauley, 1994). However, it is also suggested that MSS may affect pinniped prey abundance or behaviour, particularly if the seismic survey runs for long periods.

Fur-seals are less sensitive to low frequency sounds (<1 kHz) than to higher frequencies (>1 kHz). McCauley (1994) suggests that the sound frequency of seismic air gun pulses is below the greatest hearing sensitivity of otariid pinnipeds, but data is lacking for Australian species. Prideaux (2017) reports that the effective underwater auditory bandwidth in water for otariid pinnipeds is 60 Hz to 39 kHz.

Aerial sounds produced by the Australian fur-seal have strong tonal components at frequencies that are less than 1 kHz, although they all range up to 6 kHz with most energy between 2-4 kHz. If the low frequency components of calls are used, then seals may also hear at low frequency and may be affected by seismic source pulses. However, Shaughnessy (1999) states that seismic activity will only be a threat to pinnipeds if it takes place close to critical habitats.

Gotz et al (2009) reports that controlled exposure experiments with small acoustic sources (215 – 224 dB re 1 µPa) were carried out over 1 hour to individual harbour seals (Phoca vitulina) and grey seals (Halichoerus grypus), and in seven out of eight trials with harbour seals, the animals exhibited strong avoidance reactions. Two harbour seals equipped with heart rate tags showed immediate, but short-term, startle responses to the initial acoustic source pulses. The behaviour of all harbour seals seemed to return to normal soon after the end of each trial, even in areas where disturbance occurred on several consecutive days. Only one harbour seal showed no detectable response to the acoustic sources and approached the acoustic source to within 300 m, and seals remaining in the water returned to pre-trial behaviours within two hours of the end of the experiment (Gotz et al., 2009). General avoidance behaviour of other northern hemisphere seal species was exhibited at exposure levels above 170 dB re 1 µPa.

Prideaux (2017) reports that spatial displacement of pinnipeds by noise has been observed, however observations are too sparse. Such displacement could have serious consequences if affecting species in their critical habitats. Displacement can cause the temporary loss of important habitat, such as feeding grounds, forcing individuals to either move to sub-optimal feeding location, or to abandon feeding altogether. Noise can also reduce the abundance of prey (such as fin-fish and cephalopods). Displacement can also reduce breeding opportunities, especially during mating seasons. Foraging habitat and breeding seasons are therefore important lifecycle components of pinniped vulnerabilities. In particular, the periods of suckling and weaning are vulnerable times for both mothers and pups.

Thresholds adopted for the STLM

The NOAA (2019) guidance suggests that seals are split into two groups based on functional hearing and PTS and TTS onset thresholds levels, as outlined in Table 7.30.

Table 7.30: Sound level threshold criteria for impairment and behavioural impacts in otariid pinniped

	PTS onset*		TTS onset		Behavioural	
	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs
Threshold value	232 dB re 1 µPa PK	203 dB re 1 µPa^{2}.s SEL	226 dB re 1 µPa PK	188 dB re 1 µPa^{2}.s SEL	160 dB re 1 µPa SPL	No definition
Threshold criteria	PTS is considered injurious in marine mammals but there are no published data on the sound levels that cause PTS. The EIA evaluates dual metric criterion requiring consideration of both PK and accumulated SEL. PTS onset thresholds for marine mammals have not been directly measured, but the NFMS (2018) criteria incorporate the best available science to estimate PTS onset in marine mammals from sound energy (SEL_{24h}) or very loud, instantaneous peak sound pressure levels (PK) through extrapolation from available TTS onset measurements.		TTS onset is often defined as a threshold shift of 6 dB above the normal hearing threshold (Southall *et al*., 2007; 2019). In marine mammals, the onset level and growth of TTS is frequency-specific and depends on the temporal pattern, duty cycle and the hearing test frequency of the fatiguing stimuli. There is considerable individual difference in all TTS-related parameters between subjects and species tested to date.		NOAA (2019) currently use a step function with a 50% probability of inducing behavioural responses at an SPL of 160 dB re 1 µPa to assess behavioural impacts. This threshold value was derived from the responses of migrating baleen whales to an acoustic source sound (Malme *et al*., 1983;1984). An extensive review of behavioural responses to sound was undertaken by Southall et al (2007) which found varying responses for most marine mammals between an SPL of 140 and 180 dB re 1 µPa. There is no SEL_{24h} metric for behavioural responses in high-frequency cetaceans, so per pulse SPL of 160 dB re 1 µPA is used to assess these impacts (as it is for all cetaceans).	
Justification for threshold criteria	The TTS and PTS threshold are from NFMS (2018), which is the most current, globally recognised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing. The thresholds and weighting functions are identical to those in Southall et al (2019). Given that it is difficult to determine thresholds for behavioural response in individual cetaceans due to their varied responses (Nowacek *et al*., 2004; Gomez *et al*., 2016; Southall *et al*., 2016) and is influenced by biological and environmental factors such as age, sex, health and activity at the time of exposure, the behavioural disturbance threshold criteria applied is the current NMFS criterion for marine mammals. This summarises the most recent scientific literature on the impacts of sound on marine mammal hearing, and is therefore considered the most relevant to use for this EIA.					

* Dual metric acoustic thresholds for impulsive sounds: use whichever results in the largest isopleth for calculating PTS onset.

STLM Results

Table 7.31 presents the per-pulse results for PK thresholds in the water column for otariid pinnipeds.

Table 7.31: Maximum (Rmax) horizontal distances from the source array to modelled PK levels for otariid pinnipeds at sites 3, 6, 7 & 10

	PTS onset		TTS onset		Behavioural	
	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs	Per pulse	Over 24 hrs
Distance R_{max}	Not reached		Not reached	80 m	11.1 km	Not measurable

Table 7.31 predicts the following impacts to fur-seals:

- Behaviour – the maximum distance at which the behavioural response criterion of 160 dB re 1 µPa could be exceeded by SPL is 11.1 km.
- TTS – the distance to sound levels associated with the onset of TTS is not reached for single sound pulses, and is reached within 80 m using the SEL24h metric. However, such exposure is not likely to be triggered because seals will not remain in the one location for this duration of time.
- PTS – the distance to sound levels associated with the onset of PTS (using the PK and SEL24h metrics) is not reached for otariid pinnipeds.

Impact Assessment

The STLM results indicate that there is no potential for TTS (per pulse) and PTS impacts to pinnipeds.

Behavioural impacts for seals may extend 11.1 km horizontally from the sound source. Seals are known to forage in areas far from their breeding colonies and haul-out sites. With many such sites in Bass Strait (see Figure 5.37), it is possible that seal feeding grounds may be subject to sound levels that result in behavioural changes. However, given the abundance of foraging habitat for seals throughout Bass Strait, and the fact that the acquisition area does not represent limiting habitat, any temporary exclusion from feeding grounds is expected to be of minor consequence.

As shown in Figure 5.37, the nearest areas of breeding or haul-out sites to the acquisition area are:

- New Zealand fur-seal breeding colony – Seal Rocks, located at the southern end of King Islands' west coast, 26 km east of the acquisition area; and
- Australian fur-seal breeding colony – Reid Rocks, southeast of King Island and 50 km east of the acquisition area.

At these distances from the acquisition area, the STLM predicts that no behavioural, TTS and PTS thresholds will be reached. As such, impacts to breeding success will not occur (noting that breeding takes place onshore, not in the water).

Fish, benthic invertebrates and cephalopods, being the key prey of pinnipeds, are not likely to be impacted in the long-term by the MSS (see 'Impacts to Fish'). Fish displacement around the operating sound source will occur, but is generally temporary and localised. Cephalopods are likely to have a shorter distance to displacement than fish, and the threshold for behaviour for cephalopods is greater than that for pinnipeds, meaning that cephalopods are expected to displace to a lesser extent than pinnipeds when exposed to an equivalent level of sound. Benthic invertebrates are restricted in their ability to rapidly move away from seismic sound. This, and the literature suggesting that mortality of benthic invertebrates from MSS are unlikely, mean that benthic prey will remain available to seals. As such, the consequence to the foraging habits of fur-seals is assessed as negligible.

Demonstration of Acceptability

In accordance with Section 4 of NOPSEMA's EP decision making Guideline (GL1721, Rev 6, November 2019) and the methodology outlined in Chapter 6, Table 7.32 presents a demonstration of acceptability.

Table 7.32: Demonstration of acceptability for potential impacts to pinnipeds

Statement of acceptability	The survey does not result in injury or displacement of seals from foraging areas, breeding colonies or haul-out sites.	
Internal context	Policy compliance	ConocoPhillips HSE Policy objectives are met through implementation of this EP.
	HSEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the HSEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
External context (stakeholder engagement)	COP Sequoia has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. **Relevance to pinnipeds:** There has been no concern expressed by stakeholders about impacts to cetaceans.	

Legislative context	The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of:
	• EPBC Act 1999 (Cth).
	  • Section 254 – all listed marine species are protected in Australian waters, and it is an offence to kill or injure a listed marine species without a permit.
	• OPGGS Act 2006 (Cth).
	  • Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seafloor (and other matters)…to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.	

Industry practice	The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice (listed in order of most to least recent) demonstrates that BPEM is being implemented.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include: • Considering sensitive locations and times of year for critical activities of species that are present. • Using an MMO. • Using soft-start procedures. **Relevance to pinnipeds:** these considerations have been factored into the EIA and into the EPS. MMOs will be used and the EPBC Act Policy Statement 2.1 (which specific soft-start procedures) will be implemented by the MMOs.

	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)	This document provides guidelines regarding: • An exclusion zone for monitoring (500-m horizontal distance). • Pre-start observations in the exclusion zone (for at least 30 minutes). • Soft-start procedure. • Monitoring during periods of poor visibility and darkness. • Use of a passive acoustic monitoring (PAM) system. • Recording all monitoring data. **Relevance to pinnipeds**: the application of EPBC Act Policy Statement 2.1 for cetaceans will also minimise risks to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 db re 1 uPa for marine mammals. Shut-downs are not required to take place for seals.
	Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities (Prideaux, 2017)	This document was developed to present the BPEM for marine noise-generating activities, including MSS. It includes 12 modules covering various species groups and what should be taken into consideration when undertaking EIA. **Relevance to cetaceans:** Section B.5 of the guideline specifically discusses pinnipeds. The EIA assessment criteria listed in Section B.5.4 have been considered in this EP and the listed TTS and PTS thresholds are the same as those used for the STLM.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The EPS developed for this activity and in the design of the survey in general take into account the four practices outlined in this guideline (see Section 3.7.4). **Relevance to pinnipeds:** no specific application.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Noise (item 74) – the preparation of this EP meets the objectives of these guidelines because sensitive areas for marine life are identified, the survey is planned to avoid sensitive times of the year and soft-start and stop procedures are in place for marine mammals sighted within 500 m of the sound source. **Relevance to pinnipeds:** the application of EPBC Act Policy Statement 2.1 for cetaceans will also minimise risks to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 db re 1 uPa for marine mammals. Shut-downs are not required to take

		place for seals.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Section 8.7 (Aquatic life) – soft-start procedures, use of MMOs, cetacean sighting and reporting. • Appendix 1 (Recommended mitigation measures for cetaceans during geophysical operations) – use of exclusion zone for monitoring and soft-start procedure. **Relevance to pinnipeds:** the application of EPBC Act Policy Statement 2.1 for cetaceans will also minimise risks to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 db re 1 uPa for marine mammals. Shut-downs are not required to take place for seals.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008)	The EPS developed for this activity meet the requirements of this policy statement through the adoption of: • Part A (standard management procedures). • Part B (the use of MMOs). **Relevance to pinnipeds:** the application of EPBC Act Policy Statement 2.1 for cetaceans will also minimise risks to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 db re 1 uPa for marine mammals. Shut-downs are not required to take place for seals.
	Code of Environmental Practice (APPEA, 2008)	The EPS developed for this activity meet the requirements of this guideline with regard to geophysical surveys: • To reduce the impact on cetaceans and other marine life to ALARP and to an acceptable level. **Relevance to pinnipeds:** considered as 'marine life.'
Environmental context	MNES	
	AMPs (Section 5.1.1)	There is a 444 km^2 overlap between the acquisition area and the Zeehan AMP (a 2.2% overlap). The acquisition and operational area avoids overlap with the Apollo AMP. Appendix 1 provides an assessment of the potential impacts of the activity on the management aims of the South-East Commonwealth Marine Reserves Network Management Plan 2013-23, which encapsulates the Zeehan AMP. MSS is permitted within the AMP, which is wholly designated as a Multiple Use Zone. **Relevance to pinnipeds:** neither the Zeehan or Apollo

		AMPs list seals as key values. This is not unexpected given that both parks lack emergent rocky islands that important as seal haul out sites and breeding colonies.
	Wetlands of international importance (Section 5.1.4)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest Ramsar wetlands. **Relevance to pinnipeds**: no specific application. Pinnipeds do not live in these wetlands.
	TECs (Section 5.1.5)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest TECs. **Relevance to pinnipeds:** no specific application. The TECs are not recognised areas for pinniped feeding, breeding or haul-outs.
	KEFs (Section 5.1.7)	The acquisition area overlaps a small area of six of the 72 canyons comprising the West Tasmania Canyons KEF. **Relevance to pinnipeds:** this KEF does not list pinnipeds as a key value.
	NIWs (Section 5.1.8)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest NIWs. **Relevance to pinnipeds:** no specific application. Cetaceans do not live in these wetlands.
	Nationally threatened and migratory species (Section 5.5)	**Relevance to pinnipeds**: no specific application. Pinnipeds are listed marine species and not threatened or migratory.
	Other Matters	
	State marine parks (Sections 5.1.9, 5.1.10 & 5.1.11)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines. **Relevance to pinnipeds:** several seal breeding colonies and haul-out sites are located within state marine parks. Seismic sound will not extend to these parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	There are no approved conservation plans, listed advice or recovery plans for pinnipeds in Australian waters.
ESD principles	The application of the ESD principles to **pinnipeds** are outlined here.	
	A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	The STLM undertaken to support the EIA indicates that impacts to pinnipeds will be negligible to minor, with very few short-term and no long-term impacts to individual seals or seal populations.
	B. If there are threats of serious or irreversible	The STLM indicates that TTS and PTS thresholds for pinnipeds will not be triggered by this survey. Behavioural impacts, which extend up to distances of

	environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	11.1 km from the sound source, will not lead to serious or irreversible damage to pinnipeds or their food supply.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Impacts to pinnipeds are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value.
	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	There will not be a loss of pinniped species diversity and abundance as a result of the MSS.
	E. Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.

Impacts to Turtles

Sensitivity to Sound

There is limited information on sea turtle hearing and the impacts of underwater sound (DoEE, 2017). 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 listening. 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 aforementioned middle ear cavity, and hence they hear best underwater (Willis, 2016).

Electrophysiological and behavioural studies on green and loggerhead sea turtles found their hearing frequency range to be approximately 50–2,000 Hz, with highest sensitivity to sounds between 200 and 400 Hz (Ridgway et al., 1969; Bartol et al., 1999; Ketten & Bartol, 2005; Bartol & Ketten, 2006; Yudhana et al., 2010, Piniak et al., 2011; Lavender et al., 2002, Lavender et al., 2012;2014), although these studies were all conducted in-air. 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 higher 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.

DoEE (2017) states that turtles potentially use sound for navigation, locating prey and avoiding predators, and that that green, leatherback and hawksbill turtles can detect stimuli underwater and in air up to 1,600 Hz, but their greatest sensitivity appears to be between 50-400 Hz depending on the species.

Loggerhead turtles have been found to have the best sensitivity between 100-400 Hz.

Nelms et al (2016) conducted a review of seismic surveys and turtles that considers the studies detailed below. A common theme is the complex nature of the studies, from the interpretation of behavioural responses, determining responses due to acoustic sources or vessel noise/presence, through to difficulties in visually detecting animals. Most studies examining the effect of seismic noise on marine turtles have focused on behavioural responses given that physiological impacts are more difficult to observe in living animals.

Sea turtles have been shown to avoid low-frequency sounds (Lenhardt, 1994) and sounds from an acoustic source (O'Hara and Wilcox, 1990), but these reports did not note received sound levels. Moein et al (1995) found that penned loggerhead sea turtles initially reacted to a single acoustic source but then showed low or no response to the sound (i.e., they may have become habituated to it). Caged green turtles and loggerhead turtles increased their swimming activity in response to an approaching acoustic source when the received SPL was above 166 dB re 1 µPa and they behaved erratically when the received SPL was approximately

175 dB re 1 µPa (McCauley et al., 2000b). This study was conducted in cold water and might not represent typical responses (given that these two species are typically found in tropical and sub-tropical waters).

Sound levels defined by Popper et al (2014) show that animals are very likely to exhibit a:

- Behavioural response when they are near an acoustic source (tens of metres);
- Moderate response if they encounter the source at intermediate ranges (hundreds of metres); and
- Low response if they are far (thousands of meters) from the acoustic source.

Weir (2007) carried out observations from onboard a seismic survey vessel during a 10-month 3DMSS offshore from West Africa, 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 1,000 m of the array."

The reduction in the number of turtles observed within 1,000 m during operation of a full acoustic source array is therefore reasonably consistent with the observations of McCauley et al (2003), which indicated an avoidance response threshold of approximately 175 dB re 1 µPa (SPL).

At very close distances to the acoustic source array, there is also the possibility of temporary hearing impairment or perhaps even permanent hearing damage to turtles. However, there are very few data on temporary hearing loss and no data on permanent hearing loss in sea turtles exposed to acoustic source pulses. Although some information is available about effects of exposure to sounds from a single acoustic source on captive sea turtles, the long-term acoustic effects (if any) of a full-scale MSS on free-ranging sea turtles are unknown. The greatest impact is likely to occur if seismic operations occur in or near areas where turtles concentrate, and at seasons when turtles are concentrated there.

Thresholds adopted for the STLM

Table 7.33 presents the exposure criteria for acoustic sources for turtles. In general, any adverse effects of seismic sound on turtle behaviour depends on the species, the state of the individuals exposed, and other factors.

Table 7.33: Exposure criteria for seismic sources – turtles

	PTS onset		TTS onset		Behavioural	
	Per pulse	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**
Threshold value	232 dB re 1 µPa PK	204 dB re SEL_{24h}	226 dB re 1 µPa PK	189 dB re SEL_{24h}	Response: 166 dB SPL – McCauley et al (2000) Disturbance: 175 dB SPL – NSF (2011)	No definition
Threshold criteria	Thresholds defined recently by Finneran et al (2017) for PTS and TTS in marine turtles have been adopted. The rationale here is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol & Ketten, 2006; Dow Piniak *et al*., 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fish than to marine mammals (Popper *et al*., 2014). Popper et al (2014) provides a scale of relative risk for recoverable injury and TTS. The scale assumes that recoverable injury and TTS are possible. The relative risk is defined as: • Near field (tens of meters) - high; • Intermediate field (hundreds of metres) – low; and • Far field (thousands of metres) – Low				McCauley et al (2000) observed behavioural response in caged turtles at 166 dB SPL. Above 175 dB re 1 µPa, turtles have been observed to behave erratically, which was interpreted as an agitated state (NSF, 2011). This is interpreted as a behavioural disturbance. Both criteria are used in the modelling – response and behaviour. The Recovery Plan for Marine Turtles in Australia (DoEE, 2017) acknowledges the 166 dB re 1 µPa SPL reported by McCauley et al (2000) as the level that may result in a behavioural response to marine turtles.	
Justification for threshold criteria	There is limited information on turtle hearing. Most studies looking at the effect of seismic sound on turtles have focussed on behavioural responses given that physiological impacts are more difficult to observe in living animals. Exposure criteria developed by Popper et al (2014) based on the results of the Working Group on the Effects of Sound on Fish and Turtles, as well as Finneran et al (2017) have been adopted. Based on the limited data with regards to sound levels that illicit a behavioural response in turtles, the 166 dB SPL behavioural threshold is typically applied by the NMFS, and therefore adopted for the Australian context.					

STLM Results

Table 7.34 presents the predicted ranges for the per-pulse results for turtles for the 10 modelled sites.

Table 7.34: Maximum (Rmax) horizontal distances from the source array to modelled seafloor PK levels from four transects for turtles

SPL (L_p; dB re 1 µPa)	Site 1 (103 m)		Site 2 (69 m)		Site 3 (102 m)		Site 4 (115 m)		Site 5 (118 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
166 dB	4.72	3.68	5.43	3.94	4.5	3.55	4.34	3.38	4.62	3.47
175 dB	1.62	1.29	1.66	1.26	1.62	1.28	1.48	1.18	1.42	1.14
	Site 6 (798 m)		Site 7 (606 m)		Site 8 (299 m)		Site 9 (125 m)		Site 10 (106 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
166 dB	3.89	2.9	4.45	3.38	5.14	3.78	5.32	3.53	4.2	3.46
175 dB	0.75	0.69	1.36	0.77	1.26	0.95	1.38	1.15	1.62	1.31

Red = highest distance to threshold, green = lowest distance to threshold.

These results indicate that the greatest distance from the sound source for behavioural response is predicted to be 5.43 km and for behavioural disturbance it is 1.66 km.

The modelling predicts that the per-pulse TTS and PTS thresholds for turtles are not triggered.

Table 7.35 presents the maximum-over-depth distances to frequency weighted SEL24hr TTS and PTS thresholds for turtles and the modelled area affected by each threshold. These results predict that the greatest distance from the sound source is 500 m for TTS and 80 m for PTS.

Table 7.35: Maximum-over-depth distances to SEL24hr-based turtle criteria

SEL_{24hr} (dB re 1 µPa^2·s)	Scenario 1		Scenario 2	
	R_{max}	Area (km^2)	R_{max}	Area (km^2)
189 dB – TTS	500 m	145	460 m	124
204 dB – PTS	80 m	2.54	80 m	3.26

Impact Assessment

Impacts to turtles as a result of the Prion 3DMSS will have a minor consequence based on the following:

- Turtles are occasional vagrants in Bass Strait, with no BIAs and no nesting beaches, meaning they are unlikely to be present in and around the survey area or acoustic EMBA.
- The per-pulse TTS and PTS thresholds are not triggered.
- Behavioural response may be exceeded at distances ranging between 3.89 km and 5.43 km from the sound source, and behavioural disturbance may be exceeded at distances between 0.75 km and 1.66 km from the sound source, depending on water depths. Turtles may begin to show increased swimming behaviour as the sound source approaches. This behaviour is likely to mean that turtles will move away from the sound source, an avoidance response, and then resume normal activity.
- The SEL24hr thresholds will not be triggered because it assumes the turtle remains within that distance of the sound source for a continuous 24 hours.
- The survey will not result in permanent destruction or modification of potential turtle prey species.

Demonstration of Acceptability

In accordance with Section 4 of NOPSEMA's EP decision making Guideline (GL1721, Rev 6, November 2019) and the methodology outlined in Chapter 6, Table 7.36 presents a demonstration of acceptability.

Table 7.36: Demonstration of acceptability for potential impacts to turtles

<table>
<tr><td>Statement of acceptability</td><td colspan="2">Turtles are not injured or displaced from migratory routes or foraging, breeding and nesting grounds.
The Sequoia 3DMSS is not inconsistent with the aims of the Recovery Plan for Marine Turtles in Australia (DoEE, 2017).</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>ConocoPhillips HSE Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>HSEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the HSEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.</td></tr>
<tr><td>External context (stakeholder engagement)</td><td colspan="2">COP Sequoia has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS.
Relevance to turtles: There has been no concern expressed by stakeholders about impacts to turtles.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of:
EPBC Act 1999 (Cth).
Section 254 – all listed marine species are protected in Australian waters, and it is an offence to kill or injure a listed marine species without a permit.
OPGGS Act 2006 (Cth).
Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation, fishing, conservation of the resources of the sea and seafloor (and other matters) to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice (listed in order of most to least recent) demonstrates that BPEM is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity take into account the management measures listed for exploration in Section 4.4.1 of the guidelines, which include:
Considering sensitive locations and times of year for critical activities of species that are present.
Using an MMO.
Using soft-start procedures.
Relevance to turtles: not applicable; there are no recognised migration, feeding, breeding or nesting grounds in the Otway Basin.</td></tr>
</table>

	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)	This document provides guidelines regarding: • An exclusion zone for monitoring (500-m horizontal distance). • Pre-start observations in the exclusion zone (for at least 30 minutes). • Soft-start procedure. • Monitoring during periods of poor visibility and darkness. • Use of a passive acoustic monitoring (PAM) system. • Recording all monitoring data. **Relevance to turtles:** no specific application.
	Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities (Prideaux, 2017)	This document was developed to present the BPEM for marine noise-generating activities, including MSS. It includes 12 modules covering various species groups and what should be taken into consideration when undertaking EIA. **Relevance to turtles:** Section B.9 of the guideline specifically discusses turtles. The EIA assessment criteria listed in Section B.9.4 have been considered in this EP (i.e., assessment against TTS, PTS and behavioural thresholds).
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The EPS developed for this activity and in the design of the survey in general take into account the four practices outlined in this guideline (see Section 3.7.4). **Relevance to turtles:** no specific application.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Noise (item 74) – the preparation of this EP meets the objectives of these guidelines because sensitive areas for marine life are identified, the survey is planned to avoid sensitive times of the year and soft-start and stop procedures are in place for marine mammals sighted within 500 m of the sound source. **Relevance to turtles:** no specific application.

	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS developed for this activity meet the requirements of these guidelines with regard to: • Section 8.7 (Aquatic life) – soft-start procedures, use of MMOs, cetacean sighting and reporting. • Appendix 1 (Recommended mitigation measures for cetaceans during geophysical operations) – use of exclusion zone for monitoring and soft-start procedure. **Relevance to turtles:** no specific application.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA, 2008)	The EPS developed for this activity meet the requirements of this policy statement through the adoption of: • Part A (standard management procedures). • Part B (the use of MMOs). **Relevance to turtles:** no specific application.
	Code of Environmental Practice (APPEA, 2008)	The EPS developed for this activity meet the requirements of this guideline with regard to geophysical surveys: • To reduce the impact on cetaceans and other marine life to ALARP and to an acceptable level. **Relevance to turtles:** considered as 'marine life.'
Environmental context	MNES	
	AMPs (Section 5.1.1)	There is a 444 km^2 overlap between the acquisition area and the Zeehan AMP (a 2.2% overlap). The acquisition and operational area avoids overlap with the Apollo AMP. Appendix 1 provides an assessment of the potential impacts of the activity on the management aims of the South-East Commonwealth Marine Reserves Network Management Plan 2013-23, which encapsulates the Zeehan AMP. MSS is permitted within the AMP, which is wholly designated as a Multiple Use Zone. **Relevance to turtles:** neither the Zeehan nor Apollo AMPs list turtles as key values.
	Wetlands of international importance (Section 5.1.4)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest Ramsar wetlands. **Relevance to turtles:** no specific application. Turtles do not live in these wetlands.
	TECs (Section 5.1.5)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest TECs. **Relevance to turtles:** no specific application. The TECs are not recognised areas for turtle migration, feeding, breeding or nesting.

<table>
<tr><td></td><td>KEFs
(Section 5.1.7)</td><td>The acquisition area overlaps a small area of six of the 72 canyons comprising the West Tasmania Canyons KEF.
Relevance to turtles: this KEF does not list turtles as a key value.</td></tr>
<tr><td></td><td>NIWs
(Section 5.1.8)</td><td>The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest NIWs.
Relevance to turtles: no specific application. Turtles do not live in these wetlands.</td></tr>
<tr><td></td><td>Nationally threatened and migratory species (Section 5.5)</td><td>Relevance to turtles: turtles are listed migratory and threatened species. The EIA addresses potential impacts of the survey to turtles, which predicts only behavioural disturbance is likely (no TTS or PTS).</td></tr>
<tr><td></td><td colspan="2">Other matters</td></tr>
<tr><td></td><td>State marine parks
(Sections 5.1.9, 5.1.10 & 5.1.11)</td><td>The STLM indicates sound created by the MSS will not reach levels above ambient sound at state marine parks, which are located around islands and along mainland coastlines.
Relevance to turtles: none of the state marine parks are recognised areas of importance for turtle migration, feeding, breeding or nesting.</td></tr>
<tr><td></td><td>Species Conservation Advice/
Recovery Plans/
Threat Abatement Plans</td><td>The Recovery Plan for Marine Turtles in Australia (DoEE, 2017) lists noise interference (4K) as a threat to the six turtle species occurring in Australian waters. It also states that while the EPBC Act Policy Statement 2.1 is not designed for interactions with turtles, its implementation is likely to afford protection for turtles. However, there are no actions or interim objectives listed in the Recovery Plan relating to underwater sound. As such, the impacts of the survey are not inconsistent with the aims of this plan.
Appendix 2 provides an assessment of the impacts of the survey on the management aims of this plan.</td></tr>
<tr><td>ESD principles</td><td colspan="2">The application of the ESD principles to turtles are outlined here.<table><tr><td>A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.</td><td>The STLM undertaken to support the EIA indicates that there are unlikely to be short-term or long-term impacts to individual turtles or turtle populations.</td></tr></table></td></tr>
</table>

	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.	The STLM indicates that TTS and PTS thresholds for turtles will not be triggered by this survey. Behavioural responses, which extend up to a distance of 5.43 km from the sound source, will not lead to serious or irreversible damage to turtles.
	C. The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Impacts to turtles are assessed to be localised and temporary. These impacts will not affect present and future generations in terms of maintaining biodiversity for its intrinsic value.
	D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	There will not be a loss of turtle species diversity and abundance as a result of the MSS.
	E. Improved valuation, pricing and incentive mechanisms should be promoted.	Not relevant.

Impacts to Birds

Seabirds

The proposed acquisition area contains potential foraging habitat for a diverse array of seabirds, as listed and described in Section 5.5.9.

In the event that individual birds or flocks are present in the acquisition area during operations, vessel movement is expected to temporarily deter them from foraging in the immediate vicinity of the vessel. The risk of underwater sound significantly impacting individuals or a population of any given species during plunge/dive feeding is extremely low. While resting/rafting on the water surface, there is limited potential for seabirds to be affected by the seismic sound due to the limited transmission of sound between the air-water interface. If there is an affect, it is likely to be a startle response, resulting in the bird flying away.

An indirect impact may occur if seismic source discharges causes changes to the abundance or behaviour of prey species (fish). However, the extent to which temporary 'descending' or 'tightening' responses of schooling prey fish such as pilchards (if it occurs) affects availability to avifaunal predators either positively or negatively, is not known. As described in the section regarding fish, the effects to fish from the survey will be very localised and temporary. As such, effects to foraging seabirds is likely to be negligible.

Seabird species that may occur in the proposed acquisition area all have considerable foraging habitat present throughout Bass Strait. The size of the proposed acquisition area is not significant relative to their normal foraging environments. Any temporary dispersal of prey species (i.e., fish) due to acquisition activities would not result in any significant decrease in availability of prey species that is of biological significance for these populations given the abundance of ocean and available foraging habitat outside of the acquisition area.

Shorebirds

Shorebird species will not be affected by the MSS, given their prey is concentrated within the intertidal zone along the coastline, a significant distance from the underwater sound EMBA.

Aquatic birds

Little penguins have foraging and breeding BIAs around many of the islands of Bass Strait (see Figure 5.41), with the closest known breeding colony being 108 km west-southwest of the survey area.

Penguins communicate via vocalisations that allow partners to recognise each other and their chick. There is a lack of information on the auditory systems and communication of penguins, however the hearing range of most birds lies between 0.1 - 8 kHz (McCauley, 1994), which is also the range in which penguin sounds have been recorded in air (Kent et al., 2016). It is therefore inferred that penguins have relatively poor hearing thresholds in the lower frequencies, which is where MSS have the most energy (10-250 Hz) (McCauley, 1994).

This is supported in part by observations made by dedicated on-board MMO personnel of little penguins approaching seismic survey vessels during survey acquisition in eastern Bass Strait during 2001 and 2002 (Doodie, pers. comm., 2003; Pinzone, pers. obs., 2003), while previous seismic surveys conducted in the

Otway region observed a similar situation, suggesting that this species is not disturbed by the seismic sound source. It may be that the penguins are unaffected as they are in the seismic 'shadow' area, predominantly above the downward focus of the pulse.

McCauley (1994) concluded that:

- The perception for the low frequency of sounds of seismic array 'shots' (10-300 Hz) in water will be high but only at short distances. However, this does not rule out the possibility that seismic pulses could be detected at long ranges, given their high intensities;
- Prey species may have changes in their abundance or behaviour; and
- Seismic sound-induced changes in prey behaviour for protracted periods and within 15 km of important penguin rookeries during the summer months could have the greatest impact on the penguin's reproductive output.

During the 2014 Enterprise 3D transition zone seismic survey (2,500 cui source array), undertaken in Victorian coastal waters in depth ranges 20 to 65 m and located 1 km from the coast (~67 km northwest of the acquisition area), breeding little penguin adults were equipped with GPS and depth recorders before and concomitantly with seismic survey activities in the vicinity of known colonies. The differences in behaviour characteristics of the little penguin, such as trip duration, maximum distance travelled during foraging, path length, dive frequency, dive time and average dive depth between survey and non-survey periods was not statistically significant, suggesting that little penguins do not appear to be disturbed by seismic sound (Pichegru et al., 2016).

As with other predatory avifauna, penguins may be indirectly affected if air gun discharges alter the abundance or behaviour of prey (such as pilchards, which is predicted to be localised, as assessed earlier in 'Impacts to fish'). However, given this species routinely forages over distances of 15 – 50 km from their colonies and are highly mobile in the water, this is not expected to have any significant impact to the species.

Thresholds adopted for the STLM

There are no thresholds for underwater sound impacts to seabirds. As such, no modelling can be conducted.

Impact Assessment

Impacts to seabirds as a result of the survey will have a negligible consequence based on the following:

- Most seabirds spend very little time under the water surface, and when they do it is for several seconds at a time. This is unlikely to be long enough to result in TTS, PTS or mortality.
- The acquisition area does not contain spatially limiting food sources, with the Southern Ocean and Bass Strait providing abundant foraging grounds.
- The survey will not result in the loss of prey species (fish). Because fish temporarily move away from the sound source, birds are unlikely to be foraging for fish in areas where the sound is of a high enough intensity to cause these effects, thereby avoiding any effects themselves.
- For little penguins specifically, the nearest known breeding colony is located at Three Hummock Island, 108 km west-southwest of the acquisition area. Given that these penguins forage between 15 and 50 km from their breeding colony during the breeding season, and up to 75 km from the coast at other times (SARDI, 2011), the acquisition area is likely to lie outside their foraging grounds. As such, it is unlikely they will come close to the sound source if their prey (primarily pilchards) are frightened away by the sound. This prey will become available elsewhere for the penguins to feed on.

Demonstration of Acceptability

Given that seabirds spend such little time under the water, shorebirds reside outside the underwater sound EMBA and aquatic bird BIAs are located well outside the underwater sound EMBA, impacts to birds are assessed to be acceptable.

Impacts to the Zeehan AMP

The Sequoia 3DMSS intersects 444 km2 of the Multiple Use Zone of the Zeehan AMP (a 2.2% overlap with the park, or 47% of the Multiple Use Zone).

Underwater sound from the survey will enter the Special Use Zone of the Zeehan AMP (which is 14 km to the west of the nearest survey line), only exceeding the TTS 24-hr threshold levels for LFC.

The Apollo AMP is designated entirely as Multiple Use Zone. The Apollo AMP is located 8.5 km from the acquisition area at its closest point. Only sound levels exceeding the behavioural threshold for cetaceans and TTS 24-hr threshold levels for LFC will extend into the Apollo AMP.

There is no park-specific management plan in place for the AMPs within the South-east Marine Region, so an assessment of the Sequoia 3DMSS is conducted against the IUCN reserve management principles and the major conservation values of the park in Table 7.37. Both the Multiple Use Zone and Special Use Zone of the Zeehan AMP are assigned IUCN category VI.

Table 7.37: Impacts of the Sequoia 3DMSS against the IUCN reserve management principles and major conservation values of the Zeehan and Apollo AMPs

Category	Managed Resource Protected Area: Protected Area managed mainly for the sustainable use of natural ecosystems
IUCN category description	Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.
Primary objective	To protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.
IUCN reserve management principles (Schedule 8 of the EPBC Regulations 2000)	**How Sequoia 3DMSS complies with these principles**
The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long term.	The EIA presented throughout this EP indicates that there will be low impacts and risks to biodiversity and other natural values of the AMP.
Management practices should be applied to ensure ecologically sustainable use of the reserve or zone.	The EPS developed to manage underwater sound levels demonstrate that the values of the AMP will be managed to ALARP and an acceptable level. No resources will be extracted from the AMP.
Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.	Impacts from the survey will have no influence on the management of the zones within the AMP.
Major conservation values of the Zeehan AMP	**How Sequoia 3DMSS impacts these values**
Ecosystems, habitats and communities and associated seafloor features:	
Tasmania Province	This bioregion is noted as having a high diversity of demersal fish, with 52 endemic species (DoE, 2015). Impacts to fish from the survey are assessed to be negligible (see 'Impacts to Fish').
West Tasmania Transition	No biological values are assigned to these bioregions (DoE, 2015). The survey will not have any impacts to physical seafloor features and impacts in the water column will be very temporary in any given location. Impacts to benthic fauna present in these bioregions is addressed in 'Impacts to Molluscs' and 'Impacts to Crustaceans' and are assessed as negligible.
Western Bass Strait Shelf Transition	
Fauna:	
Important migration area for blue whales and humpback whales	Impacts to cetaceans from the survey are assessed to be negligible (see 'Impacts to Cetaceans').
Important foraging areas for black-browed, wandering and shy-albatross, and great-winged and cape petrels	Impacts to seabirds from the survey are assessed to be negligible (see 'Impacts to Birds).
Major conservation values of the Apollo AMP	**How Sequoia 3DMSS impacts these values**
Ecosystems, habitats and communities and associated seafloor features:	

Western Bass Strait Shelf Transition	As per Zeehan AMP.
Bass Strait Shelf Province	
Fauna:	
Important migration area for blue, fin, sei and humpback whales	Impacts to cetaceans from the survey are assessed to be minor (see 'Impacts to Cetaceans').
Important foraging area for black-browed and shy-albatross, Australasian gannet, short-tailed shearwater and crested tern	Impacts to seabirds from the survey are assessed to be negligible (see 'Impacts to Birds).
Cultural and heritage sites:	
Wreck of the MV City of Rayville	The shipwreck is located approximately 28 km northeast of the acquisition area. Sound levels at this distance from the acquisition area will not result in any structural damage to the shipwreck.

Effects of the Sequoia 3DMSS to the Zeehan and Apollo AMPs are considered acceptable because they are not inconsistent with the IUCN reserve management principles relevant to the parks, and because the impacts to fauna present within the parks have been determined earlier in this chapter to be ALARP and acceptable.

Impacts on Divers

Issue

As described in Section 5.7.5, the King Island coastline adjacent to the survey area supports low levels of commercial abalone diving. The closest abalone diving area to the Sequoia 3DMSS area is the WRARA, located 21 km from the nearest acquisition line.

If divers are fishing for abalone at the time of the Sequoia 3DMSS at the WRARA, there is potential that the underwater sound may be audible to divers. Similarly, the seismic sound may be audible to recreational divers who may be diving around the numerous shipwrecks along the west coast of King Island (see Section 5.6.3).

Sensitivity to Sound

There are physiological and social risks associated with underwater sound and humans.

Three main physiological symptoms associated with high-level low-frequency sound sources have been identified in humans (NATO, n.d.):

- The first involves the Pacinian corpuscle, a sensor of the nervous system that is distributed throughout the epidermis and provides for vibrotactile sensitivity. The frequency response of the Pacinian corpuscles peaks at about 250 Hz, the most annoying frequency in divers' complaints of tingling and numbness.
- The second effect involves acoustically-forced vibrations of gas pockets in the gastrointestinal tract, which may be responsible for complaints of abdominal discomfort.
- The third major effect is one involving TTS in hearing caused by the high levels of sound.

Socially and economically, restricting the ability of people to dive wherever and whenever they want may temporarily impact on their finances (commercial fishers) or their leisure time.

Table 7.38 summarises the physiological effects of underwater sound as reported by Parvin (2005).

Table 7.38: 38 Biological effects of underwater sound on divers and swimmers

SPL dB re 1uPA	Effect (500 to 2,500 Hz)
100 – 500 Hz	
170 +	Tolerance limit for divers and swimmers. Sound causes lung and body vibration.
148-157	The loudness and vibration levels become increasingly aversive. Some divers will contemplate aborting an open water dive.
140-148	A small number of divers rate the sound as “very severe.”
136-140	The sound is clearly audible. The majority of divers tolerate the sound well with only “slight” aversion.
130	Divers and swimmers are able to detect body vibration.
80-100	Auditory thresholds.
500 – 2,500 Hz	
190+	Hooded diver tolerance limit.
167-185	Tolerance limit for bareheaded divers and swimmers. Sound causes dizziness and disorientation. Divers in suit and hood are able to tolerate the sound well.
155-166	Divers tolerate these sounds well, although an increasing number of bareheaded divers indicate a “severe” aversion rating.
140-154	Sound is clearly audible to divers. Sound is tolerated well with only slight aversion.
100-140	Divers hear underwater sound, but it is masked by exhaust bubble sound.
80	Hearing threshold for hooded divers.
65	Hearing threshold for bareheaded divers.

Thresholds Adopted for the STLM

The following information is sourced largely from the JASCO STLM report (Appendix 15).

The human ear under water is about 20 dB less sensitive than in air at low frequencies (20 Hz), increasing to 40 dB at mid-frequencies (< 1 kHz), and increasing to 70–80 dB at higher frequencies. 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 (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.

Human hearing underwater with a ‘wet’ ear (i.e., water contact with ear canal) is less sensitive than sound in air and 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).

Divers wearing a neoprene hood have even higher hearing thresholds above 500 Hz due to sound absorption by the hood material at high frequencies (Parvin, 1998). Fothergill et al (2000, 2001) exposed divers to pure tones of constant frequency as well as sweeps and asked divers to rate the sound they heard on a severity scale. The auditory threshold of hearing under water was lowest at 1 kHz (SPL of 70 dB re 1 µPa) and rose for lower and higher frequencies to about 120 dB re 1 µPa at 20 Hz and at 20 kHz (Parvin, 1998). For frequencies between 100 and 500 Hz, at a received SPL of 130 dB re 1 µPa, divers and swimmers were able to detect body vibration (Fothergill et al., 2001). None of the divers tested rated levels of 140 dB re 1 µPa as “very severe”; however, at 157 dB re 1 µPa, sound was rated as “very severe” 19% of the time. No physiological damage was seen at the highest levels tested: 160 dB re 1 µPa (Fothergill et al., 2001).

As a result of such controlled diver exposure experiments, the following recreational diver and swimmer safety exposure criteria for frequencies between 100 and 500 Hz based on Fothergill et al (2001) and Parvin (2005) is:

- The maximum SPL should be 145 dB re 1 µPa over a maximum continuous exposure of 100 seconds or with a maximum duty cycle of 20% and a maximum daily cumulative total of 3 hours (Pestorius et al., 2009).

This safety exposure criteria does not imply that this level is associated with the onset of injury. Exposure studies related to divers have typically focused on military sonar exposure, with little information on seismic surveys. A precautionary safety criterion for divers for exposure to low frequency active sonar with signals between 500 and 2,500 Hz of 155 dB re 1 µPa (SPL) is commonly applied (including for shipping and port operations and international dive sites). This level is clearly audible above diver self-noise (breathing), but has not been shown to cause any physical injury. The majority of energy from the acoustic source array for the Sequoia 3DMSS is <500 Hz, and to add a further level of precaution, the safety criterion is assessed over the entire modelled frequency range (5 Hz to 25 kHz).

STLM Results

Table 7.39 presents the distances required to reach the diver and swimmer safety criterion from three modelling sites. The sites modelled (Sites 2, 3 and 4) are those closest to the west coast of King Island (see Figure 7.3) where it is known that diving and swimming occurs.

The results presented in Table 7.39 indicate that the safety criterion is reached at distances ranging between 30.6 km and 41.9 km, meaning that the criterion is reached at the eastern coastline of King Island (which is 24 km east of the eastern-most acquisition line).

Table 7.39: Maximum (Rmax) horizontal distances from the source array to modelled maximum-over-depth SPL isopleth for the human diver and swimmer assessment threshold

SPL (L_p; dB re 1 uPa)	Distance R_{max} (km)		
	Site 2 (69 m)	Site 3 (102 m)	Site 4 (115 m)
145	41.9	32.4	30.6

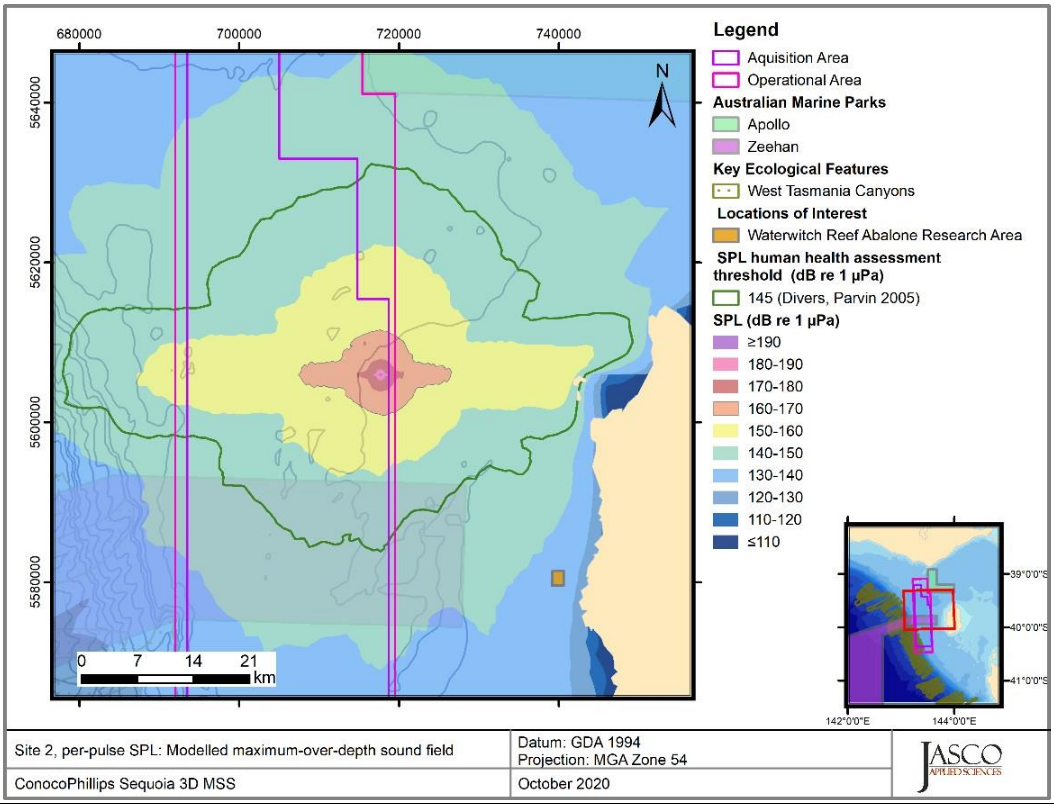
Table 7.40 presents the per-pulse levels reached at the WRARA. These results indicate that the diver and swimmer criterion of 145 dB re 1 µPa will be reached at this site.

Figure 7.7 illustrates the sound level contour maps for the modelling sites.

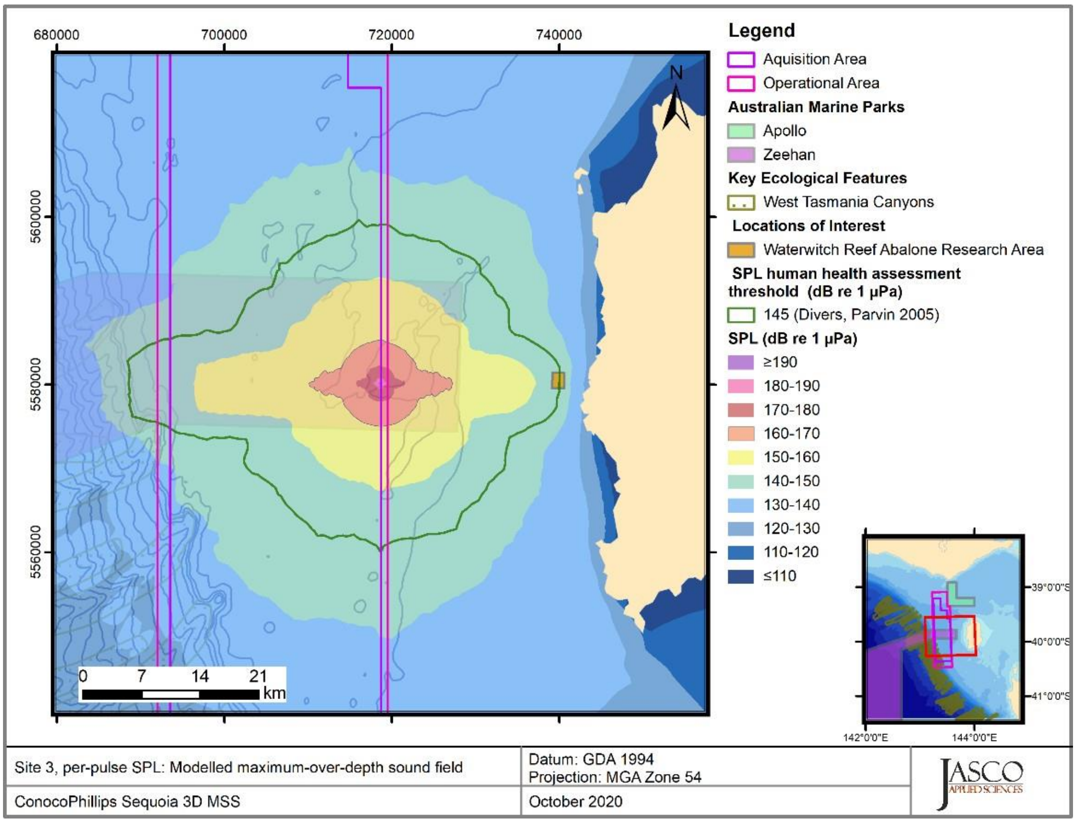
Table 7.40: Maximum-over-depth per-pulse received levels at the Waterwitch Reef abalone research area location when the array is at Site 3 (closest to the reef)

Metric	Received level at the WRARA:		
	Western edge	Centre	Eastern edge
SPL (dB re 1 uPa)	146.9	145.3	143.1

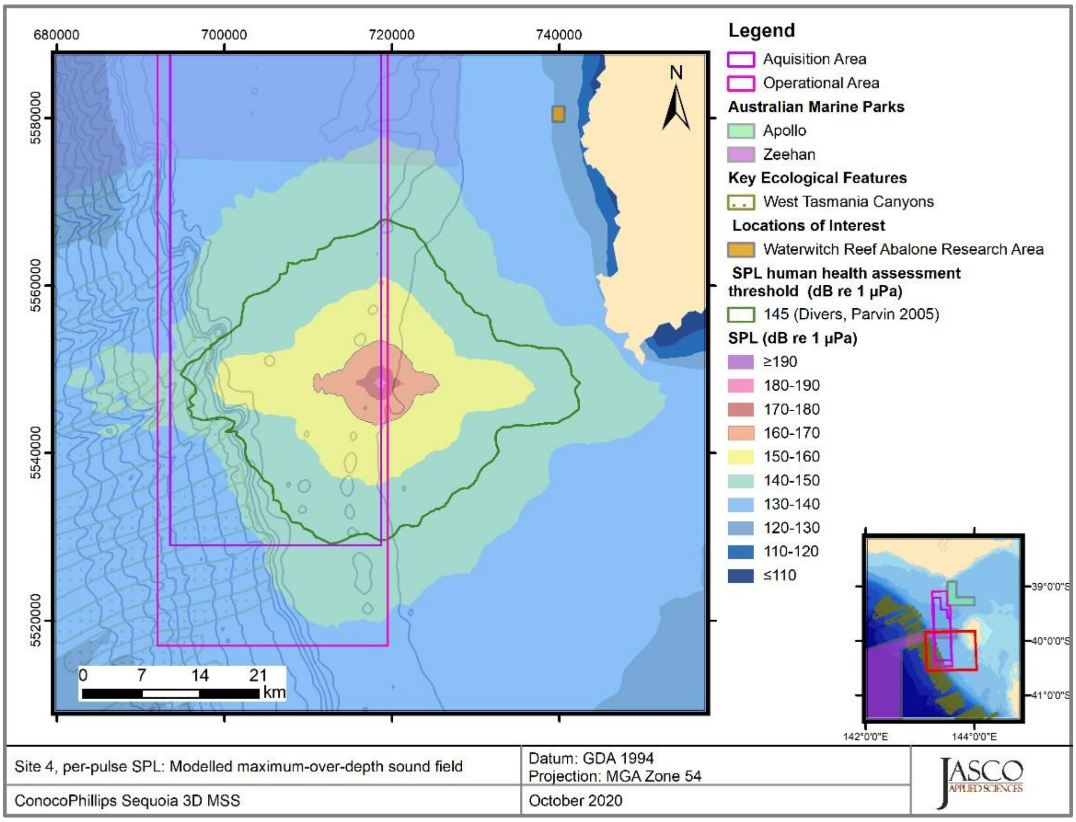
Figure 7.7: Sound level contours for the unweighted maximum-over-depth sound field and the isopleth for the human divers and swimmers health assessment criterion



Site 2 (69 m water depth)



Site 3 (102 m water depth)

	Site 4 (115 m water depth)

Impact Assessment

Limited research has been undertaken into the physiological effects of underwater low frequency sound on humans. Available studies have concentrated on frequency bands 100 to 500 Hz (as most seismic survey energy is produced at frequencies below 500 Hz) and 500 to 2,500 Hz. Table 7.34 details the physiological effects of low frequency sound (100 to 500 Hz) based on available research (Parvin, 2005).

DMAC (2011) reports that the intensity of the sound experienced by a diver is dependent on the power of the seismic acoustic source array and the distance between the diver and the seismic acoustic source, but other factors may have important effects. These factors include the:

- Water depth at which the seismic activity takes place;
- Presence of thermoclines (layering due to changes in temperature);
- Depth of the diver versus the depth of the thermocline;
- Bottom conditions;
- Salinity; and
- Sea state.

The multiple factors involved make it difficult to determine a safe or tolerable distance between seismic surveys and diving, particularly in shallow water (DMAC, 2011).

Not withstanding this, the STLM predicts there are likely to be times when the human diver and swimmer safety criterion is exceeded along the west coast of King Island and at the WRARA. These will be limited to the eastern-most acquisition lines, which are 86 km long. At a sail speed of 4 knots (7.4 km/hr), these lines will take about 12 hours to complete. If divers are present in the water adjacent to the east coast of King Island during these times, the sound level could be rated as very severe and they may feel the need to abandon their dive, but it is not at a level that would cause injury. Given the short periods of time when it is advisable not to be in the water, the consequence of these restrictions is assessed as negligible (financial loss) and minor (social impact)

- Swimming beaches along the east coast of King Island (i.e., sandy beaches with suitable access, moving north to south) are restricted to:
- Yellow Rock Beach (12 km stretch along the northwest part of the island);
- North of the Porky Creek river mouth (2.2 km long);
- Near the mouth of the Porky Creek (1.9 km long);
- Stingray Bay at Currie (1.2 km long);
- South of Netherby Point (3.1 km long); and
- Fitzmaurice Bay near Pearshape (1.6 km long), north of the Seal Rock State Reserve.

As illustrated in Figure 7.7, the human diver and swimmer criterion is not exceeded in areas immediately adjacent to beaches, so people will be safe to swim in the nearshore waters while the eastern-most survey lines are being acquired.

Demonstration of Acceptability

The demonstration of acceptability methodology is not suitable for application to human receptors. ConocoPhillips considers that impacts on divers from the Sequoia 3DMSS are acceptable because:

- The STLM is based on conservative criterion,
- There are only short periods of time where underwater sound is predicted to exceed the criterion; and
- Consultation between ConocoPhillips and relevant persons (see EPS at the end of this underwater sound section) will aim to ensure that relevant persons understand the risks and avoid diving during acquisition of the eastern-most survey lines.

Impacts to the Indigo Communications Cable

As described in Section 5.7.3, the Indigo telecommunications cable traverses a distance of 21 km east-west across the northern part of the acquisition area (see Figure 5.43).

The International Cable Protection Commission (ICPC) document No 8 ‘Procedure to be followed whilst offshore seismic work is undertaken in the vicinity of active submarine cable systems’ (Issue 9) (ICPC, 2014) states that if the internal components of the cable are subject to acceleration greater than specification, there is a risk of serious damage. Where an MSS results in pressure greater than 2 bar at the seafloor, the survey design must be adjusted to reduce the pressure.

Overpressure is the positive peak pressure, or what is modelled in the STLM as peak pressure (PK). Based on the conversion of PK to bar (10*(PK-220)/20), a 2 bar overpressure is equivalent to ~226 dB re 1uPa PK. This PK threshold is the same as that applied to sponges and corals on the seafloor, and the STLM predicts that this threshold is not reached. As such, no impacts to the telecommunications cable are predicted.

At least two MSS have been undertaken over sections of the Telstra Bass Strait 2 telecommunications cable (153 km east of the Sequoia survey area, Figure 5.43) since it was laid in 2003, these being Labatt 3DMSS (2008), which overlapped 23 km of the cable and the Chappell 3DMSS (2011), which overlapped 12.6 km of the cable. No impacts from these surveys to the cable were reported. As such, it is expected that the Sequoia 3DMSS will similarly have no impact on the Indigo communications cable. ConocoPhillips Australia has not received feedback from Superloop (owners of the Indigo communications cable) regarding whether they have any concerns about the survey proceeding over the cable.

Impacts to or from UXO

As described in Section 5.7.7 (and illustrated in Figure 5.43), there are areas of known UXO in and around the Sequoia 3DMSS area. The area overlapped by the survey area is a former air-to-air firing range. Advice provided from the Department of Defence to ConocoPhillips Australia is that the majority of the ammunition used in this firing range would have been 'ball' (non-high explosive) and the risk of the MSS resulting in detonation of any ammunition is negligible.

ConocoPhillips Australia considers the risk of the MSS on UXO to be ALARP and acceptable because the DoD considers the risks to be negligible.

Cumulative Impact Assessment

ConocoPhillips Australia definition of cumulative impacts is provided in Section 6.4.3 of the EP.

Cumulative impacts are also defined in Elliott (2014) as those impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with an existing project.

Cumulative EIA is notoriously difficult to undertake because of the many uncertainties associated with the impacts of past projects and uncertainties in determining reasonably foreseeable actions.

To address this, NOPSEMA's Acoustic impact evaluation and management information paper (N-04750-IP1765, June 2020) provides advice on describing the cumulative impacts in MSS EPs. In Section 3.1.2 of this information paper, it states that cumulative impact scenarios may include:

- Multiple exposures over the duration of one activity (e.g., consecutive parts of an activity);
- Multiple exposures from consecutive activities;
- Cumulative impacts over a large area where there are two or more simultaneous sound generating activities;
- Cumulative impacts over consecutive seasons in areas that are considered biologically important for certain receptors;
- Cumulative impacts from multiple, different sources of sound; and
- Interactions between sound and other stressors.
- Section 3.4.2 of the NOPSEMA information paper states that with regard to making predictions and evaluating impacts:
- The evaluation must assess the cumulative effects from the full activity scope and the biological or ecological consequence of all relevant effects at an appropriate spatial scale.
- The evaluation of impacts should also consider the potential for cumulative effects from multiple noise sources, either concurrent or sequential in the region of the proposed activity.

These cumulative impact assessment criteria are applied to the Sequoia 3DMSS in Table 7.41.

Cumulative impacts relating to underwater sound can occur when the time between MSS activities is less than the recovery rate of any potential impacts to receptors. Popper (2018) notes that for fish, 24 hours is likely far too long a period of time for calculation of accumulation of energy in determining potential harm (e.g., TTS) and therefore, there is no scientific basis for determining impacts longer than 24 hours. Similarly,

the NMFS applies a 'resetting' of SELcum after 12 hours of non-exposure (Stadler & Woodbury, 2009). It is also noted that the most likely impact to fish from cumulative sound exposure is TTS. If TTS does occur, recovery will start as soon as the most intense sound ends, so recovery within 24 hours (or less) is likely (Popper, 2018). As such, cumulative impacts to fish populations from past MSS or simultaneous MSS are unlikely to occur, especially as immigration and recruitment of unaffected individuals to a population will increase the resilience of that population.

Table 7.41: Cumulative Impact Assessment

Activity	Assessment
Multiple exposures over the duration of the activity	
This is addressed for each relevant group of marine receptors through the use of the accumulated 24-hr SEL in this chapter. Shipping traffic in and immediately around the survey area is very light and as such, the cumulative impacts of infrequent third-party vessel movements occurring concurrently with the Sequoia 3DMSS are not assessed.	
Otway development drilling and well abandonment (RMS ID 4963)	Beach Energy is proposing to drill and abandon several wells in Vic/L23 and T/L2 commencing in the first half of 2021 and located about 28 km west of the closest point to the Sequoia 3DMSS acquisition area. This activity may occur concurrently with the Sequoia 3DMSS. The EP for the drilling and abandonment campaign states that underwater sound from support vessels (above ambient sound) is not extended to extend more than 3-4 km from the vessel, meaning it will not extend into the Sequoia 3DMSS acquisition area. The TTS for LFC for the Sequoia 3DMSS (56.6 km) extends to the drilling area, but because the timing of the survey id designed to avoid PBW migration and foraging in the region and avoid the peak and shoulder seasons for SRW migrating out of calving areas or using interconnecting habitat on the west coast of King Island, cumulative impacts to threatened LFC from these two activities occurring concurrently are likely to be avoided or negligible.
Multiple exposures from consecutive activities	
Otway Basin 2DMSS (RMS ID 4834)	Schlumberger Australia undertook this multi-client survey from 16 January to 21 April 2020, with its closest acquisition line approximately 15 km to the west of the proposed Sequoia acquisition area. No cumulative effects resulting from this activity and the Sequoia 3DMSS are predicted because: • If the Sequoia 3DMSS commences as planned, there will be a gap of 15 months between the two surveys. Applying the NMFS 'resetting' and Popper (2018) guidance, 15 months of non-exposure to a similar sound source is sufficient time for any resident fauna to recover from previous exposure to sound. • The longest distances to effect modelled for biological receptors for the activity is 7 km for LFC and 4.9 km for fish, meaning that sound of sufficient volume to result in behavioural effects or TTS did not extend into the Sequoia 3DMSS area.
There is no certainty about what geophysical or seismic activities may precede or proceed the Sequoia 3DMSS. The information presented here is based on discussions with other titleholders regarding reasonably foreseeable activities.	

T/30P geophysical and geotechnical seafloor survey (RMS ID 5197)	Beach Energy is proposing to undertake an 8-day 2D MSS (using a sound source of 160 cui over an area of 36 km^2) as part of the T/30P geophysical and geotechnical seafloor survey. This is located about 36 km west of the proposed Sequoia acquisition area and is proposed to take place in the first half of 2021. The EP for this activity states that the activity will not occur during the period when blue, fin, pygmy right and sei whales are likely to be foraging in the eastern area of the blue whale foraging BIA where the survey is located. It will be undertaken outside the period when SRW may be present in the area. The EP predicts no mortality or injury to marine invertebrates. No cumulative effects resulting from this activity and the Sequoia 3DMSS are predicted because: • If this activity proceeds during the timeframe stated, there will be at least two months between it and the Sequoia 3DMSS starting. Applying the NMFS and Popper (2018) 'resetting' guidance, two months of non-exposure to a similar sound source is sufficient time for any resident fauna to recover from previous exposure to sound. • It is located 36 km away, well beyond the longest distances to effect modelled for biological receptors for the activity (which is 1.5 km for behavioural effects to LFC).
Prion 3DMSS (RMS 5496)	Beach Energy plans to acquire the Prion 3DMSS (141 km east of the Sequoia acquisition area) between July 2021 and June 2022, though it may commence any time up to 2023. The survey proposes to use a 2,495 cui airgun array with 10-12 streamers. While the EP nominates preferred seasons for survey acquisition, a specific time has not been nominated and therefore an assessment of cumulative effects is not possible. Nevertheless, the fact that the Prion 3DMSS is located 141 km east of the Sequoia 3DMSS means that sound from both surveys will not overlap if they were to be conducted at the same time. There is a sufficient distance between both surveys such that LFC would be able to migrate, forage and feed in areas free of seismic sound.
Flanagan 3DMSS (RMS IS 2772)	3D Oil acquired the Flanagan 3DMSS in T/49P (the northern part of the Sequoia 3DMSS) during November and December 2014 using a 3,500 cui source array. Applying the NMFS and Popper (2018) 'resetting' guidance, 7-8 years of non-exposure to a similar sound source is sufficient time for any resident fauna to recover from previous exposure to sound.
Cumulative impacts over a large area where there are two or more simultaneous sound generating activities	

Otway Deep MSS (RMS ID 4496)	Proposed by Spectrum Geo Australia (now TGS), this EP was accepted in June 2019 but has not yet been acquired. The time windows in which it is approved to acquire the survey are: • Seasons 1 + 2 - 1st October 2019 to end February 2020 (expired) and 1st October 2020 to end February 2021 (this has not taken place). • Seasons 1 + 3 - 1st October 2019 to end February 2020 (expired) and 1st October 2021 to end February 2022. • Seasons 2 + 3 - 1st October 2020 to end February 2021 and 1st October 2021 to end February 2022. At its nearest point, the acquisition area is located about 11 km to the west of the Sequoia acquisition area. The longest distances to effect predicted in the Otway Deep MSS EP are 8.4 km (cetacean behaviour) and 48.15 km for TTS cumulative exposure for LFC. ConocoPhillips Australia commissioned JASCO to undertake cumulative STLM in the event that the Otway Deep MSS occurs concurrently with the Sequoia 3DMSS. This information is presented following this table. Few if any cumulative effects resulting from both surveys operating concurrently are likely because: • Both survey contractors will remain in close communication to maintain at least a 40 km distance between each other. • The overlap in survey windows is short (October only), regardless of whether both surveys commenced in 2021 or 2022. Given the large size of the proposed

Sequoia 3DMSS-specific Cumulative STLM

ConocoPhillips Australia commissioned JASCO to prepare cumulative STLM for the scenario in which the Otway Deep MSS may be undertaken concurrently with the Sequoia 3DMSS. As outlined in Table 7.38, the Otway Deep MSS has the most likelihood of occurring at the same time as the Sequoia 3DMSS.

The modelling approach for the two surveys considered source directivity and the area's range-dependent environmental properties. The seismic source arrays considered in the modelling studies were:

- A 3,480 cui seismic source array to be used during the Sequoia 3D MSS; and
- A 3,475 cui seismic source array that could be operated during the Otway Deep MSS.

The additive effects of multiple concurrent seismic surveys in the region include:

- The effects of multiple individual sound fields in separate geographic locations resulting in spatially separate areas of disturbance, such as when surveys occur at a significant distance from one another; and
- The potential interaction of sound fields produced by separate MSS, where sound waves from the separate seismic sources may be received either in synchrony ("in sync") or out of synchrony ("out of sync").

This analysis primarily considers Item 2.

Any additional surveys will be conducted without any intended temporal synchronisation between operations and the short duration of the acoustic source impulses (hundreds of milliseconds) as compared to the inter-pulse interval of several seconds, therefore any the perfect alignment of impulses is highly unlikely.

For this assessment, the closest two single impulse modelling sites from the modelling assessment for both surveys were considered, Site 1 from the Sequoia 3DMSS (103 m water depth) and Site 6 from the Otway

MSS (1,076 m water depth) (Figure 7.8). The locations for the two single impulse sites are 50 km apart (10 km further apart than the 40 km separation for concurrent operations that would be applied during each survey), however they provide guidance to the relative extent of the sound fields.

This analysis quantifies the SPL that would result from combining the sound fields from both surveys under two assumptions, given the aforementioned caveats:

- Scenario 1: Pulses from both surveys do not overlap; and
- Scenario 2: Pulses from both surveys overlap in time at any given point.

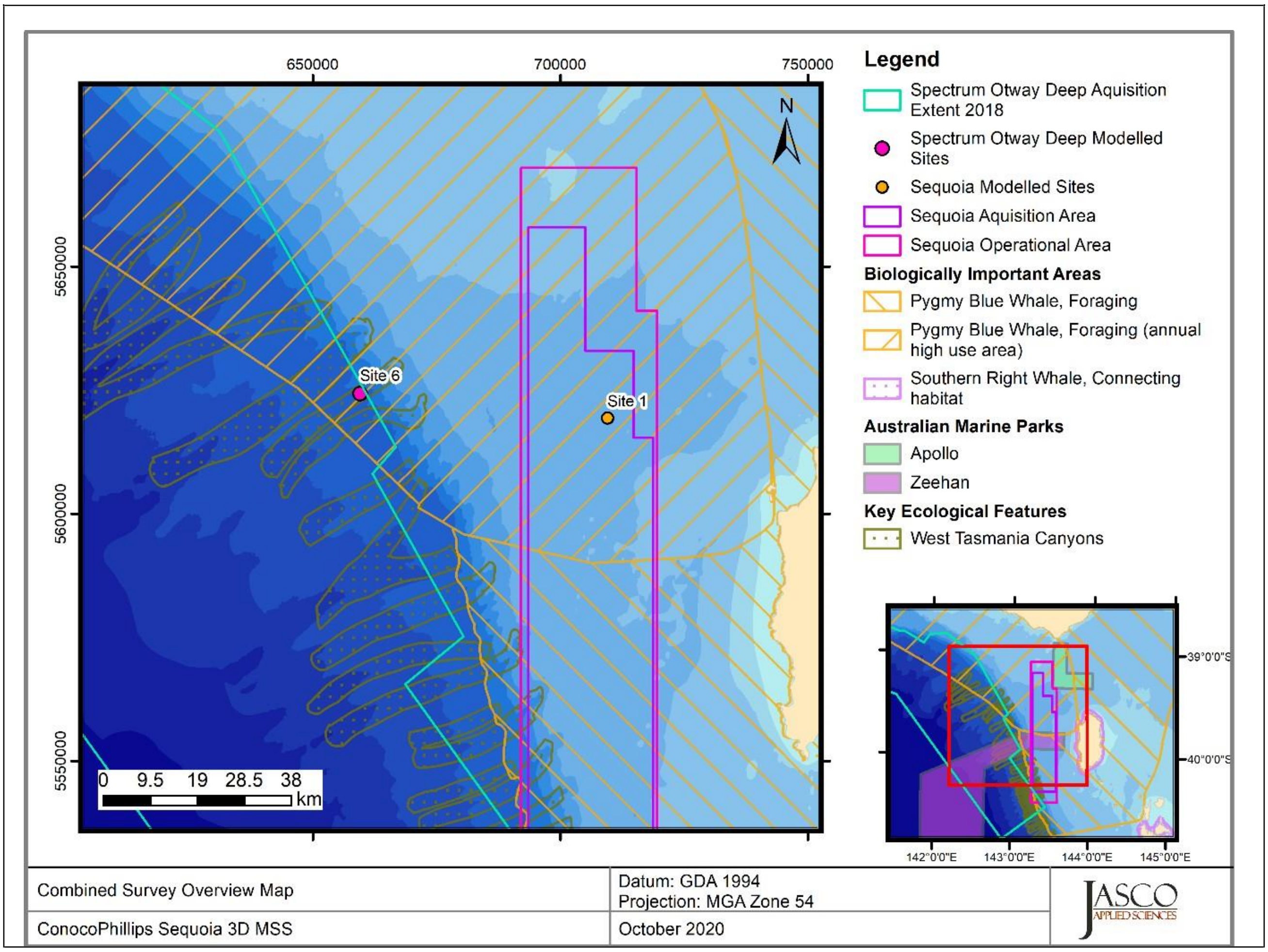
This study quantifies how the use of two seismic sources might influence the received sound levels and the extent of seismic effects compared with the use of a single source. The key conclusion from this analysis is that the two sources are largely non-synergetic in terms of per-pulse sound fields. An increase in sound levels may sometimes occur temporarily at locations where the received signals from each source occur in sync. However, in most instances, pulses will be out of sync and increased received per-pulse sound levels will rarely occur.

A conservative assessment of the cumulative impacts of sound has been undertaken to consider the unlikely case of two pulses exactly synchronised with each other, or for SPL the 125 ms window used for the assessment aligning. This is because this scenario has the potential to increase sound levels. For pulses occurring simultaneously, the relative difference between received levels from the two surveys is important. To place this in context, if the received level at a nominal location of interest from each survey was to be the same, then the combined SPL would be 3 dB higher than the individual SPL, which represents a doubling of sound energy. However, the greater the difference in received SPL at the nominal receiver from each source, the smaller the resulting increase. For example, a difference of 10 dB between the received levels results in an increase equivalent to 0.4 dB for the combined level.

While the pulses will still line up occasionally for a brief moment at some locations, unless they coincide roughly equidistant to both sources, the synchronous signals will be closer to one or the other of the two sources and their amplitudes will then be too unequal for the sum level to differ much from the stronger of the two components.

Therefore, the sound produced by two separate sources may generally be treated as spatially separated sound fields and single pulse sound levels will not typically increase as a result of synchronous pulses of sound. However, in circumstances when two seismic sources sail within close proximity of each other, the overall area where sound levels associated with different effects thresholds are exceeded will be greater. This would only occur for a relatively short period when the two survey vessels and seismic sources are operating at their closest points of approach to one another. At other times, the two seismic survey vessels may be tens or hundreds of kilometres apart.

Figure 7.8: Modelling sites for the cumulative STLM



The sound level contour maps for the Scenario 1 is presented in Figure 7.8 and Scenario 2 is presented in Figure 7.9. The increase in modelled SPL results for the overlap scenario (Scenario 2) compared to the no overlap scenario is shown in Figure 7.10.

Figure 7.9: Sound level contours showing unweighted maximum-over-depth SPL results for Scenario 1 (the two seismic source arrays do not overlap in time)

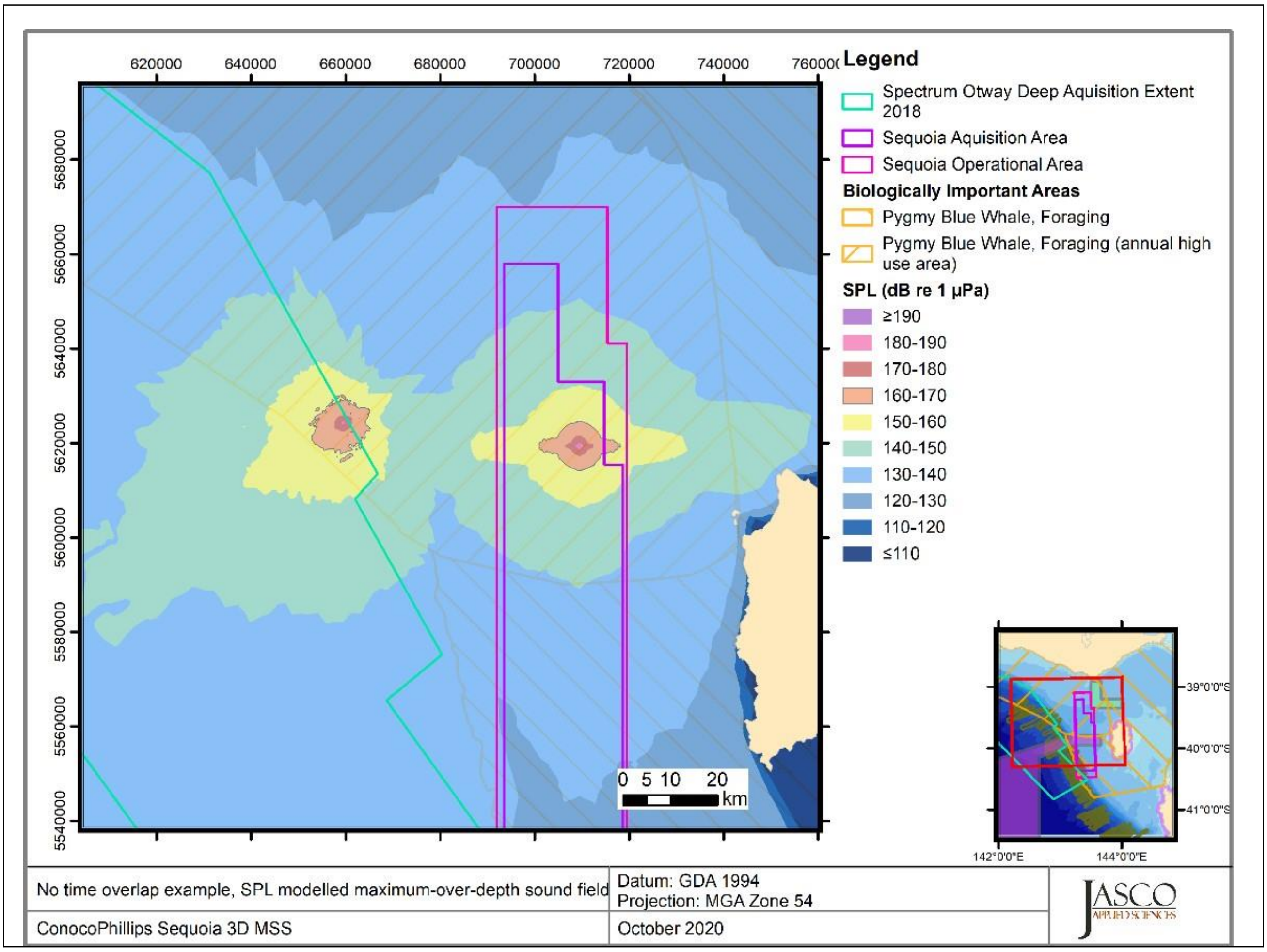
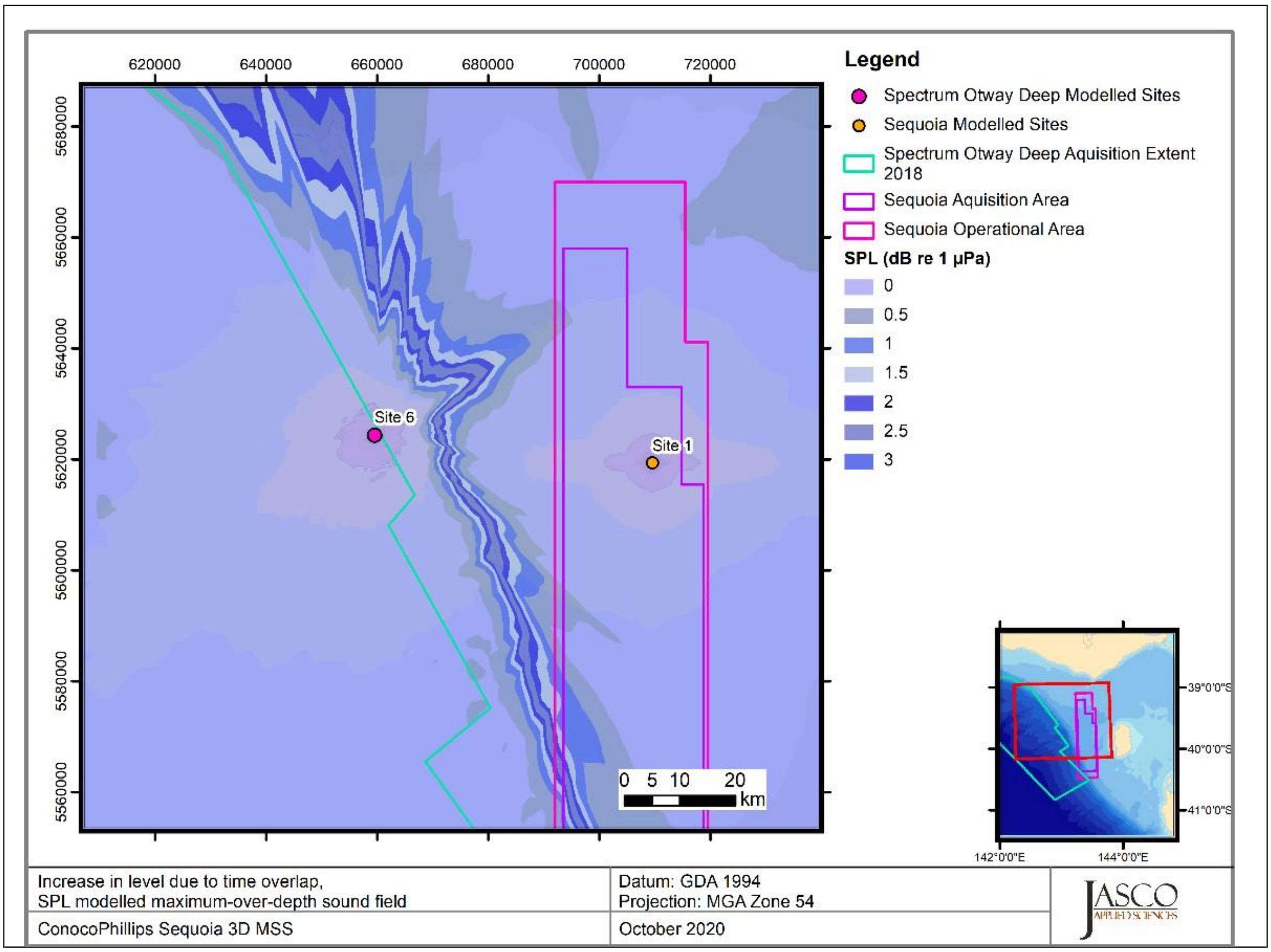


Figure 7.10: Sound level contours showing unweighted maximum-over-depth SPL results for Scenario 2 (the two seismic source arrays do overlap in time)



The most conservative cumulative operations exposure scenario accounting for a single impulse from both the Sequoia 3D MSS and the Otway Deep MSS is to consider two simultaneous impulses at the minimum possible separation distance proposed for concurrent operations. While this distance will be no less than 40 km, the two modelling sites available for consideration from each survey had a minimum separation of 50 km.

Given that both surveys will be conducted without any intended temporal synchronisation between operations and the short duration of the acoustic source impulses (hundreds of milliseconds) as compared to the shot interval of several seconds (8.1 seconds for the Sequoia 3D MSS and 8 seconds for Otway Deep MSS), this scenario is not very likely. Nevertheless, considering the possibility of both surveys occurring simultaneously, and the scenario of simultaneous impulses, the relative difference between received levels from the two surveys is important. The differences are most likely related to the relative difference in distance of the two surveys to the points of interest, differences in bathymetry and geological sub-bottom features as well as the aforementioned difference in source level between the two arrays.

Figure 7.8 and Figure 7.9 illustrate how two pulses may combine to increase sound levels when they are exactly synchronised, compared with two pulses that are slightly out of synch, with a maximum difference of 3 dB, as shown in Figure 7.10.

The worst-case scenario (simultaneous impulses for the arrays in the two modelling sites) does not alter the area ensonified associated with any of the single impulse thresholds applied, or the distances to these thresholds.

The overall acoustic footprint from accumulated SELs from two sources may therefore increase. However, given that the greatest contribution to accumulated SEL occurs from the closest pulses, any increase in the potential for effects such as TTS in marine fauna would occur when the seismic sources are operating in close proximity to one another. For actual surveys, the shape of the sound fields, which is related to the line plan, needs to be considered for thresholds such as TTS.

To reduce the risk of cumulative impacts from concurrent MSS, best practice is to maintain a spatial separation of at least 40 km between the active seismic sources (BOEM, 2014). ConocoPhillips Australia will maintain a minimum separation distance of 40 km from any other MSS being undertaken in the region.

Maintaining a separation distance of this magnitude will ensure multiple active sound sources do not overlap and therefore will not cause higher SEL for marine species. This approach reduces the risk from cumulative noise effects to ALARP.

Industry Practice to Mitigate Cumulative Effects

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 (BOEM, 2014). To minimise the impacts to marine life by providing a ‘corridor’ between vessels, the environmental impact statement from this review included a requirement for a 40 km (21.6 nm) geographic separation distance (based on worst case scenarios) between the sources of simultaneous MSS. This is now a routinely adopted control in the seismic survey industry.

Of importance is that two seismic sources operating simultaneously will not result in an additive increase in the received sound level close to each source. Rather, close to each source the combined levels are very similar to those produced by that source alone. As such, two operating seismic sources separated by 40 km will not significantly increase the area where there is a risk of physiological impacts to marine fauna. It is also reasonable to assume that any MSS will implement at least standard mitigation measures from EPBC Act Policy Statement 2.1, such as ramp-up and power down/shut down zones. The implementation of these standard mitigation measures will further mitigate the sound risk impacts to marine fauna (and specifically cetaceans) from two seismic sources operating simultaneously at a 40 km separation distance.

Monitoring for other Seismic Surveys

Following acceptance of this EP, ConocoPhillips Australia will continue to monitor the NOPSEMA website for submitted and accepted MSS EPs that may contribute to cumulative noise in the Sequoia survey area. If a survey is permitted within 40 km of the Sequoia 3DMSS and its timing indicates it may overlap that for Sequoia, ConocoPhillips Australia will contact the relevant titleholder to ensure arrangements are made to reduce cumulative impacts wherever possible. As a minimum, ConocoPhillips Australia will not acquire seismic data within 40 km of another actively acquiring seismic vessel.

Analysis of approved MSS

A review of the NOPSEMA website to determine what MSS have recently taken place, are approved to take place or are under assessment in the general vicinity of the Sequoia 3DMSS (using the Otway and Tasmania search areas on the NOPSEMA website) has been undertaken. Table 7.42presents the results of this review (as of 13 November 2020), and excludes the Dorrigo 3DMSS (given that the Sequoia 3DMSS replaces the Dorrigo 3DMSS).

Table 7.42: Analysis of MSS Environmental Plans

Activity	Assessment
Accepted and acquired	
Otway Basin 2DMSS (RMS ID 4834)	Schlumberger Australia undertook this multi-client survey from 16 January to 21 April 2020, and its closest acquisition line was about 15 km to the west of the proposed Sequoia acquisition area.
Accepted but not yet acquired	
Otway Deep MSS (RMS ID 4496)	Proposed by Spectrum Geo Australia (now TGS), this EP was accepted in June 2019 but has not yet been acquired. The time windows in which it is approved to acquire the survey are listed in Table 7.38. The cumulative STLM discussed outlines the potential impacts of both surveys operating simultaneously.
Under assessment	
T/30P geophysical and geotechnical seafloor survey (RMS ID 5197)	Beach Energy is proposing to undertake an 8-day 2D MSS (using a sound source of 160 cui over an area of 36 km^2) as part of the T/30P geophysical and geotechnical seafloor survey. This is located about 36 km west of the proposed Sequoia acquisition area and is proposed to take place in the first half of 2021.
Due to be formally submitted for assessment	
Prion 3DMSS	Beach Energy plans to acquire the Prion 3DMSS (141 km east of the Sequoia acquisition area). Beach Energy submitted the EP for public exhibition in December 2020.

7.1.5. Impact Assessment

Table 7.43 presents the impact assessment for underwater sound.

Table 7.43: Impact assessment for underwater sound

Summary	
Summary of impacts	Physiological or pathological impacts to local populations of marine fauna.
Extent of impacts	An EMBA for each of the major fauna groups is defined earlier in this section.
Duration of impacts	Underwater sound will only be generated for the duration of the survey. Impacts related to behaviour, TTS or PTS are temporary. In some cases, impacts are permanent (e.g., plankton close to the sound source) but recovery at the population level will be rapid.
Level of certainty of impacts	Low certainty – invertebrates. Moderate certainty – turtles, seals, plankton. High certainty – fish, cetaceans.
Impact decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined. MSS are regularly undertaken and have a mature regulatory regime in Australia.
Impact Consequence Severity (unmitigated)	
Biological	Biodiversity consequence criteria
Plankton	Negligible
Crustaceans	Negligible
Molluscs, sponges and corals – benthic	Negligible
Molluscs – pelagic	Negligible
Fish – with swim bladders	Negligible
Fish – without swim bladders	Negligible

Cetaceans – LFC	Negligible	
Cetaceans – MFC	Negligible	
Cetaceans – HFC	Negligible	
Pinnipeds	Negligible	
Turtles	Negligible	
Avifauna	Negligible	
Divers	Minor	
Swimmers	Negligible	
Fisheries	Social consequence (access & operations)	Financial consequence (potential)
Giant crab – Victorian	Negligible	Negligible
Giant crab – Tasmanian	Minor	Minor
Southern rock lobster – Victorian	Negligible	Negligible
Southern rock lobster – Tasmanian	Negligible	Negligible
SESS – gillnet, hook and trap	Negligible	Negligible
CTS – otterboard trawl	Negligible	Negligible
Impacts to values/infrastructure		
AMPs	Negligible	
KEFs	Negligible	
Telecommunications cable	Negligible (business interruption)	
UXO	Negligible (safety consequence)	
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
No mortality or permanent injury to threatened cetaceans resulting from the Sequoia 3DMSS. Temporal overlap with high value benthic commercial fisheries is avoided.	The survey is undertaken only during the months of August, September and October in order to avoid PBW migration and foraging and avoid the peak fishing season for SRL and giant crab.	Daily operations reports verify that the survey only took place during August, September and/or October.
	ConocoPhillips' proprietary CSI technology is used so that the survey time is kept to no more than 60 days (or about 30 days active survey time) rather than up to 98 days on location without the use of CSI.	Contract documentation, as-deployed layout diagrams and end-of-survey report verify the use of CSI technology.
AMPs		
The major conservation values of the Apollo and Zeehan AMPs are protected.	The survey is undertaken only during the months of August, September and October in order to avoid PBW migration and foraging in the region (and avoids the peak and shoulder seasons for SRW migrating out of calving areas or using interconnecting habitat on the west coast of King Island).	Daily operations reports verify that the survey only took place during August, September and/or October.
	Vessel activity is limited to the Multiple Use Zone of the Zeehan AMP, which allows for petroleum exploration (no ingress into the Special Use Zone is permitted). No line turns occur in the Apollo AMP.	Real time survey data and navigation mapping verifies no entry into the Special Purpose Zone of the Zeehan AMP. Real time survey data and navigation mapping verifies no entry into the Apollo AMP.

Cetaceans		
Trained and experienced MMOs will undertake marine mammal observations.	<u>EPBC Act Policy 2.1 - Part B.1</u> Two competent (sufficiently experienced) MMOs will be based aboard the survey vessel to conduct marine mammal observations for the duration of the survey.	MMO CVs verify they are competent (sufficiently experienced) in undertaking MMO duties.
		MMO sighting data is available for the duration of the survey.
All crew aboard the seismic survey vessel are inducted into the EPBC Act Policy 2.1 requirements.	<u>EPBC Act Policy 2.1 - Part A.2</u> The MMOs undertake cetacean awareness sessions for key vessel crew.	Cetacean management information is available in the crew induction presentation.
		Induction attendance records verify that awareness sessions took place.
PBW and SRW continue to forage and migrate without displacement or injury.	<u>EPBC Act Policy 2.1 - Part A.3</u> *A.3.1-3.2: Start-up procedures* • Pre-start visual observations - for 30 minutes out to 3 km. • Soft start, increasing power over a 30-minute period, with visual observations out to 3 km. Delay start up procedures/power down any operating acoustic source if whales are observed within 3 km of the source and shut down if they approach within 500 m (the 'shut down zone'). Resume soft start procedures once the whale has been observed to move outside the 'low power zone' (2 km).	MMO data sheets and end-of-survey marine fauna observers report verify implementation of procedure and that no visually obvious signs of cetacean distress are noted.
	A3.3: Start-up delay procedures • If during the soft start procedure a whale is observed to enter the 'low power zone' (within 2 km of the source), the acoustic source will be reduced to minimum power. • If a whale is observed within the shutdown zone of the source, the power source will be shut down. • If a PBW or SRW is sighted during soft start, the acoustic source will be shut down (in recognition that their Conservation Management Plans list MSS as threats and because these two species have BIAs intersected by the acquisition area).	

<table>
<tr><td rowspan="4"></td><td>Soft-start procedures will only resume after the whale has been observed to exit the low power zone or if the whale has not been sighted for 30 minutes (only the latter in the case of a PBW or SRW).</td><td rowspan="3"></td></tr>
<tr><td>A.3.4-3.5: Operations procedure
If a whale is sighted within or about to enter the low power zone (2 km), the acoustic source will be reduced to minimum power. If the whale is a PBW or SRW, the acoustic source will be shut down.
If a whale is observed within or about to enter the shutdown zone (500 m), the acoustic source will be shut down.
Soft-start procedures will only resume after the whale has been observed to move outside the low power zone or if the whale has not been sighted for 30 minutes (only the latter in the case of a PBW or SRW).</td></tr>
<tr><td>Excise area procedure
After sailing through the excise area, full power can proceed without the need for implementing the soft-start procedure.
This is because:
The sound generated by acquiring the preceding section of line (the other side of the excise area) will have acted as a deterrent to whales approaching the lower power or shut down zones.
The excise area is not related to cetacean protection.
MMOs will be used throughout the survey
The survey will take place avoid PBW migration and foraging in the region and avoids the peak and shoulder seasons for SRW migrating out of calving areas or using interconnecting habitat on the west coast of King Island.</td></tr>
<tr><td>Full power will to capture full-fold data in the acquisition area – soft-starts will only take place in the operational area on the run ins to the survey lines.</td><td>Daily operations reports/maps and seismic data verifies no data acquisition in the operational area.</td></tr>
</table>

	Pre-MSS acoustic source array full power testing will only take place in the acquisition area (not in the operational area or areas beyond this).	Daily operations reports verify acoustic source array testing was only undertaken in the acquisition area.
Cetacean sightings are reported to the DAWE.	EPBC Act Policy 2.1 - Part A.4 ConocoPhillips Australia will report cetacean sightings online to the DAWE within 2 months of survey completion using the online Cetacean Sightings Application: http://www.marinemammals.gov.au/sorp/sightings	Copies of sighting reports are maintained to verify reports were made.
Cetacean strategy is discussed during daily operations meetings onboard the survey vessel.	Cetacean strategy will be discussed each day to assess all available data on whale presence. This information will be used to inform the operational strategy for the coming day's acquisition.	Daily operations reports indicate that sighting data has been used to inform daily operational planning.
Commercial fisheries		
Commercial fishers are compensated for any displacement or proven loss of catch.	No acquisition will take place in the excise area (and associated buffer) so as to avoid impacts to the giant crab fishery.	Final survey report verifies that no acoustic pulses were generated in the excise area.
	ConocoPhillips Australia makes their Adjustment Protocol (see Section 4.7) and claim form available to fishers who have expressed concern about displacement or loss of catch so that they are able to make a claim for losses.	Email correspondence verifies procedure was issued to relevant fishers.
Cumulative effects		
Sufficient distance will be maintained between any simultaneous seismic surveys.	The NOPSEMA website will be regularly monitored for submitted and accepted MSS EPs that may contribute to cumulative noise in the survey area.	A current list of nearby proposed and accepted MSS EPs is available to verify monitoring is taking place.
	ConocoPhillips Australia will maintain close communication with TGS regarding the timing of the proposed Otway Deep 3DMSS (which has an accepted EP in place and is able to survey between 1 Oct 2021-end Feb 2022) in order to time the surveys to avoid cumulative impacts where there is spatial overlap.	Correspondence records are available to verify that the timing for both surveys has been considered to avoid cumulative impacts.

	If ConocoPhillips Australia becomes aware of the potential for another MSS to take place in the same area at the same time as this survey, at least a 40 km (21 nm) separation will be maintained between active sources to ensure sound from one source doesn't interfere with sound from the other and to reduce the possibility of cumulative sound impacts.	Daily operations reports verify a separation distance and/or time-sharing arrangement is in place.
Divers		
There is no injury to divers.	ConocoPhillips Australia will liaise with the WRARA operator (DPIPWE) and the two commercial abalone divers to keep them informed of when acquisition is scheduled to take place in the eastern most part of the acquisition area so that: • A SIMOPS plan can be developed between affected parties to ensure both activities can operate simultaneously; or • Diving can be avoided at these times.	Consultation records verify that consultation took place with persons relevant to commercial diving.
Vessel-specific		
Survey vessel engines and thrusters are well maintained.	Engines and thrusters are maintained in accordance with manufacturer's instructions via the Planned Maintenance System (PMS) to ensure they are operating efficiently.	PMS records verify that engines and thrusters are maintained to schedule. Clean Design certification is current.

Impact Consequence Severity (residual)		
Biological	Biodiversity consequence criteria	
Plankton	Negligible	
Crustaceans	Negligible	
Molluscs, sponges and corals – benthic	Negligible	
Molluscs – pelagic	Negligible	
Fish – with swim bladders	Negligible	
Fish – without swim bladders	Negligible	
Cetaceans – LFC	Negligible	
Cetaceans – MFC	Negligible	
Cetaceans – HFC	Negligible	
Pinnipeds	Negligible	
Turtles	Negligible	
Avifauna	Negligible	
Divers	Negligible	
Swimmers	Negligible	
Fisheries	Social consequence (access & operations)	Financial consequence (potential future losses)
Giant crab – Victorian	Negligible	Negligible
Giant crab – Tasmanian	Minor	Negligible
SRL – Victorian	Negligible	Negligible
SRL – Tasmanian	Negligible	Negligible

SESS – gillnet, hook and trap	Negligible	Negligible
CTS – otterboard trawl	Negligible	Negligible

Demonstration of ALARP		
'Negligible' and 'minor' residual impact consequences are considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required. Only one of the 20 receptors rated higher than 'minor.' Despite this, given that the generation of underwater sound is the key impact related to MSS and has generated the most interest by relevant persons, presented below are the control measures that were considered during the Sequoia 3DMSS design phase but not adopted.		
Control considered	Hierarchy of control type	Analysis
Conduct the MSS only in waters deeper than 150 m to avoid areas of importance for the southern rock lobster fishery.	Elimination	SIV has requested that ConocoPhillips Australia excludes undertaking the survey in water depths less than 150 m deep to avoid important southern rock lobster fishing grounds. ConocoPhillips Australia has considered this request, but 91% of the survey occurs in waters <150 m deep and all four prospects are located in water depths <150 m. This means the survey objectives and the permit requirements could not be met, making this request unviable.
Reduce the size of the acquisition area to the same size as that of the previously proposed Dorrigo 3DMSS.	Elimination	Reducing the size of the acquisition area to be the same as that of the previously proposed Dorrigo 3DMSS means that the northern prospect, Flanagan, would be excluded from the survey. The northern part of the acquisition area is about 6.2 km south of the 'Big Reef' bathymetric structure, which is an important fishing ground for SRL. The STLM indicates that particle motion thresholds relevant to SRL extend several hundred metres from the sound source at the seafloor and therefore will not extend to this feature. As such, SRL stocks at the 'Big Reef' are not likely to be affected by seismic sound. The purpose of the Sequoia 3DMSS is to acquire geophysical data to provide a 3D image of the subsurface geology within the T/49P permit area in order to identify prospective commercially viable gas reservoirs for future drilling (and development, if proven viable). The legacy 2D and 3D seismic data acquired in this permit indicate the potential for prospective geological structures to be present, but are currently insufficiently imaged to adequately confirm the extent and integrity of these structures. The acquisition of high-quality 3D seismic data reduces the financial risk of drilling unnecessary exploration wells if the geological structures are determined to be non-prospective.

Avoid spawning times for commercial fishing species.	Elimination	Combined spawning periods for key fishing stock in the region (such as SRL, giant crab, fin-fish) cover all 12 months of the year. As such, the survey could not proceed if the spawning period for all species was to be avoided. The survey is timed, in part, to avoid the fishing season for SRL and giant crab, thereby avoiding spatial conflicts with commercial fishing vessels. While SRL, giant crab, abalone, scallop and blue warehou are known to spawn at the same time as the survey is proposed, these species are widely distributed in the Southern Ocean and Bass Strait and the scientific literature and STLM indicates the extent of impacts to larvae are negligible. ConocoPhillips believes that on balance, the survey window minimises impacts to key biological and fisheries receptors. The CSI technology to be used for the Sequoia 3DMSS significantly reduces the time involved to acquire the seismic data, thereby reducing the temporal overlap with spawning.
Avoid acquiring data in the Zeehan AMP.	Elimination	One of the prospects lies nearly entirely within the Multiple Use Zone of the Zeehan AMP. As such, it is not possible to excise the AMP from the acquisition area without significantly comprising the objectives of the survey. For this reason, the AMP is not excised from the survey. The major conservation values of the Zeehan AMP are the: • Migration areas for PBW and humpback whales – avoided by the timing of the survey for the PBW and avoids peak humpback whale migration season. • Foraging grounds for several albatross and petrel species – not impacted by the survey. • Physical seafloor features – not impacted by the survey. The lack of impacts to the major conservation values of the Zeehan AMP and the fact that the Multiple Use Zone allows for petroleum exploration means there is no justification for excluding it from the survey.
Use a lower sound volume to minimise the distance to effects for biological receptors.	Engineering	The initial requirements for the MSS specified the use of a sound source array up to 4,500 cui based on previous MSS conducted in Australia by ConocoPhillips Australia. In light of the shallow depths of the prospects to be targeted during the Sequoia 3DMSS, analysis was undertaken that determined that using the lower sound source of 3,480 cui would still achieve the survey objectives. This is the smallest volume able to meet the survey objectives (see Section 2.6).

<table>
<tr><td>Use of passive acoustic monitoring (PAM) for the detection of cetaceans.</td><td>Engineering</td><td>PAM was considered as an alternate means of detecting the presence of cetaceans during the survey. As a cetacean detection method, PAM has been used to detect whales that vocalise at high frequencies/intensities such as MFC and HFC (e.g., sperm whales) and, in conjunction with visual monitoring, can enhance cetacean detection effectiveness.
PAM has the advantage of potentially detecting cetaceans during night hours and during periods of poor visibility when they cannot be visually detected.
However, while PAM can be a valuable tool in identifying the presence of cetaceans, the following factors limit its effectiveness:
It is most suitable for MFC and HFC, which are generally of lower concern in this region compared to LFC. It is difficult for PAM to pick up vocalisations of LFC such as PBW and SRW.
Bearing accuracy and range estimation is limited because it is not as accurate as visual observations (unless visual observations cannot be undertaken, such as during night time or low visibility conditions).</td></tr>
<tr><td>Conduct a regional study to quantify spatial and temporal impacts of MSS on the larvae of fisheries resources.</td><td>N/A – scientific study</td><td>The peer-reviewed and accepted scientific literature indicates that the effects of MSS to plankton and fish eggs/larvae are restricted to a highly localised area around active a seismic sound source.
The 2018 CarbonNet Pelican 3DMSS study into the effects on plankton in Bass Strait (see earlier in this section) found no statistical difference in zooplankton diversity or abundance when comparing pre- and post-MSS samples.
Undertaking a similar pre- and post-MSS plankton survey in the Sequoia 3DMSS area is unlikely to yield additional information.</td></tr>
<tr><td>Use of night-time/poor visibility procedures (Part B.2) of the EPBC Act Policy Statement 2.1</td><td>Administrative</td><td rowspan="4">By timing the survey to take place between the start of August and end of October, the recognised peak and shoulder seasons for SRW migrating out of calving areas or using interconnecting habitat on the west coast of King Island, along with PBW migration and foraging, are avoided (see Section 5.5.6 for a summary of cetacean presence and absence in the region).
As such, providing additional MMOs on the support vessels or in spotter planes is unlikely to result in whale sightings. Similarly, undertaking night-time observations is unlikely to result in sightings for these and other threatened whales. Given the low chance of whale sightings, increasing shut-down and low-power zones will also have little benefit.
The costs associated with these controls (in the hundreds of thousands of dollars) would therefore be grossly disproportionate with the low risk of encountering whales. The HSE risks of using spotter flights to undertake MMO duties is unacceptable given the low risk of encountering whales.</td></tr>
<tr><td>Increased shut-down and low-power zones implemented to minimise impacts to whales.</td><td>Administrative</td></tr>
<tr><td>Place MMOs on the support vessels (in addition to the survey vessel).</td><td>Administrative</td></tr>
<tr><td>Undertake aerial observations for whales at all times of the year.</td><td>Administrative</td></tr>
<tr><td colspan="3">Demonstration of Acceptability</td></tr>
</table>

The demonstration of acceptability has been presented earlier in this section for each receptor group and is not duplicated here.	
Environmental Monitoring	
• MMO observations from the survey vessel.	
Record Keeping	
• MMO CVs. • MMO daily reports. • MMO end-of-survey report. • MMO CSA data. • MMO induction presentation and sign-on sheets.	• Daily operations reports. • Compensation agreement and completed claims forms, assessments and correspondence. • List of nearby proposed and accepted MSS EPs. • Survey vessel PMS records.

7.2. IMPACT 2 – Routine Emissions - Light

7.2.1. Causal Pathway

Lighting of the survey and support vessels is required to support safe navigation and work practices. The following activities will result in artificial light glow:

- Vessel navigation lighting will be maintained while vessels are on location in accordance with relevant requirements for maritime safety purposes;
- Deck lighting for the safety of personnel working on deck;
- The stern of the deck will have floodlights pointing to sea to ensure streamers can be observed; and
- The floating towed equipment trailing at the tail end of the cables are lit by warning lights.

7.2.2. Known and Potential Environmental Impacts

The known and potential impacts of light glow are:

- Localised light glow may act as an attractant or deterrent for marine fauna (e.g., fish, squid and zooplankton), in turn affecting predator-prey dynamics and can also affect schooling, spatial distribution, migration, reproduction and changes in population dynamics; and
- Attraction of migratory birds which can lead to injury or mortality from collisions, disorientation and unnecessary energy expenditure;
- Attraction of non-migratory seabirds, which can become trapped within the sphere of light where they mill around until they become exhausted or get injured from collisions;
- Attraction of seabirds that may use offshore structures as habitual roosting sites; and
- Attraction or disorientation of turtles (particularly hatchlings).

7.2.3. EMBA

The Environment that May Be Affected (EMBA) for light glow associated with vessel activities is likely to be a precautionary distance of 20 km for light sensitive receptors (e.g., seabird fledglings and turtles) (DoEE,2020).

Light-sensitive receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Squid;
- Marine reptiles; and
- Seabirds and migratory birds.

7.2.4. Evaluation of Environmental Impacts

The distance of the closest point of the operational area from the nearest shoreline (18 km) and nearest town (Currie, 19 km) means vessel lighting will have low visibility from land and therefore aesthetic impacts will be negligible.

The main mechanisms of impact to light sensitive fauna are related to:

- Disorientation, attraction or repulsion, and
- Disruption of natural behaviours

Shipping and fishing activities in Bass Strait (including squid fishing, which uses bright lights directed onto the water surface) are common activities, and the lighting levels associated with the survey and support vessels are not considered to be different from these sources or make an additional contribution.

Marine Reptiles

There are no turtle nesting beaches or BIAs within the survey area or EMBA so the potential for disruption to turtle nesting, hatchling orientation, sea-finding and dispersal behaviour is expected to be negligible.

Seabirds

Seabirds may be attracted to light glow from the survey and support vessels at night. Bright lighting can disorientate birds, thereby increasing the likelihood of seabird injury or mortality through collision with the vessel, or mortality from starvation due to disrupted migration or foraging at sea (Wiese et al., 2001 in DSEWPC, 2011; Rajkhowa, 2014). This disorientation may also result in entrapment, stranding, grounding and interference with navigation (DoEE, 2020). Once grounded, DoEE (2020) reports that petrel species in the Southern Ocean may be unable to take off from a deck. The DoEE (2020) notes that seabird fledglings may be affected by lights up to 15 km away.

Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie et al., 2008) and that lighting can attract birds from large catchment areas (Wiese et al., 2001). Artificial light may provide enhanced capability for seabirds to forage at night.

Due to the absence of seabird breeding colonies within the survey area, which is located 22 km west of little penguin, short-tailed shearwaters and black-faced cormorant BIAs on King Island; 87 km northwest of the Hunter Island Group Important Bird Area and 26 km south of Cape Otway), light glow from small moving and temporary light sources is not expected to result in impacts at the species population level or indirectly at the ecosystem level. Each of these key locations are located more than 20 km away from the survey area, which is the precautionary threshold applied by the National Light Pollution Guidelines for Wildlife (DoEE, 2020).

There are no actions within the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-16 (DSEWPC, 2011a) or the National Light Pollution Guidelines for Wildlife (DoEE, 2020) that are compromised by light emissions from the vessels.

Fish and plankton

Depending on the species, fish and zooplankton may be directly or indirectly attracted to lights. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan et al., 2001), with traps drawing catches from up to 90 m (Milicich et al., 1992). Lindquist et al (2005) concluded from a study of larval fish populations around an oil and gas platform in the Gulf of Mexico that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, was caused by the platforms' light fields. The concentration of organisms attracted to light results in an increase in food source for predatory species and marine predators are known to aggregate at the edges of artificial light halos. Shaw et al (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms. This could potentially lead to increased predation rates compared to unlit areas. Given the constant movement of the survey vessel, this is likely to only affect transient individuals and not result in any detectable impact at the population level.

Cetaceans

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to monitor their environment rather than visual sources (Simmonds et al., 2004), so light is not considered to be a significant factor in cetacean behaviour or survival.

7.2.5. Impact Assessment

Table 7.44 presents the impact assessment for light emissions.

Table 7.44: Impact assessment for light emissions

Summary		
Summary of impacts	Localised light glow may act as an attractant or deterrent for marine fauna (e.g., fish, squid and zooplankton), in turn affecting predator-prey dynamics and can also affect schooling, spatial distribution, migration, reproduction and changes in population dynamics; and attraction of migratory birds which can lead to injury or mortality from collisions, disorientation and unnecessary energy expenditure.	
Extent of impacts	Localised (small radius of light glow around the survey vessel and support vessels).	
Duration of impacts	Temporary (duration of survey).	
Level of certainty of impacts	HIGH. The impacts of light glow on marine fauna are well known.	
Impact decision framework context	A - nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
Impact Consequence Severity (unmitigated)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Routine maritime practice		
External vessel lighting conforms to that required by maritime safety standards.	Light glow is minimised by managing external vessel lighting in accordance with: • AMSA Marine Orders Part 30 (Prevention of Collisions). • AMSA Marine Orders Part 59 (Offshore Support Vessel Operations).	Vessel class certifications are current.
Survey-specific controls		
Attraction to lights for birds and marine fauna is	Lighting is directed to working areas (rather than overboard) to minimise light spill to the ocean.	Completed vessel inspection checklists and photos verify that lights are directed inboard, and

kept to a minimum.	Lighting directed overboard can be manually over-ridden (with a local switch were possible) such that it is only switched on as required (e.g., man overboard).	where this is not possible, lights are switched off when not in use.
	Blinds will be lowered on all portholes and windows at night.	Completed daily environmental checklists and photos verify that blinds are drawn each night.
Impact Consequence Severity (residual)		
Negligible		
Demonstration of ALARP		
A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the impact to the point that any additional, alternative, or improved control measures fail to lower the impact any further.		
Demonstration of Acceptability		
Criteria	Demonstration	
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.	
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.	
Stakeholder engagement	Stakeholders have not raised concerns about light emissions.	
Legislative context	The EPS outlined in this EP align with the requirements of: • *Navigation Act 2012* (Cth): • Part 3 (Prevention of Collisions). • AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures). • AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment). • AMSA Marine Orders Part 30 (Prevention of Collisions).	
Industry practice	The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice demonstrates that BPEM is being implemented.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to: • Light emissions - minimise external lighting to that required for navigation and safety of deck operations.
	Best Available Techniques BAT) Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines specifically regarding lighting for offshore activities.

	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of EPS for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Ship collision (item 120) - to avoid collisions with third-party and support vessels, offshore facilities should be equipped with navigational aids that meet national and international requirements, including navigational lights on vessels.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	No guidelines provided regarding the management of light emissions.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: Reduce the impact on cetaceans and other marine life to ALARP and an acceptable level.
	Light-specific guidance	
	The National Light Pollution Guidelines for Wildlife (DoEE, 2020)	An assessment of the survey against these guidelines is included in Appendix 1. This assessment indicates that many of the measures relating to seabirds in these guidelines are not applicable or not achievable for the survey based on its location being remote from seabird rookeries. Measures relating to turtles and shorebirds are not applicable.
Environmental context	MNES	
	AMPs (Section 5.1.1)	The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (DNP, 2013) identifies light pollution associated with offshore mining operations and other offshore activities as a threat to the AMP network. The EPS listed in this table aimed at minimising light pollution emitted from the activity vessels do not conflict with the strategies outlined in the plan that aim to address this threat. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	Localised light glow will not have any impacts on Ramsar wetlands.

	TECs (Section 5.1.6)	Localised light glow will not have any impacts on TECs.
	NIWs (Section 5.1.8)	Localised light glow will not have any impacts on NIWs.
	Nationally threatened and migratory species (Section 5.5)	Localised light glow will not have any significant impacts on threatened or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	Localised light glow will not have any impacts on state marine parks. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	The management actions listed for seabirds in The National Light Pollution Guidelines for Wildlife (DoEE, 2020) have been considered. The National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC, 2011a) does not list artificial lighting as a key threat. The Recovery Plan for Marine Turtles in Australia (DoEE, 2017) is not relevant given the rare occurrence of turtles and absence of turtle BIAs and nesting beaches in Bass Strait.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• Fauna interactions with lighting.		
Record Keeping		
• Vessel class certifications. • Completed inspection checklists. • Photos.		

7.3. IMPACT 3 – Routine Emissions – Atmospheric

7.3.1. Causal Pathway

The following survey activities will generate atmospheric emissions:

- Combustion of MDO from the vessel engines, generators and fixed and mobile deck equipment; and
- Painting and paint storage, resulting in the release of fugitive volatile organic carbons (VOCs) as vapours.

Based on a 2018 3DMSS in Bass Strait, 18 tonnes of fuel was used per day by the survey vessel. This results in the daily emissions of approximately:

- 0.6 tonnes of nitrogen dioxide (NOX);
- 0.02 tonnes of sulphur dioxide (SOX); and

- 55 tonnes of carbon dioxide (CO_2).

Based on a 60-day MSS, this activity could be expected to use 1,080 tonnes of fuel, resulting in similar daily emissions of NOX, SO_X and CO2.

7.3.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of atmospheric emissions are:

- Localised and temporary decrease in air quality due to gaseous emissions and particulates from MDO combustion; and
- Addition of greenhouse gas (GHG) to the atmosphere (influencing global warming potential).

7.3.3. EMBA

Combustion emissions are typically discharged from an exhaust stack that is elevated several metres above the vessel deck to facilitate dispersion. The EMBA for combustion emissions is the local air shed with dispersion expected within hundreds of metres of the vessels, both horizontally and vertically.

Receptors that may occur within this EMBA, either as residents or migrants, are seabirds.

7.3.4. Evaluation of Environmental Impacts

Localised and temporary decrease in air quality from MDO combustion

The combustion of MDO can create continuous or discontinuous plumes of particulate matter (soot or black smoke) and the emission of non-GHG, such as SOX and NOX. Inhaling this particulate matter can cause or exacerbate health impacts to humans exposed to the particulate matter, such as offshore project personnel or residents of nearby towns (e.g., respiratory illnesses such as asthma) depending on the number of particles inhaled. Similarly, the inhalation of particulate matter may affect the respiratory systems of fauna. In the proposed acquisition area, this is limited to seabirds overflying the vessel/s.

It is rare that fuel combustion on the vessels will generate black smoke. Particulate matter released from the vessels is not likely to impact on the health or amenity of the nearest human coastal settlements (e.g., Currie), as offshore winds will rapidly disperse and dilute particulate matter. This rapid dispersion and dilution will also ensure that seabirds are not exposed to concentrated plumes of particulate matter from vessel exhaust points.

Contribution to the GHG effect

The use of fuel to power engines, generators and any mobile/fixed plant will result in gaseous emissions of GHG such as CO_2, methane (CH_4) and nitrous oxide (N2O). While these emissions add to the GHG load in the atmosphere, which adds to global warming potential, they are relatively small on a state, national and global scale, representing an insignificant contribution to overall GHG emissions.

7.3.5. Impact Assessment

Table 7.45 presents the impact assessment for atmospheric emissions.

Table 7.45: Impact assessment for atmospheric emissions

Summary		
Summary of Impacts	Decrease in air quality due to gaseous emissions and particulates from diesel combustion and contribution to the incremental build-up of GHG in the atmosphere (influencing global warming potential).	
Extent of impacts	Localised (local air shed for air quality), widespread (for GHG).	
Duration of impacts	Temporary (duration of survey – emissions are rapidly dispersed and diluted).	
Level of certainty of impact	HIGH – the impacts of atmospheric emissions are well known.	
Impact decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
Impact Consequence Severity (unmitigated)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Routine maritime practice		
Combustion systems operate in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) requirements.	Only low-sulphur (<0.5% m/m) marine-grade diesel will be used in order to minimise SOx emissions.	Bunker receipts verify the use of low-sulphur marine grade diesel.
	All combustion equipment is maintained in accordance with the Planned Maintenance System (PMS) (or equivalent).	PMS records verify that combustion equipment is maintained to schedule.
	Vessels with gross tonnage >400 tonnes possess equipment, systems, fittings, arrangements and materials that comply with the applicable requirements of MARPOL Annex VI.	International Air Pollution Prevention (IAPP) Certificate is current.
	Vessels >400 gross tonnes and involved in an international voyage implement their Ship Energy Efficiency Management Plan (SEEMP) to monitor and reduce air emissions.	SEEMP records verify energy efficiency records have been adopted.
	Vessels >400 gross tonnes must ensure that firefighting and refrigeration systems are managed to minimise Ozone Depleting Substances (ODS).	ODS record book is available and current.
Solid combustible waste will only be burned within an incinerator, and only if logistics don't allow for the timely removal of waste from the	Only a MARPOL VI-approved incinerator is used to incinerate solid combustible waste (food waste, paper, cardboard, rags, plastics).	International Maritime Organization (IMO) incinerator certificate verifies the incinerator meets MARPOL requirements.
	Incineration is only conducted when the vessel is >12 nm from the shore.	Survey-specific discharges and emissions register indicates no incineration within 12 nm of the shore.

vessel.	Oil and other noxious liquid substances will not be incinerated.	The Oil Record Book and Garbage Record Book verify that waste oil and other noxious liquid substances are transferred to shore for disposal.
Fuel use will be measured, recorded and reported.	Fuel use will be measured, recorded and reported for abnormal consumption, and in the event of abnormal fuel use, corrective action is taken to minimise air pollution.	Fuel use is recorded in the daily operations reports.

<table>
<tr><th>Impact Consequence Severity (residual)</th></tr>
<tr><td>Negligible</td></tr>
<tr><th>Demonstration of ALARP</th></tr>
<tr><td>A ‘negligible’ residual impact consequence is considered to be ALARP and a ‘lower order’ impact. The routine maritime practices and survey-specific controls already in place have lowered the impact to the point that any additional, alternative, or improved control measures fail to lower the impact any further.</td></tr>
</table>

<table>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td>Criteria</td><td colspan="2">Demonstration</td></tr>
<tr><td>Policy compliance</td><td colspan="2">ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>Management system compliance</td><td colspan="2">Chapter 8 describes the EP implementation strategy employed for this activity.</td></tr>
<tr><td>Stakeholder engagement</td><td colspan="2">Stakeholders have not raised concerns about atmospheric emissions.</td></tr>
<tr><td>Legislative context</td><td colspan="2">The EPS outlined in this EP align with the requirements of:
• Navigation Act 2012 (Cth):
  • Chapter 4 (Prevention of Pollution).
  • AMSA Marine Order Part 79 (Marine pollution prevention – air pollution).
• Protection of the Sea (Prevention of Pollution by Ships) Act 1983 (Cth):
  • Part IIID (Prevention of Air Pollution).
  • AMSA Marine Orders Part 97 (Air Pollution), enacting MARPOL Annex VI (especially Regulations 6, 14, 16).
• National Greenhouse and Energy Reporting Act 2007 (Cth).</td></tr>
<tr><td rowspan="2">Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to:
• Section 4.4.3 - Combustion emissions;
  • Use of high efficiency equipment to minimise power demand.
  • Selection of low sulphur diesel.
  • Regular plant maintenance.
  • Regular maintenance and emission control devices on vehicles and machinery.</td></tr>
</table>

	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	The EPS listed in this table meet these guidelines for offshore activities with regard to management of fugitive emissions (item 22). The BAT are met for the source and survey vessels.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of EPS for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Air emissions (item 11). The overall objective to reduce air emissions. Air emissions (item 12). During equipment selection, air emission specifications should be taken into account, as should the use of very low sulphur content fuels and/or natural gas.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS listed in this table meet these guidelines with regard to: • Section 8.6 (Hazardous materials): Use of marine diesel oil or marine gas oil (low sulphur content); • Section 8.6 (Hazardous materials): The exhaust systems should be services on a regular basis. Section 8.8 (Vessel operations): Engine fuel mixtures must be adjusted to maximise clean burning and reduce emissions.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: Reduce GHG emissions to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.1.1)	Atmospheric emissions will not directly affect nearby AMPs. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section	Atmospheric emissions will not directly affect any Ramsar wetlands.

	5.1.4)	
	TECs (Section 5.1.6)	Atmospheric emissions will not directly affect any TECs.
	NIWs (Section 5.1.8)	Atmospheric emissions will not directly affect any NIWs.
	Nationally threatened and migratory species (Section 5.5)	Atmospheric emissions will not directly affect threated or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	Atmospheric emissions will not directly affect any state marine parks. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	• The National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC, 2011a) lists climate change as a key threat, though the most pervasive threat is accidental mortality and injury from interactions with fishing activities. • The Recovery Plans and Conservation Advice for the Blue, Sei, Fin, Southern Right and Humpback Whales lists climate change as a key threat, though the most pervasive threats are whaling, vessel strike and entanglement. • The Recovery Plan for Marine Turtles in Australia lists climate change as a key threat. • The Recovery Plan for the Orange-bellied parrot lists climate change as a key threat, though the most pervasive threat is loss of habitat. See Appendix 2 for additional detail regarding the impacts of routine activities on the management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• Fuel use.		
Record Keeping		
• PMS records. • Fuel use records. • Bunkering receipts. • Waste manifests (for incineration).		• ODS record book. • Oil record book. • Garbage record book. • Survey-specific discharges and emissions register.

7.4. IMPACT 4 – Routine Discharges – Putrescible Waste

7.4.1. Causal Pathway

The generation of food waste (putrescible waste) from the vessel galleys will result in the overboard discharge of this waste. The average volume of putrescible waste discharged overboard depends on the number of persons on board at any time, and the types of meals prepared.

NERA (2018) estimate the volume of putrescible waste to be in the order of 1-2 kg per person per day. Assuming 60 people working on the survey vessel and 6 people on each of the two support vessels (a total of 72 people), an estimated 72 - 144 kg of putrescible waste will be generated per day.

7.4.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of putrescible waste discharges are:

- Temporary and localised increase in nutrient concentrations and organic matter in waters surrounding the discharge point; and
- An associated increase in scavenging behaviour of marine fauna and seabirds (at the sea surface or within the water column).

7.4.3. EMBA

The EMBA for putrescible waste discharges is likely to be the top 10 m of the water column within a 100 m radius from the discharge point. This is based on modelling of continuous wastewater discharges undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex, Western Australia).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles; and
- Avifauna.

7.4.4. Evaluation of Environmental Impacts

The overboard discharge of macerated food wastes creates a localised and temporary increase in the nutrient load of near-surface waters and increases biological demand in the receiving waters. Organic materials from the discharge are a food source for scavenging marine fauna and/or seabirds, whose numbers may temporarily increase as a result. The rapid consumption of putrescible waste by scavenging fauna, its physical and microbial breakdown and dispersion and well-mixed waters of the survey area ensures that the impacts of such discharges are negligible.

The impacts of putrescible waste discharges to the physical and biological environment are expected to have insignificant consequences because of the:

- Small discharge volumes;
- Intermittent nature of the discharge;
- Maceration of the waste prior to discharge;
- High dilution and dispersal factor in open waters;
- Long distance from shore;
- Rapid consumption by fauna;
- High biodegradability and low persistence of the waste; and

- The absence of sensitive habitats in the survey area.

7.4.5. Impact Assessment

Table 7.46 presents the impact assessment for putrescible waste discharges.

Table 7.46: Impact assessment for putrescible waste discharges

Summary		
Summary of impacts	Increase in nutrient concentrations and organic matter in surface and near-surface waters around the discharge point, which may lead to an increase of scavenging behaviour of pelagic fish and seabirds and increased biological oxygen demand.	
Extent of impacts	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of impacts	Intermittent and temporary - rapid dispersion and biodegradation	
Level of certainty of impacts	HIGH – the impacts of putrescible waste discharges on marine fauna are well known.	
Impact decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
Impact Consequence Severity (unmitigated)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Routine maritime practice		
Putrescible waste discharges comply with AMSA Marine Order 95 (Marine pollution prevention – garbage), which enacts MARPOL Annex V.	A MARPOL Annex V-compliant Garbage Management Plan (GMP) is in place (for vessels >100 GRT tonnes or certified to carry 15 persons or more) that sets out the procedures for minimising, collecting, storing, processing and discharging garbage.	A GMP is in place, readily available onboard and kept current.
	A macerator is on board the survey vessel, functional, in use and set to macerate putrescible waste to a particle size ≤25 mm using to ensure rapid breakdown upon discharge.	PMS records verify that the macerator is functional and regularly maintained or replaced.
	Records of food waste disposal to be maintained in a Garbage Record Book.	A Garbage Record Book is in place and verifies waste discharge locations and volumes.
	Macerated putrescible waste (≤25 mm) is only discharged overboard when the vessel is >3 nm from the nearest shoreline.	A Garbage Record Book is in place and verifies waste discharge locations and volumes.
	Un-macerated putrescible waste is only discharged overboard when the vessel is >12 nm from the nearest shoreline.	
Survey-specific controls		

<table>
<tr><td rowspan="2">As above.</td><td colspan="2">Waste management and housekeeping requirements are communicated to all personnel boarding the vessels to ensure discharges are in accordance with MARPOL Annex V.</td><td>Vessel induction includes waste management requirements.</td></tr>
<tr><td colspan="2">Support vessels without a macerator and for non-putrescible galley waste on all vessels, waste is returned to shore for disposal.</td><td>A Garbage Record Book is in place and verifies waste discharge locations and volumes.</td></tr>
<tr><th colspan="4">Impact Consequence Severity (residual)</th></tr>
<tr><td colspan="4">Negligible</td></tr>
<tr><th colspan="4">Demonstration of ALARP</th></tr>
<tr><td colspan="4">A ‘negligible’ residual impact consequence is considered to be ALARP and a ‘lower order’ impact. The routine maritime practices and survey-specific controls already in place have lowered the impact to the point that any additional, alternative, or improved control measures fail to lower the impact any further.</td></tr>
<tr><th colspan="4">Demonstration of Acceptability</th></tr>
<tr><td>Criteria</td><td colspan="3">Demonstration</td></tr>
<tr><td>Policy compliance</td><td colspan="3">ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>Management system compliance</td><td colspan="3">Chapter 8 describes the EP implementation strategy employed for this activity.</td></tr>
<tr><td>Stakeholder engagement</td><td colspan="3">Stakeholders have not raised concerns about putrescible waste discharges.</td></tr>
<tr><td>Legislative context</td><td colspan="3">The EPS outlined in this EP align with the requirements of:
• Navigation Act 2012 (Cth):
  • Chapter 4 (Prevention of Pollution).
  • AMSA Marine Order 95 (Marine Pollution Prevention - garbage).
• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
  • Section 26F (which implements MARPOL Annex V).</td></tr>
<tr><td rowspan="3">Industry practice</td><td colspan="3">The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry
(IOGP-IPIECA, 2020)</td><td colspan="2">The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to:
• Section 4.5.1 - organic (food) waste from the kitchen should, at a minimum, be macerated to <25 mm prior to discharge to sea, in compliance with MARPOL Annex V requirements.</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td colspan="2">The EPS listed in this table meet these guidelines for offshore activities with regard to:
• Environmental monitoring (item 26) - the BAT are met for the survey with regard to monitoring waste streams.</td></tr>
</table>

	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Other waste waters (item 44) - food waste from the kitchen should, at a minimum, be macerated to acceptable levels and discharged to sea, in compliance with MARPOL 73/78 requirements.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines are met with regard to: • Section 8.5 (Waste Management) - vessels have a waste management plan in accordance with MARPOL Annex V.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • Reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.1.1)	Putrescible waste may be discharged within the Zeehan AMP or float to it or the Apollo AMP. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of these AMPs
	Wetlands of international importance (Section 5.1.4)	Putrescible waste discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.1.6)	Putrescible waste discharges will not intersect any TECs.
	NIWs (Section 5.1.8)	Putrescible waste discharges will not intersect any nationally important wetlands.
	Nationally threatened and migratory species (Section 5.5)	Putrescible waste discharges do not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	This hazard does not intersect any state marine parks. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	The discharge of putrescible waste does not compromise the specific objectives or actions (regarding marine pollution) of the Albatross and Giant Petrels Recovery Plan (DSEWPC, 2011) or any of the other species Recovery Plans, Conservation Management Plans or Conservation Advice referenced in this EP. See Appendix 2 for additional detail regarding the impacts of routine activities on the management aims of threatened species plans.

ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).
Environmental Monitoring	
• Volume/weight of non-macerated waste sent ashore.	
Record Keeping	
• GMP. • PMS records. • Garbage Record Books	• Training matrices. • Induction records.

7.5. IMPACT 5 – Routine Discharges – Sewage and Grey Water

7.5.1. Causal Pathway

The use of ablution, laundry and galley facilities by vessel crews will result in the discharge of sewage and grey water. The composition of sewage and grey water (when untreated) may include:

- Particulate matter – such as solids composed of floating, settleable, colloidal and dissolved matter, substances that affect aspects of aesthetics such as ambient water colour, the presence of surface slicks/sheens and odour.
- Chemical contaminants – including:
  - Nutrients (e.g., ammonia, nitrite, nitrate and orthophosphate);
  - Organics (e.g., volatile and semi-volatile organic compounds, oil and grease, phenols, endocrine disrupting compounds); and
  - Inorganics (e.g., hydrogen sulphide, metals and metalloids, surfactants, phthalates, residual chlorine);
- Biological pathogens – including bacteria, viruses, protozoa and parasites.

Most large vessels generate 5-15 m^3 wastewater/day, the majority of which is grey water (wastewater from showers, laundry, galley and wash basins) (AMSA, 2016).

NERA (2017) estimates that the total volumes of sewage and grey water typically generated at offshore facilities range between 0.04 and 0.45 m^3 per person per day. Assuming 60 people working on the survey vessel and 6 people on each of the two support vessels (a total of 72 people), this equates to between 2.98 and 33.3 m^3 of sewage and grey water generated daily. Based on a 60-day survey, this could result in the discharge of between 178 and 1,998 m^3 of wastewater discharged from the vessels for this survey.

7.5.2. Known and Potential Environmental Impacts

The known and potential environmental impact of treated sewage and grey water discharges is:

- Temporary and localised increase in the nutrient concentrations and organic matter of surface waters around the discharge point; and
- An associated increase in scavenging behaviour of marine fauna and seabirds (at the sea surface or within the water column).

7.5.3. EMBA

The EMBA for sewage and grey water discharges associated with vessel activities is likely to be the top 10 m of the water column and a 50 m radius from the discharge point. This is based on modelling of continuous wastewater discharges (including treated sewage and greywater) undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex), which found:

- Rapid horizontal dispersion of discharges occurs due to wind-driven surface water currents;

- Vertical discharge is limited to about the top 10 m of the water column due to the neutrally buoyant nature of the discharge; and
- A concentration of a component within the discharge stream is reduced to 1% of its original concentration at no less than 50 m from the discharge point under any condition (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles; and
- Seabirds.

7.5.4. Evaluation of Environmental Impacts

Water quality

Nutrients in sewage, such as phosphorus and nitrogen, may contribute to eutrophication of receiving waters (although usually only still, calm, inland waters and not offshore waters), causing algal blooms, which can degrade aquatic habitats by reducing light levels and producing certain toxins, some of which are harmful to marine life and humans. Given the tidal movements and currents in open oceanic waters and the large assimilative capacity of the oligotrophic receiving waters, eutrophication is not expected to occur. Sewage and grey water will be treated through a STP to a tertiary level, to mitigate potential impacts relating to the release of chemicals and pathogens to receiving waters. Solids that are retained in the treatment process are held onboard prior to disposal at a licensed onshore facility. In the event of a STP malfunction onboard the survey vessel (and for support vessels without a STP), untreated sewage and grey water is discharged only when the vessel is greater than 12 nm from the nearest shore.

The effects of treated 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 m, 100 m and 200 m downstream of the rig 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 conservative given the high numbers of personnel onboard a drill rig (typically 100-120) compared with vessels undertaking the survey, and the environment much less dispersive than vessels that are in constant movement in Bass Strait.

Treated sewage and grey water discharges will be rapidly diluted in the surface layers of the water column and dispersed by currents. The biological oxygen demand of the treated effluent will be low as sewage and grey water will be treated prior to release. On release, surface water currents will assist with oxygenation of the discharge. Depletion of oxygen in receiving waters is therefore unlikely to occur.

Biological receptors

Plankton forms the basis of all marine ecosystems, and plankton communities have a naturally patchy distribution in both space and time (ITOPF, 2011a). They are known to have naturally high mortality rates (primarily through predation), however in favourable conditions (e.g., supply of nutrients), plankton populations can rapidly increase. Once the favourable conditions cease, plankton populations will collapse and/or return to previous conditions. Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF, 2011a).

Any potential change in plankton diversity, abundance and composition as a result of treated sewage and grey water discharges is expected to be very low (given the waste stream is treated) and localised (as outlined in the EMBA), and is likely to return to background conditions within tens to a few hundred metres of the discharge location (NERA, 2017). Accordingly, impacts higher up the food chain (e.g., fish, reptiles, birds and cetaceans) are expected to be negligible.

Social impacts

Treated sewage and grey water discharges will not have any impacts on social activities in or around the survey area because of the long distance between recreational beaches (swimming and fishing) and the survey area (and most vessel-related activities) and because there are no recognised dive sites (e.g., shipwrecks, reefs) in the survey area.

The impacts of treated sewage and grey water discharges to the physical, biological and social environment are expected to have negligible consequences because of the:

- Low discharge volumes;
- Intermittent nature of the discharge;
- Treatment of the waste stream prior to discharge;
- High dilution and dispersal factor in open waters;
- Distance from shore;
- High biodegradability and low persistence of the waste; and
- Absence of sensitive habitats in the survey area.

7.5.5. Impact Assessment

Table 7.47 presents the impact assessment for the discharge of treated sewage and grey water.

Table 7.47: Impact assessment for the discharge of treated sewage and grey water

Summary		
Summary of impacts	Reduction in water quality around the discharge point, increase in nutrients.	
Extent of impacts	Localised – up to 50 m horizontally and 10 m vertically from the discharge point.	
Duration of impacts	Temporary – until the discharge is diluted to a point where it is undetectable above background.	
Level of certainty of impact	HIGH – the impacts of treated sewage and grey water discharges water quality are well known.	
Impact decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
Impact Consequence Severity (unmitigated)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Routine maritime practice		
Sewage and grey water are treated prior to overboard	Where sewage and grey water is treated in a STP, the STP meets MARPOL standards and discharged only when the vessel is <3 nm from nearest shore.	ISPP certificate is valid and verifies the installation of a MARPOL-approved STP.

discharge in accordance with Regulation 9 of MARPOL Annex IV.	The STP is maintained in accordance with the vessel's PMS.	PMS records confirm that the STP is maintained to schedule.
	In accordance with Regulation 11 of MARPOL Annex IV (as enacted by Marine Order 96), treated sewage and grey water is only discharged when the vessel is > 3 nm from nearest shore.	Records verify that treated sewage is only discharged when the vessel is >3 nm from shore.
Untreated sewage will only be discharged overboard in accordance with Regulation 11 of MARPOL Annex IV.	In the event of a STP malfunction (and for support vessels without a STP), untreated sewage and grey water is discharged only when the vessel is > 12 nm from shore.	Survey-specific discharges and emissions register verifies that untreated sewage is only discharged when vessels are >12 nm from shore.

Impact Consequence Severity (residual)	
Negligible	
Demonstration of ALARP	
A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the impact to the point that any additional, alternative, or improved control measures fail to lower the impact any further.	
Criteria	Demonstration
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.
Stakeholder engagement	Stakeholders have not raised concerns about sewage and grey water discharges.

Legislative context	The EPS outlined in this EP align with the requirements of:
	• Navigation Act 2012 (Cth):
	  ◦ Chapter 4 (Prevention of Pollution).
	  ◦ AMSA Marine Order 95 (Marine Pollution Prevention - sewage).
	• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
	  ◦ Section 26D (which implements MARPOL Annex IV).

Industry practice	The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.

	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this hazard are in line with the management measures listed in Section 4.5.1 - offshore discharges (sewage and grey water): • Grey and sewage water from showers, toilets, and kitchen facilities should be treated in an appropriate on-site marine sanitary treatment unit. • Sewage units to be in compliance with MARPOL Annex V requirements.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines for offshore activities with regard to managing sewage and grey water discharges.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of EPS for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Other waste waters (item 44) - grey and black water should be treated in an appropriate on-site marine sanitary treatment unit in compliance with MARPOL.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • Reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.1.1)	The conservation values of AMPs will not be impacted by sewage and grey water discharges. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	Sewage and grey water discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.1.6)	Sewage and grey water discharges will not intersect any TECs.
	NIWs (Section 5.1.8)	Sewage and grey water discharges will not intersect any NIWs.

	Nationally threatened and migratory species (Section 5.5)	Sewage and grey water discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	Sewage and grey water discharges will not intersect any state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	None triggered by this hazard. See Appendix 2 for additional detail regarding the impacts of routine activities on the management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• None required.		
Record Keeping		
• ISPP certificate. • STP PMS records. • Survey-specific discharges and emissions register.		

7.6. IMPACT 6 – Routine Discharges – Cooling and Brine Water

7.6.1. Causal Pathway

Cooling water

Seawater is used as a heat exchange medium for cooling engines and other equipment. Seawater is drawn up from the ocean, where it is de-oxygenated and sterilised by electrolysis (by release of chlorine from the salt solution) and then circulated as coolant for various equipment through the heat exchangers (in the process transferring heat from the machinery) and is then discharged to the ocean at depth. Upon discharge, it will be warmer than the ambient water temperature and may contain low concentrations of residual biocide and scale inhibitors if they are used to control biofouling and scale formation.

The maximum cooling water discharge rate for the vessels that may be used is unknown. Also unknown is the temperature at which the heat exchangers are designed to discharge the cooling water at (generally several degrees Celsius above ambient sea temperature). The volume depends on the equipment being cooled, but for a survey vessel, is likely to be in the tens of cubic metres each day.

Brine water

Brine (hypersaline) water is created through the desalination process that creates freshwater for drinking, showers, cooking etc. This is achieved through reverse osmosis (RO) or distillation resulting in the discharge of brine with a salinity ~10-15% higher than seawater. Upon discharge, the denser brine is will sink through the water column.

7.6.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of cooling water and brine discharges are:

- Temporary and localised increase in sea water temperature and salinity; and
- Potential toxicity impacts to marine flora and fauna associated with residual biocide and scale inhibitors.

7.6.3. EMBA

The EMBA for cooling water and brine discharges associated with vessel activities is likely to be the top 10 m of the water column and a 100 m radius from the discharge point. This is based on modelling of continuous wastewater discharges undertaken by Woodside for its Torosa South-1 drilling program (in the Scott Reef complex), which found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being less than 1°C above background levels within 100 m (horizontally) of the discharge point, and will be within background levels within 10 m vertically (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles and
- Avifauna.

7.6.4. Evaluation of Environmental Impact

Temporary and localised increase in seawater temperature

Once in the water column, cooling water will remain in the surface layer, where turbulent mixing and heat transfer with surrounding waters will occur. Prior to reaching background temperatures, the impact of increased seawater temperatures down current of the discharge may result in changes to the physiological processes of marine organisms, such as attraction or avoidance behaviour, stress or potential mortality.

Impacts to most receptors are expected to be negligible even within the localised mixing zone.

Temporary and localised increase in sea surface salinity

Brine water will sink through the water column where it will be rapidly mixed with receiving waters and be dispersed by ocean currents. Walker and MacComb (1990) found that most marine species are able to tolerate short-term fluctuations in water salinity in the order of 20-30%, and it is expected that most pelagic species passing through a denser saline plume would not suffer adverse impacts. Other than plankton, pelagic species are mobile and would be subject to slightly elevated salinity levels for a very short time as they swim through the 'plume.' As such, salinity impacts to receptors are expected to be negligible.

Potential toxicity impacts

Scale inhibitors and biocide are likely to be used in the heat exchange and desalination process to avoid fouling of pipework. Scale inhibitors are low molecular weight phosphorous compounds that are water-soluble, and only have acute toxicity to marine organisms about two orders of magnitude higher than typically used in the water phase (Black et al., 1994). The biocides typically used in the industry are highly reactive, degrade rapidly and are highly soluble in water (Black et al., 1994).

These chemicals are inherently safe at the low dosages used, as they are usually 'consumed' in the inhibition process, ensuring there is little or no residual chemical concentration remaining upon discharge.

The impacts of cooling and brine water discharges to the physical and biological environment are expected to have negligible consequences because of the:

- Low discharge volumes;
- Intermittent nature of the discharge;
- 'Consumption' of the chemicals prior to discharge;
- High dilution and dispersal factor in open waters; and
- Absence of sensitive habitats in the activity area.

7.6.5. Impact Assessment

Table 7.48 presents the impact assessment for the discharge of cooling and brine water.

Table 7.48: Impact assessment for the discharge of cooling and brine water

Summary		
Summary of impacts	Increased sea surface temperature and salinity around the discharge point. Potential toxicity impacts to marine fauna from residual biocide and scale inhibitors.	
Extent of impacts	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of impacts	Temporary – duration of the survey.	
Level of certainty of impact	HIGH – the impacts of sea surface temperature and salinity increases on marine fauna are well known.	
Impact decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
Impact Consequence Severity (unmitigated)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Routine maritime practice		
The RO plant and equipment that requires cooling by water is well maintained.	Plant and equipment that requires cooling by water is maintained in good working order in accordance with the vessels' PMS.	Vessel PMS records verify that equipment that requires cooling is maintained in accordance with OEM requirements.
	If an Electrolytic Marine Growth Protection System (EMGPS) is used, it is maintained in accordance with the PMS to ensure it is operating efficiently (without the use of chemicals).	PMS records verify that the EMGPS is maintained to schedule.
Only low-toxicity chemicals are used in the cooling and brine water systems.	Only OCNS 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM)-rated chemicals (i.e., low toxicity) are used in the cooling and brine water systems.	Vessel chemical inventories records verify that biocides and scale inhibitors are of low toxicity.
Impact Consequence Severity (residual)		
Negligible		
Demonstration of ALARP		
A 'negligible' residual impact consequence is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the impact to the point that any additional, alternative, or improved control measures fail to lower the impact any further.		

Demonstration of Acceptability		
Criteria	Demonstration	
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.	
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.	
Stakeholder engagement	Stakeholders have not raised concerns about cooling and brine water discharges.	
Legislative context	There are no legislative controls regarding cooling and brine water discharges.	
Industry practice	The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this hazard are in line with the management measures listed for offshore discharges (cooling water and desalination brine) in Section 4.5.3 of the guidelines: • Biocide dosing kept to a minimum in accordance with the equipment manufacturer's specifications. • Freshwater generation to be limited to volumes necessary for operational requirements.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines for offshore activities with regard to managing cooling and brine water discharges.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of EPS for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Cooling water (items 41 & 42) – antifouling chemical dosing to prevent marine fouling of cooling water systems should be carefully considered and appropriate screens to be fitted to the seawater intake to avoid entrainment and impingement of marine flora and fauna. The cooling water discharge depth should be selected to maximise mixing and cooling of the thermal plume to ensure it is within 3°C of ambient seawater temperature within 100 m of the discharge point. • Desalination brine (item 43) – consider mixing desalination brine from the potable water

		system with cooling water or other effluent streams.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	No guidelines provided regarding management of cooling and brine water.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • Reduce the volume of wastes produced to ALARP and to an acceptable level.
	MNES	
	AMPs (Section 5.1.1)	Cooling and brine water may be discharged within the Zeehan AMP. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	Cooling and brine water discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.1.6)	Cooling and brine water discharges will not intersect any TECs.
	NIWs (Section 5.1.8)	Cooling and brine water discharges will not intersect any NIWs.
	Nationally threatened and migratory species (Section 5.5)	Cooling and brine water discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	Cooling and brine water discharges will not intersect any state marine parks. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	None triggered by this hazard. See Appendix 2 for additional detail regarding the impacts of routine activities on the management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• None required.		
Record Keeping		

• PMS records. • Chemical inventories.

7.7. IMPACT 7 – Routine Discharges – Bilge Water and Deck Drainage

7.7.1. Causal Pathway

Bilge tanks on the vessels will receive fluids from closed deck drainage and machinery spaces that may contain contaminants such as oil, detergents, solvents, chemicals and solid waste. On the survey vessel, an oily water separator (OWS) will treat this water prior to discharge overboard in order to meet the MARPOL requirement that no greater than 15 ppm oil-in-water (OIW) is discharged overboard. The volume of these discharges is small and intermittent (as required, based on bilge tank storage levels). Where no OWS is present (in the case of support vessels), these fluids are retained in tanks for onshore disposal.

Vessel decks that are not bunded and drain directly to the sea may lead to the discharge of contaminated water, caused by ocean spray and rain ('green water') or deck washing activities.

7.7.2. Known and Potential Environmental Impacts

The known and potential environmental impacts of the discharge of bilge water and deck drainage are:

- Temporary and localised reduction of surface water quality (organics and toxins) around the discharge point; and
- Acute toxicity to marine fauna through ingestion of, or contact with, contaminated water within the mixing zone in the event of malfunction of the OWS or an uncontrolled spill emanating from an open drainage area.

7.7.3. EMBA

The EMBA for bilge and deck water discharges is likely to be the top 10 m of the water column and less than a 100 m radius from the discharge point. This is based on modelling of continuous wastewater discharges undertaken by Woodside for its Torosa South-1 drilling program in the Scott Reef complex (Woodside, 2008).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles; and
- Avifauna.

7.7.4. Evaluation of Environmental Impact

Temporary and localised reduction of surface water quality

Small volumes and low concentrations of oily water (<15 ppm) from bilge discharges and traces of chemicals or hydrocarbons discharged to the ocean through open deck drainage may temporarily reduce water quality.

Given the absence of sensitive habitat types in the water column of the EMBA for these discharges, the greatest risk will be to plankton and pelagic fish. These discharges will be rapidly diluted, dispersed and biodegraded to undetectable levels within 100 m of the discharge point and will therefore have a negligible impact to these receptors.

Potential toxicity impacts

While small volumes and low concentrations of oily water from bilge discharges may temporarily reduce water quality, such discharges are not expected to induce acute or chronic toxicity impacts to marine fauna or plankton through ingestion or absorption through the skin.

In the event a vessel OWS malfunctions and discharges off-specification water, toxicity impacts may occur within a localised mixing zone and any reduction in water quality would be localised and temporary (short term) and unlikely to have any measurable impact on species diversity or abundance.

In general, the impacts of bilge water and deck drainage to the physical and biological environment are expected to have negligible consequences because of the:

- Low discharge volumes;
- Intermittent nature of the discharge;
- High dilution and dispersal factor in open waters; and
- Absence of sensitive habitats in the survey area and EMBA.

7.7.5. Impact Assessment

Table 7.49 presents the impact assessment for the discharge of bilge water and deck drainage.

Table 7.49: Impact assessment for the discharge of bilge water and deck drainage

<table>
<tr><th colspan="3">Summary</th></tr>
<tr><td>Summary of impacts</td><td colspan="2">Increased sea surface temperature and salinity around the discharge point.
Potential toxicity impacts to marine fauna from residual biocide and scale inhibitors.</td></tr>
<tr><td>Extent of impacts</td><td colspan="2">Localised – up to 100 m horizontally and 10 m vertically from the discharge point.</td></tr>
<tr><td>Duration of impacts</td><td colspan="2">Intermittent during the survey.</td></tr>
<tr><td>Level of certainty of impacts</td><td colspan="2">HIGH – the impacts of oily water discharges to the ocean are well known.</td></tr>
<tr><td>Impact decision framework context</td><td colspan="2">A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.</td></tr>
<tr><th colspan="3">Impact Consequence Severity (unmitigated)</th></tr>
<tr><td colspan="3">Minor</td></tr>
<tr><th colspan="3">Environmental Controls and Performance Measurement</th></tr>
<tr><td>EPO</td><td>EPS</td><td>Measurement criteria</td></tr>
<tr><td colspan="3">Routine maritime practices</td></tr>
<tr><td rowspan="2">Bilge water discharges comply with MARPOL Annex I requirements.</td><td>For vessels >400 gross tonnes, all bilge water passes through a MARPOL-compliant OWS set to limit OIW to <15 ppm prior to overboard discharge.</td><td>IOPP certificate is current.</td></tr>
<tr><td>The OWS is maintained in accordance with the vessel PMS.</td><td>PMS records verify that the OWS is</td></tr>
</table>

	The OWS is calibrated in accordance with the vessel PMS to ensure the 15 ppm OIW limit is met.	maintained to schedule.
	The residual oil from the OWS is pumped to tanks and disposed of onshore.	The Oil Record Book verifies that waste oil is transferred to shore.
Level 1 spills (<10 m^3) of oil or oily water overboard are rapidly responded to by the vessel contractor.	The vessel-specific Shipboard Marine Pollution Emergency Plan (SMPEP) is implemented in the event of an overboard spill of hydrocarbons or chemicals.	Incident report verifies that the SMPEP was implemented.
Planned open deck discharges are non-toxic.	Deck cleaning detergents are biodegradable.	Safety Data Sheets (SDS) verify that deck cleaning agents are biodegradable.
Hydrocarbon or chemical spills to deck are prevented from being discharged overboard.	Hydrocarbon and chemical storage areas (process areas) are bunded and drain to the bilge tank.	Site inspections (and associated completed checklists) verify that bunding is in place and piping and instrumentation diagrams (P&IDs) verify that, for vessels, they drain to the bilge tank.
	Portable bunds and/or drip trays are used to collect spills or leaks from equipment that is not contained within a permanently bunded area (non-process areas).	Site inspections (and associated completed checklists) verify that portable bunds and/or drip trays are used in non-process areas as required.
Impact Consequence Severity (residual)		
Negligible		
Demonstration of ALARP		
A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the impact to the point that any additional, alternative, or improved control measures fail to lower the impact any further.		
Demonstration of Acceptability		
Criteria	Demonstration	
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.	
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.	
Stakeholder engagement	Stakeholders have not raised concerns about bilge water and deck drainage discharges.	

Legislative context	The EPS outlined in this EP align with the requirements of:
	• Navigation Act 2012 (Cth):
	  • Chapter 4 (Prevention of Pollution).
	  • AMSA Marine Order 91 (Marine Pollution Prevention - oil).
	• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
	  • Part II (Prevention of pollution by oil).
	  • Part III (Prevention of pollution by noxious substances).	

Industry practice	The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.	

Legislative context	The EPS outlined in this EP align with the requirements of:
	• Navigation Act 2012 (Cth):
	  • Chapter 4 (Prevention of Pollution).
	  • AMSA Marine Order 91 (Marine Pollution Prevention - oil).
	• Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
	  • Part II (Prevention of pollution by oil).
	  • Part III (Prevention of pollution by noxious substances).	

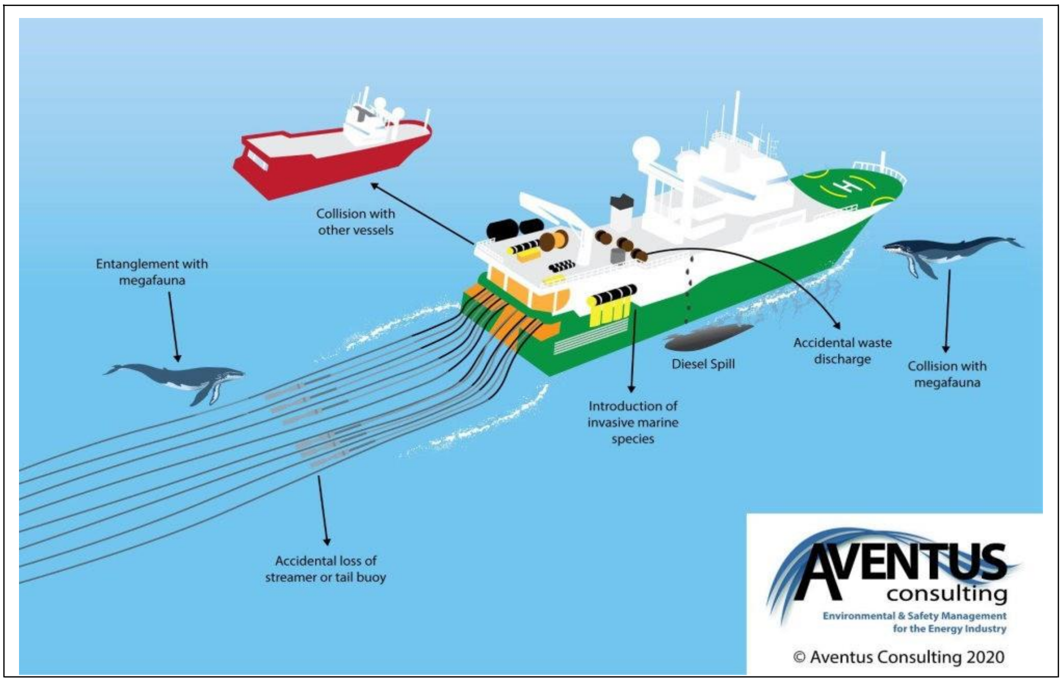
Industry practice	The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this hazard are in line with the management measures listed for offshore discharges (deck drainage and bilge water) in Section 4.5.2 of the guidelines: • Vessels must have an IOPP Certificate (for vessels >400 gross tonnes) and equipped with MARPOL/IMO-compliant oil/water treatment system (as appropriate to vessel class). • Hydrocarbon and chemical storage areas are to be bunded with no residues/spills permitted to enter the overboard drainage system unless it first goes through a closed drainage treatment system. • Vessels to maintain an Oil Record Book (applicable to vessels >400 gross tonnes), including the discharge of dirty ballast or cleaning water. • Discharge into the sea of oil or oily mixtures is prohibited except when the OIW of the discharge without dilution does not exceed 15 ppm. For support vessels, discharge of treated oily water to only occur when a vessel is en route. • Contaminated deck drainage and bilge water to be contained and treated prior to discharge in accordance with EHS Guidelines for Offshore Oil and Gas Development 2015. If treatment to this standard is not possible, these waters should be contained and shipped to shore for disposal. • Extracted hydrocarbons from oil-in water separator systems to be stored in suitable containers and transported to shore for treatment and/or disposal by a certified waste oil disposal contractor.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and	The EPS listed in this table meet these guidelines for offshore activities with regard to: • Management of drain water (item 24) – the BAT are met for vessel operations with regard to

	Production (European Commission, 2019)	ensuring deck coaming is in place, maintaining a chemical inventory, implementing an inspection, maintenance and repair schedule and ensuring that personnel are trained in the use of spill kits.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of EPS for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Other waste waters (item 44) – bilge waters from machinery spaces in support vessels should be routed to the closed drain system or contained and treated before discharge to meet MARPOL requirements. Deck drainage water should be routed to separate drainage systems. This includes drainage water from process and non-process areas. All process areas should be bunded to ensure that drainage water flows into the closed drainage system.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS listed in this table meet these guidelines with regard to: • Section 8.5 (Waste management). • Section 8.6 (Hazardous materials). • Section 8.8 (Vessel operations).
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • Reduce the risk of release of substances into the marine environment to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.1.1)	Bilge water and deck drainage may be discharged within the Zeehan AMP. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	Bilge water and deck drainage discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.1.6)	Bilge water and deck drainage discharges will not intersect any TECs.

	NIWs (Section 5.1.8)	Bilge water and deck drainage discharges will not intersect any NIWs.
	Nationally threatened and migratory species (Section 5.5)	Bilge water and deck drainage discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	Bilge water and deck drainage discharges do not intersect any state marine parks. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	None triggered by this hazard. See Appendix 2 for additional detail regarding the impacts of routine activities on the management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• None required		
Record Keeping		
• PMS records. • IOPP certificate. • Oil Record Book. • Crew training records. • Inspection and checklist records.	• P&IDs. • SDS (for deck cleaning agents). • Incident reports. • SMPEP.	

The following sections assess environmental risks (i.e., from unplanned events that *may* happen), presented pictorially in Figure 7.11

Figure 7.11: Simplified pictorial representation of risks which may arise from the survey vessel



7.8. RISK 1 – Displacement of or Interference with Third-party Vessels

7.8.1. Causal Pathway

The physical presence of the survey and support vessels and the survey streamers will result in the enforcement of an exclusion zone for the duration of the survey in order to ensure the safety of the vessel crews and third-party vessel operators, such as passenger ferries, merchant vessels and commercial fishing vessels.

Note, this section deals with displacement and interference with socio-economic receptors. Collision hazards (and subsequent MDO spill impacts) are addressed in Section 7.12.

7.8.2. Known and Potential Environmental Risks

The known and potential impacts of the displacement of or interference with third-party vessels are:

- Collision potential with third-party vessels (and damage in the case of collision);
- Diversion of third-party vessels from their navigation paths (resulting in longer sail times and greater fuel consumption); and
- Damage to or loss of fishing equipment and/or loss of commercial fish catches.

7.8.3. EMBA

The EMBA for the displacement or interference with third-party vessels is anywhere within the operational area (wherever vessel movements occur), and an exclusion zone will be declared around the survey vessel and streamers.

Receptors in the EMBA include:

- Commercial fishing vessels;
- Recreational vessels (e.g., yachts); and
- Merchant vessels.

7.8.4. Evaluation of Environmental Risks

Displacement of third-party vessels

The conduct of survey activities will temporarily exclude other users of the marine environment in order to protect the streamers and survey vessel. Given that the operational area is close to two minor shipping lanes, no impacts to shipping activity are expected. In the unlikely scenario that the survey vessel does encounter merchant vessels, the inability of the survey vessel to take sudden evasive action with streamers trailing means that the support vessels would engage the third-party vessel to change course. This may result in a negligible increase in travel time and fuel cost for third-party vessels, but in the context of an entire journey, this is not considered significant.

The survey period overlaps the closure of the Victorian southern rock lobster and giant crab fisheries (1st of June to 15th of November for females and 15th of September to 15th of November for males) (VFA, 2020). For the Tasmanian rock lobster fishery, the survey area is closed to rock lobster fishing from 1st of May until 15th of November for females and from 1st of October until 15th of November for males (VFA, 2020). In addition, the Tasmanian giant crab fishery has recorded its lowest monthly catch during August, September, and October for the last three seasons (DPIPWE, 2020j). Given these closures and sparse use of the area by fishers, the consequence of displacement during the survey period is minor.

Interference with third-party vessels

In the event of a vessel-to-vessel collision, health and safety impacts are more likely than environmental impacts. Should the force of a collision be enough to breach a vessel hull (which is unlikely due to the low speed of the survey and supports vessels), an MDO spill may eventuate (this is addressed in Section 7.12).

Damage to or loss of fishing equipment and loss of catch

Commercial (and recreational) fishing vessels will be excluded from operating in close proximity to the survey vessel and streamers for the duration of the survey so as to avoid damage to the towed equipment. Interactions between the survey and support vessels and third-party vessels is likely to be minimal, mostly because of the slow-moving nature of the survey vessel (4.5 knots or 8.3 km/hr), its high visibility (due to size) and ease of manoeuvrability of the support vessels to avoid a collision. Due to this visibility, it is also unlikely that fishing gear (such as trawl nets) would be damaged, as fishing vessels would detour around the vessel/s once communication between the vessels is made.

In the event that third-party vessels breach the safety exclusion maintained by the support vessels, there is potential for fishing gear to become entangled in the survey streamers, resulting in damage or loss. In addition to the cost of repairing or replacing this equipment, it could also result in the loss of income from caught fish during that fishing expedition.

7.8.5. Risk Assessment

Table 7.50 presents the risk assessment for displacement or interference with third-party vessels.

Table 7.50: Risk assessment for displacement or interference with third-party vessels

Summary	
Summary of risk	Presence of survey vessel (and trailing equipment) and support vessels, resulting in vessel-to-vessel collision, exclusion from fishing grounds, damage to or loss of fishing equipment and loss of commercial fish catches.
Extent of risks	Highly localised – immediately around vessels.

Duration of risks	Short-term (minutes for a third-party vessel detour) to long-term (vessel collision).		
Level of certainty of risks	HIGH – the impacts associated with vessel collisions are well known.		
Risk decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.		
Risk Assessment (unmitigated)			
Risk	Likelihood	Consequence Severity	Risk rating
Displacement	Frequent	Minor	Medium
Interference	Probable	Minor	Medium

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Routine maritime practices		
No incidents or complaints of spatial conflict with third-party vessels or fishing equipment.	The survey and support vessels are readily identifiable to third-party vessels.	Visual inspection (and associated completed checklists) verify that the anti-collision monitoring equipment (e.g., 24-hour radar watch, GMDSS and Automatic Identification System [AIS]) is functional and in use.
	Visual and radar watch is maintained on the bridge of the survey and support vessels at all times. The Vessel Master and deck officers have a valid SCTW certificate in accordance with AMSA Marine Order 70 (seafarer certification) (or equivalent) to operate radio equipment to warn of potential third party spatial conflicts (e.g. International Convention on Standards of Training, Certification and Watch-keeping for Sea-farers [STCW95], GDMSS proficiency).	Appropriate qualifications are available.
	The Vessel Masters issue warnings (e.g., radio warning, flares, lights/horns) to third-party vessels approaching the safety exclusion zone in order to prevent a collision with the vessels or equipment.	Radio operations communications log verifies that warnings to third-party vessels approaching the safety exclusion zone have been issued when necessary.
Vessel-to-vessel collisions are managed in accordance with vessel-specific emergency	The Vessel Master will sound the general alarm, manoeuvre the vessel to minimise the effects of the collision and implement all other measures as outlined in the vessel or structure collision procedure (or equivalent).	Incident report verifies that the relevant safety procedure was implemented.

procedures.	Vessel collisions will be reported to AMSA (for Commonwealth waters) if that collision has or is likely to affect the safety, operation or seaworthiness of the vessel or involves serious injury to personnel.	Incident report verifies that AMSA were notified of a vessel collision.
Survey-specific controls		
No incidents or complaints of spatial conflict with third-party vessels or fishing equipment.	ConocoPhillips Australia has undertaken thorough pre-survey consultation with fishing stakeholders to ensure that commercial fishers are aware of the survey operations, timing and safety exclusion zone requirements.	Consultation records verify that safety exclusion requirements were communicated to commercial fishing stakeholders.
	ConocoPhillips' proprietary CSI technology is used so that the survey time is kept to no more than 60 days (or about 30 days active survey time) rather than up to 98 days on location without the use of CSI. This reduces the period of time in which spatial conflict could occur.	Contract documentation, as-deployed layout diagrams and end-of-survey report verify the use of CSI technology.
	The AHO will be notified of survey activities at least a month prior to survey commencement to enable the promulgation of Notice to Mariners and AusCoast navigational warnings.	Notice to Mariners is available, including survey and support vessel details, location and timing.
		Auscoast warnings list the vessel locations.
	Prior to the survey commencing, ConocoPhillips Australia will obtain approval from VFA and/or DPIPWE to remove and relocate lobster/crab pots or other fishing equipment that may be in the path of the survey vessel.	Approval document from VFA and/or DPIPWE is available.
	Constant communication between the survey vessel and support vessels is maintained to ensure that the support vessels are patrolling the safety exclusion zone at all times.	Daily operations reports verify that the support vessels are patrolling the safety exclusion zone.
	The tail buoys on the seismic streamers will have flashing lights and radar reflectors so they are visible to other marine users.	Visual confirmation (and associated completed checklists) verifies that these measures are in place during survey acquisition.
	The survey vessel will display the appropriate lights and day shapes for a vessel with restricted ability to manoeuvre during survey operations.	

	One of the support vessels will remain in close proximity to the survey vessel (generally one ahead of the survey vessel and one astern of the tail buoys) and will intercept approaching vessels that have not heeded radio advice about avoiding the safety exclusion zone.	Radio operations communications log verifies that a support vessel has intercepted a third-party vessel approaching the safety exclusion zone when necessary.

Risk Assessment (residual)			
Risk	Likelihood	Consequence Severity	Risk rating
Displacement	Remote	Minor	Low
Interference	Remote	Minor	Low

Demonstration of ALARP
A 'low' residual risk rating consequence is considered to be ALARP and a 'lower order' risk. The routine maritime practices and survey-specific controls already in place have lowered the risk to the point that any additional, alternative, or improved control measures fail to lower the risk any further.

Demonstration of Acceptability	
Criteria	Demonstration
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.
Stakeholder engagement	Stakeholders have not raised concerns about displacement of or interference with third-party vessels.

Legislative context	The EPS outlined in this table align with the requirements of:
	• OPGGS Act 2006 (Cth).
	    • Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with navigation or fishing (among others)… to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the person.
	• *Navigation Act 2012* (Cth).
	    • Chapter 6 (Safety of navigation), particularly Part 3 (Prevention of collisions).
	    • AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures).
	    • AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment).
	    • AMSA Marine Order Part 30 (Prevention of Collisions).

Industry practice	The consideration and adoption of the controls outlined in the below-listed guidelines and codes of practice demonstrates that BPEM is being implemented.

	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this hazard are in line with the management measures listed for offshore physical presence in Section 4.3.1 of the guidelines, which include: • Develop exclusion zones in consultation with key stakeholders, including local fishing communities; raise awareness of exclusion zones with all stakeholders. • Issue a 'Notice to Mariners' through the relevant government agencies, detailing the area of operations. • Ensure all vessels adhere to International Regulations for Preventing Collisions at Sea (COLREGS), which set out the navigation rules to be followed to prevent collisions between two or more vessels. • Optimise vessel use to ensure the number of vessels required and length of time that vessels are on site is as low as practicable.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines specifically regarding physical presence for offshore activities.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Ship Collision (item 120) – to avoid collisions with third-party and support-vessels, offshore facilities [interpreted to include the survey vessel] should be equipped with navigational aids that meet national and international requirements.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS listed in this table meet these guidelines with regard to: • Section 8.4 (Travel – water travel) – maintain a lookout for, and establish communications with local fishing boats, tourist diving vessels, etc, where possible to minimise interruption with their operations and equipment.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • Reduce the impact on other marine resource users to ALARP and to an acceptable level. • To reduce risks to public safety to ALARP and an acceptable level.
	MNES	

Environmental context	AMPs (Section 5.1.1)	This hazard is irrelevant to AMPs. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	This hazard will not intersect any Ramsar wetlands.
	TECs (Section 5.1.6)	This hazard will not intersect any TECs.
	NIWs (Section 5.1.8)	This hazard will not intersect any nationally important wetlands.
	Nationally threatened and migratory species (Section 5.5)	This hazard will not have any impacts on threatened or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	This hazard will not intersect any state marine parks. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.
	Species Conservation Advice/	None triggered by this hazard.
	Recovery Plans/ Threat Abatement Plans	See Appendix 2 for additional detail regarding the impacts of routine activities on the management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• Continuous bridge monitoring.		
Record Keeping		
• Stakeholder consultation communication records. • Notice to Mariners. • Auscoast warnings. • Bridge communication logs. • Crew qualifications. • Incident reports.		

7.9. RISK 2 – Accidental Discharge of Hazardous and Non-Hazardous Materials and Wastes

7.9.1. Causal Pathway

The handling and storage of materials and waste on board a vessel has the potential to result in accidental overboard disposal of hazardous and non-hazardous materials and wastes, creating marine debris and pollution.

Small quantities of hazardous and non-hazardous materials are used in routine operations and maintenance and waste is created, and then handled and stored on the vessels. In the normal course of operations, solid and liquid hazardous and non-hazardous materials and wastes will be stored until it is disposed of via port facilities for disposal at licensed onshore facilities. However, accidental releases to sea are a possibility, especially in rough ocean conditions when items may roll off or be blown off the deck.

Based on a 2018 3DMSS in Bass Strait, 23.4 kg/day of non-degradable and degradable waste was generated by the survey vessel. For the 60-day Sequoia 3DMSS survey, it can be reasonably be expected that 1,403 kg of non-degradable and degradable waste may be generated.

The following non-hazardous materials and wastes will be disposed of to shore, but have the potential to be accidentally dropped or disposed overboard due to overfull bins, crane operator error or improper storage:

- Paper and cardboard;
- Wooden pallets;
- Scrap steel, metal and aluminium;
- Glass;
- Foam (e.g., ear plugs); and
- Plastics (e.g., hard hats).

The following hazardous materials (defined as a substance or object that exhibits hazardous characteristics, is no longer fit for its intended use and requires disposal, and as outlined in Annex III to the Basel Convention, may be toxic, flammable, explosive and poisonous) may be used and waste generated through the use of consumable products and will be disposed to shore, but may be accidentally dropped or disposed overboard or could be lost as a result of hose connection failure, overfilling of tanks or emergency disconnection of hoses:

- Hydrocarbons, hydraulic oils and lubricants;
- Hydrocarbon-contaminated materials (e.g., oily rags, pipe dope, oil filters);
- Batteries, empty paint cans, aerosol cans and fluorescent tubes;
- Contaminated personal protective equipment (PPE);
- Laboratory wastes (such as acids and solvents); and
- Larger dropped objects (that may be hazardous or non-hazardous) may be lost to the sea through accidents (e.g., crane operations) include:
    - Sea containers;
    - Towed equipment;
    - ROV; and
    - Entire skip bins/crates.

7.9.2. Potential Environmental Risks

The risks of the release of hazardous and non-hazardous materials and waste to the ocean are:

- Marine pollution (temporary and localised reduction in water quality)
- Injury and entanglement of individual animals (such as seabirds and pinnipeds);
- Toxicity to marine fauna through ingestion or absorption;
- Localised (and normally temporary) smothering or contamination of benthic habitats; and
- Navigation hazards to transiting vessels.

7.9.3. EMBA

The EMBA for the accidental disposal of hazardous and non-hazardous materials and waste is likely to extend for kilometres from the release site (as buoyant waste drifts with currents) or localised for non-buoyant items that sink to the seabed.

Receptors susceptible to waste that may occur within this EMBA, either as residents or migrants, are:

- Benthic fauna;

- Benthic habitat (sand and reef substrates);
- Pelagic fish;
- Cetaceans;
- Pinnipeds;
- Turtles; and
- Avifauna.

The EPBC Act-listed species documented as being negatively impacted by the ingestion of, or entanglement in, harmful marine debris (and known to occur in the EMBA) are (according to DoEE, 2020a):

- The five turtle species (loggerhead, green leatherback, hawksbill and flatback);
- Eight albatross species and three petrel species;
- Other birds (flesh-footed shearwater, southern fairy prion);
- Australian fur-seal;
- Indian Ocean bottlenose dolphin; and
- The southern right, pygmy blue, humpback, sei, pygmy right and killer whales.

7.9.4. Evaluation of Environmental Risks

Non-hazardous Materials and Waste

If discharged overboard, non-hazardous materials and wastes can cause smothering of benthic habitats as well as injury or death to marine fauna or seabirds through ingestion or entanglement (e.g., plastics caught around the necks of seals or ingested by turtles, seabirds and fish). For example, the TSSC (2015d) reports

that there have been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion since 1998 (humpback whales being the main species).

Marine fauna including cetaceans, turtles and seabirds can be severely injured or die from entanglement in marine debris, causing restricted mobility, starvation, infection, amputation, drowning and smothering (DoEE, 2018b). Seabirds entangled in plastic packing straps or other marine debris may lose their ability to move quickly through the water, reducing their ability to catch prey and avoid predators, or they may suffer constricted circulation, leading to asphyxiation and death. In marine mammals and turtles, this debris may lead to infection or the amputation of flippers, tails or flukes (DoEE, 2018b). Plastics have been implicated in the deaths of a number of marine species including marine mammals and turtles, due to ingestion.

If dropped objects such as bins are not retrievable (e.g., by crane), these items may permanently smother very small areas of seabed, resulting in the loss of benthic habitat. However, as with most subsea infrastructure, the items themselves are likely to become colonised by benthic fauna over time (e.g., sponges) and become a focal area for sea life, so the net environmental impact is likely to be neutral. Seabed substrates can rapidly recover from temporary and localised impacts. The benthic habitats in the operational area are broadly similar to those elsewhere in the region (e.g., extensive sandy seabed), so impacts to very localised areas of seabed will not result in the long-term loss of benthic habitat or species diversity or abundance.

Hazardous Materials and Waste

Hazardous materials and wastes released to the sea cause pollution and contamination, with either direct or indirect effects on marine organisms. For example, chemical or hydrocarbon spills can (depending on the volume released) impact on marine life from plankton to pelagic fish communities, causing physiological damage through ingestion or absorption through the skin. Impacts from an accidental release would be limited to the immediate area surrounding the release, prior to the dilution of the contaminant with the surrounding seawater. In an open ocean environment such as Bass Strait, it is expected that any minor release would be rapidly diluted and dispersed, and thus any impacts would be temporary and localised.

Solid hazardous materials, such as paint cans containing paint residue, batteries and so forth, would settle on the seabed if dropped overboard. Over time, this may result in the leaching of hazardous materials to the seabed, which could result in the adjacent substrate becoming toxic and unsuitable for colonisation by benthic fauna. The benthic habitats of the survey area are broadly similar to those elsewhere in the region (e.g., extensive sandy seabed), so impacts to very localised areas of seabed will not result in the long-term loss of benthic habitat or species diversity or abundance.

7.9.5. Risk Assessment

Table 7.51 presents the risk assessment for the accidental disposal of hazardous and non-hazardous materials and wastes.

Table 7.51: Risk assessment for the accidental discharge of hazardous and non-hazardous materials and wastes to the marine environment

Summary		
Summary of risk	Marine pollution (temporary and localised reduction in water quality), injury and entanglement of individual animals (such as seabirds and seals) and smothering or contamination of benthic habitats. Navigation risk to vessels.	
Extent of risks	Non-buoyant waste may sink to the seabed near where it was lost. Buoyant waste may float long distances with ocean currents and winds.	
Duration of risks	Short-term to long-term, depending on the type of waste and location.	
Level of certainty of risk	HIGH – the effects of inappropriate waste discharges are well known.	
Risk decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.	
Risk Assessment (unmitigated)		
Likelihood	Consequence Severity	Risk rating
Rare	Minor	Medium
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Routine maritime practices		
No unplanned release of hazardous or non-hazardous solid wastes or materials.	A MARPOL Annex V-compliant Garbage Management Plan is in place for the survey vessel (and for support vessels >100 gross tonnes or certified to carry 15 persons or more) that sets out the procedures for minimising, collecting, storing, processing and discharging garbage.	A GMP is in place, readily available on board and kept current.
	Waste is stored, handled and disposed of in accordance with the GMP. This includes measures including: • No discharge of general operational or maintenance wastes or plastics or plastic products of any kind. • Waste containers are covered with secure lids to prevent solid wastes from blowing overboard. • All solid wastes are stored in designated areas before being sent ashore for recycling, disposal or treatment. • Any liquid waste storage on deck must have at least one barrier to minimise the risk of spills to deck entering the ocean. This can include containment lips on deck (primary bunding) and/or secondary containment measures (bunding, containment pallet, transport packs, absorbent pad barriers) in place.	GMP is available and current.
		Inspections verify that waste is stored and handled according to its waste classification.
		Inspections verify that waste receptacles are properly located, sized, labelled, covered and secured for the waste they hold.
		A licensed shore-based waste contract is in place for the management of onshore waste transport and disposal.

	• Correct segregation of solid and hazardous wastes.	
	A chemical locker is available, bunded and used for the storage of all greases and non-bulk chemicals (i.e., those not in tote tanks) so as to prevent discharge overboard.	Site inspection verifies that greases and chemicals are stored in a chemical locker.
Personnel are competent in spill response and have appropriate resources to respond to a spill.	The vessel crews are competent in spill response and have appropriate response resources in order to prevent or minimise hydrocarbon or chemical spills discharging overboard. Fully stocked SMPEP response kits and scupper plugs or equivalent drainage control measures are readily available and used in the event of a spill to deck to prevent or minimise discharge overboard.	Training records verify that vessel crews receive spill response training.
		Site inspections (and associated completed checklists) verify that fully stocked spill response kits and scupper plugs (or equivalent) are available on deck in high-risk locations.
		Review of incident reports indicate that the spills of hydrocarbons or chemicals to deck are cleaned up.
Avoid objects being dropped overboard	Large bulky items are securely fastened to or stored on the deck to prevent loss to sea.	A completed pre-departure inspection checklist verifies that bulky goods are securely sea-fastened.
	The crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects (e.g., vessel-to-vessel transfers).	Completed handling and transfer procedure checklist, Permit to Work (PTW) and/or risk assessments verify that the procedure is implemented prior to each transfer.
	The crane operators are trained to be competent in the handling and transfer procedure to prevent dropped objects.	Training records verify that crane operators are trained in the loading and unloading procedure.
	The vessel PMS are implemented to ensure that lifting equipment remains in certification and fit for use at all times to minimise the risk of dropped objects.	PMS records verify that lifting equipment is maintained to schedule and in accordance with OEM requirements.
	Visual inspection of lifting gear is undertaken every quarter by a qualified competent person (e.g., maritime officer) and lifting gear is tested regularly in line with the vessel PMS.	Inspection of PMS records and Lifting Register verifies that inspections and testing have been conducted to schedule.

Chemicals and hydrocarbons are stored and transferred in a manner that prevents bulk release.	All hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.	Visual inspection verifies that hydrocarbons and chemicals are stored within secure receptacles within bunded areas or dedicated chemical lockers that drain to bilge tanks.
	Vessels' PMS are implemented to ensure the integrity of chemical and hydrocarbon storage areas and transfer systems are maintained in good order.	Vessel PMS records verify that chemical and hydrocarbon storage areas and transfer systems (e.g., bunds, tanks, pumps and hydraulic hoses) are maintained to schedule and in accordance with OEM requirements.
	Where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.	Visual inspection verifies that where hydrocarbons and chemicals are stored within open draining decks, receptacles are stored on/in temporary bunds.
	Crane transfers of bulk chemicals and hydrocarbons are undertaken in accordance with the vessel contractor lifting and loading procedure, or equivalent, and under a Permit to Work (PTW).	PTW records verify that crane transfers of bulk chemicals and hydrocarbons are undertaken in accordance with the procedure.
Survey-specific controls		
No unplanned release of hazardous or non-hazardous solid wastes or materials.	Vessel crews and visitors are inducted into waste management procedures to ensure they understand how to implement the GMP.	Induction and attendance records verify that all crew members are inducted.
	Waste types and volumes are tracked and logged.	Waste tracker is available and current.
	Solid waste that is accidentally discharged overboard is recovered if reasonably practicable.	Incident records are available to verify that credible and realistic attempts to retrieve the materials lost overboard were made.

Avoid loss of seismic survey streamers	Streamers are fitted with streamer retrieval devices (SRD) that inflate when the SRD reaches a maximum depth. The tail of each streamer has an RGPS tail buoy. If a streamer is lost then the RGPS position of the tail buoy combined with the visual presence of the SRDs would be used to locate and retrieve it. The sources are all suspended from floats and each float will be fitted with an RGPS unit.	Pre-deployment inspection verifies that equipment is fitted and in good working order.
	The vessel contractor's Matrix of Permitted Operations (MOPO) (or equivalent), which sets limits for certain activities dependant on weather conditions) will be used to guide the	Daily reports record weather conditions and verify that streamers are
	deployment of streamer and source equipment so that damage to (and potential loss of) equipment caused by rough seas is avoided.	not deployed during rough seas.
	Survey contractor will employ its dropped object procedure to recover dropped objects or untangle snagged objects where safe to do so (taking into consideration water depth, size of object, risk to navigation, and HSE matters).	Incident investigation reports are available for incidents of dropped or snagged objects.

Risk Assessment (residual)		
Likelihood	Consequence Severity	Risk rating
Remote	Minor	Low

Demonstration of ALARP
A 'low' residual risk rating is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the risk to the point that any additional, alternative, or improved control measures fail to lower the risk any further.

Demonstration of Acceptability	
Criteria	Demonstration
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.
Stakeholder engagement	Stakeholders have not raised concerns about the accidental discharge of waste.

<table>
<tr><td>Legislative context</td><td colspan="2">The EPS outlined in this EP align with the requirements of:
Navigation Act 2012 (Cth):
Chapter 4 (Prevention of Pollution).
Marine Orders Part 47.
Marine Orders Part 94 (Marine pollution prevention – packaged harmful substances).
Marine Orders Part 95 (Marine pollution prevention – garbage).
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth):
Part III (Prevention of pollution by noxious substances).
Part IIIA (Prevention of pollution by packaged harmful substances).
Part IIIC (Prevention of pollution by garbage).</td></tr>
<tr><td rowspan="4">Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry
(IOGP-IPIECA, 2020)</td><td>The EPS developed for this activity are in line with the management measures listed for hazardous waste and non-hazardous waste discharges in Sections 4.6.2 and 4.6.3 of the guidelines, which include:
Segregating hazardous and non-hazardous wastes prior to disposal.
Managing hazardous waste in accordance with their SDS and tracking it to final destination.
Not deliberately discharging waste overboard.</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>The EPS listed in this table meet these guidelines for offshore activities with regard to:
Risk management for handling and storage of chemicals (item 19). The BAT are met for the survey with regard to implementing chemical transfer procedures and ensuring chemicals are stored in separate, labelled containers.</td></tr>
<tr><td>Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall,
2016)</td><td>The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of the EPS for this EP and the survey design in general.</td></tr>
</table>

	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Waste management (items 46) – materials should be segregated offshore and shipped to shore for reuse, recycling or disposal. A waste management plan should be developed and contain a mechanism allowing waste consignments to be tracked. • Hazardous materials management (item 72) – principles relate to the selection of chemicals with the lowest environmental and health risks.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS listed in this table meet these guidelines with regard to: • Section 8.5 (Waste management) – measures for managing waste are addressed through the EPS mainly through the requirement for a GMP. • Section 8.6 (Hazardous materials) – stipulations that fuel and oils are stored in appropriate areas.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • To reduce the risk of any unplanned release of material into the marine environment to ALARP and to an acceptable level.
	Waste management-specific	
	Guidelines for the Development of GMPs (IMO, 2012)	The vessels' GMPs are developed in accordance with these guidelines.
	International Dangerous Goods Maritime Code (IMO, 2014)	The storage and handling of dangerous goods on the vessels is managed in accordance with this code.
Environmental context	MNES	
	AMPs (Section 5.1.1)	The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (DNP, 2013) identifies marine debris as a threat to the AMP network. The EPS listed in this table aim to minimise the generation of marine debris and are aligned with the strategies outlined in the plan.
	Wetlands of international importance (Section 5.1.4)	The unplanned discharge of hazardous and non-hazardous materials and waste is highly unlikely to reach Ramsar wetlands.

	TECs (Section 5.1.6)	The unplanned discharge of hazardous and non-hazardous materials and waste is highly unlikely to reach any TECs.
	NIWs (Section 5.1.8)	The unplanned discharge of hazardous and non-hazardous materials and waste is highly unlikely to reach any nationally important wetlands.
	Nationally threatened and migratory species (Section 5.5)	The unplanned discharge of hazardous and non-hazardous materials and waste is highly unlikely to have any impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	The unplanned discharge of hazardous and non-hazardous materials and waste is highly unlikely to intersect any state marine parks. See Appendix 1 for additional detail regarding the impacts of non-routine activities on the management aims of state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	• Marine pollution is a threat identified in the National recovery plan for threatened albatross and giant petrels 2011-2016 (DSEWPC, 2011a). Population monitoring is the suggested action to deal with marine pollution. The risks posed by this hazard do not impact this action.
		• The conservation advice for humpback whales (TSSC, 2015d) and the Conservation Management Plan for the Blue Whale (DoE, 2015d) identify marine debris as a threat, but there are no conservation management actions to counter this. The EPS listed in this table aim to minimise the generation of marine debris. • The conservation advice for hooded plovers (DoE, 2014) identifies ingestion of marine debris as a threat that requires reducing inshore debris. The EPS listed in this table aim to minimise the generation of marine debris. • The EPS listed in this table meet objective one of the Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia’s coasts and oceans (DoEE, 2018b), which is to contribute to the long-term prevention of the incidence of harmful marine debris. See Appendix 2 for additional detail regarding the impacts of non-routine activities on the

		management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• Waste tracking.		
Record Keeping		
• Vessel contractor pre-qualification report/s. • GMP. • Garbage Record Book. • Crew induction and attendance records.	• Inspection records/checklists. • Shore-based waste contract. • Incident reports.	

7.10. RISK 3 – Vessel Collision or Entanglement with Megafauna

7.10.1. Causal Pathway

The movement of the survey and support vessels throughout the operational area, together with the presence of seismic streamers, has the potential to result in collision or entanglement with megafauna.

7.10.2. Potential environmental risks

The risks of vessel strike with megafauna are:

- Injury; and
- Death.

7.10.3. EMBA

The EMBA for megafauna vessel strike or entanglement with streamers is the immediate area around the vessel and towed streamers.

Receptors at risk within this EMBA are:

- Cetaceans (whales and dolphins);
- Pinnipeds (fur-seals);
- Sharks; and
- Turtles.

7.10.4. Evaluation of Environmental Risks

Cetaceans and pinnipeds are naturally inquisitive marine mammals that are often attracted to offshore vessels, and dolphins commonly 'bow ride' with offshore vessels. The reaction of whales to the approach of a vessel is quite variable. Some species remain motionless when in the vicinity of a vessel while others are known to be curious and often approach ships that have stopped or are slow moving, although they generally do not approach, and sometimes avoid, faster moving ships (Richardson et al., 1995). Turtles have been known to become trapped in the tail buoys that are attached to the end of seismic streamers.

Peel et al (2016) reviewed vessel strike data (2000-2015) for marine species in Australian waters and identified the following:

- Whales including the humpback, pygmy blue, Antarctic blue, southern right, dwarf minke, Antarctic
- minke, fin, bryde's, pygmy right, sperm, pygmy sperm and pilot species were identified as having interacted with vessels. The humpback whale exhibited the highest incidence of interaction followed by the southern right whale, and these species may migrate through the waters of the survey area during the survey period (see Section 5.5.6).
- Dolphins including the Australian humpback, common bottlenose, Indo-pacific bottlenose and Risso's dolphin species were also identified as interacting with vessels. The common bottlenose dolphin exhibited the highest incidence of interaction. A number of these species may reside in or pass through the waters of the survey area (see Section 5.5.6).
- There were no vessel interaction reports during the period for either the Australian or New Zealand fur-seal. There have been incidents of seals being injured by boat propellers, however all indications are
- rather than 'boat strike' these can be attributed to be the seal interacting/playing with a boat, with a number of experts indicating the incidence of boat strike for seals is very low.
- All turtle species present in Australian waters are identified as interacting with vessels. The green and loggerhead species exhibited the highest incident of interaction. The presence of turtles in the survey area and EMBA is considered remote.

Collisions between vessels and cetaceans occur more frequently where high vessel traffic and cetacean habitat coincide (WDCS, 2006). There have been recorded instances of cetacean deaths in Australian waters (e.g., a Bryde's whale in Bass Strait in 1992), though the data indicates this is more likely to be associated with container ships and fast ferries (WDCS, 2006). Some cetacean species, such as humpback whales, can detect and change course to avoid a vessel (WDCS, 2006). The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with an animal (species not defined) (NMSC, 2010).

The DoE (2015d) reports that there were two blue whale strandings in the Bonney Upwelling (western Victoria) with suspected ship strike injuries visible. When the vessels are stationary or slow moving, the risk of collision with cetaceans is extremely low, as the vessel sizes and underwater noise 'footprint' will alert cetaceans to its presence and thus elicit avoidance. Laist et al (2001) identifies that larger vessels moving in excess of 10 knots may cause fatal or severe injuries to cetaceans with the most severe injuries caused by vessels travelling faster than 14 knots. When the source and support vessels are operating within the surveyarea, they will be travelling typically 4.5 knots (8.3 km/hr) while acquiring seismic data or will be stationery, so the risk associated with fast moving vessels is minimised for this activity. There may be an emergency situation whereby a support vessel is required to increase its speed (e.g., in response to a person overboard).

The DSEWPC (2012b) notes that whale entanglement in nets and lines often causes physical damage to skin and blubber. These wounds can then expose the animal to infection. Entanglement can also result in amputation (e.g., of a flipper or tail fluke), and death over a prolonged period. The DoE (2015d) states that entanglement (in the context of fishing nets, lines or ropes) has the potential to cause physical injury that can result in loss of reproductive fitness, and mortality of individuals from drowning, impaired foraging and associated starvation, or infection or physical trauma. There is a negligible risk of this occurring to megafauna with tethered ROVs as the tethers are likely to break under the weight of entanglement.

Slow travel speeds combined with the low likelihood of presence of southern right whales, humpback whales and pygmy blue whales in and around the operational area during the proposed survey period, makes it highly unlikely that vessel strike or streamer entanglement with threatened whale species will occur.

The Australian and New Zealand fur-seals are highly agile species that haul themselves onto rocks and oil and gas platform structures (jackets). As such, it is likely that they will be able to avoid seismic streamers and are unlikely to become entangled within them (especially with horizontal separation between the streamers being approximately 75 m).

7.10.5. Risk Assessment

Table 7.52 presents the risk assessment for vessel collision with megafauna.

Table 7.52: Risk assessment for vessel collision with megafauna

Summary			
Summary of risks	Injury or death of marine megafauna.		
Extent of risks	Localised (limited to individuals coming into contact with the vessel or streamers).		
Duration of risks	Temporary (if individual animal dies or has a minor injury) to long-term (if there is a serious injury).		
Level of certainty of risk	HIGH – injury may result in the reduced ability to swim and forage. Serious injury may result in death.		
Risk decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.		
Risk Assessment (unmitigated)			
Risk	Likelihood	Consequence Severity	Risk rating
Individual animal	Remote	Moderate	Medium
Population level	Remote	Minor	Low
Environmental Controls and Performance Measurement			
EPO	EPS		Measurement criteria
Survey-specific controls			
No injury or death of megafauna as a result of vessel strike or entanglement with subsea equipment.	Through constant bridge and MMO watch, vessels comply with the Australian National Guidelines for Whale and Dolphin Watching for Vessels (DoEE, 2017) when working within the operational area. This means: • Caution zone (300 m either side of whales and 150 m either side of dolphins) – vessels must operate at no wake speed in this zone.		Daily operations reports note when megafauna were sighted and what actions were taken to avoid collision or entanglement.
	• No approach zone (100 m either side of whales and 50 m either side of dolphins) – vessels should not enter this zone and should not wait in front of the direction of travel or an animal or pod/group. • Do not encourage bow riding. • If animals are bow riding, do not change course or speed suddenly. • If there is a need to stop, reduce speed gradually.		

	Vessel crew has completed an environmental induction covering the above-listed requirements for vessel and megafauna interactions.	Induction and attendance records verify that all crews have completed an environmental induction.
Vessel strike or entanglement is reported to regulatory authorities.	Vessel strike causing injury to or death of a cetacean is reported to the DAWE via the online National Ship Strike Database (https://data.marinemammals.gov.au/report/shipstrike) within 72 hours of the incident.	Electronic record of report submittal is available. Incident report is available within the OMS.
	Entanglement of megafauna is reported to the Whale and Dolphin Emergency Hotline on 1300 136 017 as soon as possible. No attempts to disentangle megafauna should be made by vessel crew.	Incident report verifies contact was made with the Whale and Dolphin Emergency Hotline.

Risk Assessment (residual)			
Risk	Likelihood	Consequence Severity	Risk rating
Individual animal	Remote	Moderate	Medium
Population level	Remote	Minor	Low

Demonstration of ALARP
A 'medium' residual risk rating is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the risk to the point that any additional, alternative, or improved control measures fail to lower the risk any further.

Demonstration of Acceptability	
Criteria	Demonstration
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.
Stakeholder engagement	Stakeholders have not raised concerns about vessel collision with megafauna.

Legislative context	The EPS outlined in this EP align with the requirements of:
	• EPBC Act 1999 (Cth):
	  • Section 199 (failing to notify taking of listed species or listed ecological community).
	• EPBC Regulations 2000 (Cth):
	  • Part 8 (Interacting with cetaceans and whale watching).
	  • AMSA Marine Notice 2016/15 – Minimising the risk of collisions with cetaceans.

Industry practice	The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.

	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this activity are in line with the management measures listed for collision with marine fauna in Section 4.7.5 of the guidelines: • Monitoring for the presence and movement of large cetaceans and pinnipeds so that avoidance can be taken when marine fauna is observed to be on a collision course with vessels.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines for offshore activities with regard to minimising the risk of collisions with megafauna.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of EPS for this EP and the survey design in general.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS listed in this table meet these guidelines with regard to: • Section 8.7 (Aquatic life) – reporting incidents involving aquatic life to the appropriate authorities.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There are no guidelines regarding minimising the risk of vessel strike or entanglement with megafauna.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • Reduce the risks to the abundance, diversity, geographical spread and productivity of marine species to ALARP and to an acceptable level.
	Megafauna collision-specific	
	The Australian Guidelines for Whale and Dolphin Watching (DoEE, 2017)	The EPS listed in this table are aligned with the requirements of these guidelines, despite the fact that the support vessels are not acting in the capacity of dedicated whale or dolphin watching vessels.
	National Strategy for Reducing Vessel Strike on	The EPS listed in this table are aligned with objective 3 of this strategy, which is to reduce the
	Cetaceans and other Marine Megafauna	likelihood and severity of megafauna vessel collisions.

	(DoEE, 2017).	
Environmental context	MNES	
	AMPs (Section 5.1.1)	The risk of collisions with megafauna does not have any effect on nearby AMPs. See Appendix 1 for additional detail regarding the impacts of non-routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	The risk of collisions with megafauna will not have any effect on Ramsar wetlands.
	TECs (Section 5.1.6)	The risk of collisions with megafauna will not have any effect on TECs.
	NIWs (Section 5.1.8)	The risk of collisions with megafauna will not have any effect on NIWs.
	Nationally threatened and migratory species (Section 5.5)	The low speed of the survey and support vessels, along with the timing of the survey to avoid peak whale migration, makes it unlikely that vessel strike or entanglement with megafauna will occur. If vessel strike or entanglement does occur to individual animals, this will not be a significant impact in the context of species' populations.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	The risk of collisions with megafauna does not have any effect on state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Vessel collisions (and/or entanglements) are listed as a threat to cetaceans in the: • Conservation Management Plan for the Southern Right Whale (DSEWPC, 2012b); • Conservation Management Plan for the Blue Whale (DoE, 2015d); • Conservation advice for the sei whale (TSSC, 2015b); • Conservation advice for the fin whale (TSSC, 2015c); and • Conservation advice for the humpback whale (TSSC, 2015d). The EPS listed in this table aim to minimise the risk of vessel strike and entanglement with megafauna and do not breach the management actions of the above-listed whale conservation plans. See Appendix 2 for additional detail regarding the impacts of non-routine activities on the management aims of threatened species plans.

ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).
Environmental Monitoring	
• MMO and vessel crew sightings.	
Record Keeping	
• Vessel crew induction presentation and attendance records. • Megafauna sighting records. • Incident reports.	

7.11. RISK 4 – Introduction and Establishment of Invasive Marine Species

7.11.1. Causal Pathways

The Department of Agriculture, Water and the Environment (DAWE formerly DAWR, 2018) defines marine pests (referred to in this EP as invasive marine species, IMS) as:

non-native marine plants or animals that harm Australia's marine environment, social amenity or industries that use the marine environment, or have the potential to do so if they were to be introduced, established (that is, forming self-sustaining populations) or spread in Australia's marine environment.

The following activities have the potential to result in the introduction of IMS in the survey area:

- Discharge of vessel ballast water; and
- Translocation of foreign species through biofouling on vessel hulls, niches (e.g., thruster tunnels, sea chests) or in-water equipment (e.g., seismic source arrays and streamers).

The survey and support vessels may 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 on board at any time.

Biofouling is the accumulation of aquatic microorganisms, algae, plants and animals on vessel hulls and submerged surfaces. More than 250 non-indigenous marine species have established in Australian waters, with research indicating that biofouling has been responsible for more foreign marine introductions than ballast water (DAWR, 2015).

The DAWR estimates that ballast water is responsible for 30% of all marine pest incursions into Australian waters (DAWR, 2018). The DAWR declares that all saltwater from ports or coastal waters outside Australia's territorial seas presents a high risk of introducing foreign marine pests into Australia (AQIS, 2011), while DAWR (2018) notes that the movement of vessels and marine infrastructure is the primary pathway for the introduction of IMS.

7.11.2. Potential Environment Risks

The risks of IMS introduction (assuming survival, colonisation and spread) include:

- Reduction in native marine species diversity and abundance through competition for resources;
- Displacement of or predation on native marine species;
- Depletion of commercial fish stocks (and associated socio-economic effects); and
- Changes to conservation values of protected areas.

7.11.3. EMBA

The EMBA for IMS introduction is anywhere within the survey area, though if IMS survive the introduction and go on to colonise and spread, this EMBA could extend to large parts of Bass Strait. However, survival is not expected in deep oceanic waters (>170 m depth) with establishments more likely within shallower waters (<50m) where vessels are stationary for extended periods of time.

Receptors most at risk within this EMBA, either as residents or migrants, are:

- Benthic fauna (because of their limited ability to move to other suitable areas);
- Benthic habitat; and
- Pelagic and demersal fish.

7.11.4. Evaluation of Environmental Risks

Successful IMS invasion requires the following three steps:

- Colonisation and establishment of the marine pest on a vector (e.g., vessel hull) in a donor region (e.g., home port).
- Survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g., activity area).
- Colonisation (e.g., dislodgement or reproduction) of the marine species in the recipient region, followed by successful establishment of a viable new local population.

If successful invasion takes place, the IMS is likely to have little or no natural competition or predation, thus potentially outcompeting native species for food or space, preying on native species or changing the nature of the environment. It is estimated that approximately one in six introduced marine species becomes pests (AMSA, n.d).

Marine pest species can also deplete fishing grounds and aquaculture stock, with between 10% and 40% of Australia's fishing industry being potentially vulnerable to marine pest incursion (AMSA, n.d). For example, the introduction of the Northern Pacific seastar (Asterias amurensis) in Victorian and Tasmanian waters was linked to a decline in scallop fisheries. Similarly, the ability of the New Zealand screw shell (Maoricolpus roseus) to reach densities of thousands of shells per square metre has presented problems for commercial scallop fishers (MESA, 2017). The ABC (2000) reported that the New Zealand screw shell is likely to displace similar related species of screw shells, several of which occupy the same depth range and sediment profile.

Marine pests can also damage marine and industrial infrastructure, such as encrusting jetties and marinas or blocking industrial water intakes. By building up on vessel hulls, they can slow the vessels down and increase fuel consumption.

The CoA (2009) states that the operational and maintenance needs of immersible seismic survey equipment means that they do not typically pose a threat for biofouling accumulation and translocation, though biofouling can be present in streamer joints and the gaps of collar joints.

At this stage of survey development, it is unknown which survey vessel will be contracted. However, the IMS risks posed by the source and support vessels will be managed in accordance with the EPS outlined in Table7.53 and will begin with a pre-qualification assessment undertaken by the new vessel contractor prior to charter to confirm that biofouling and ballast water controls meet the requirements of this EP.

7.11.5. Risk Assessment

Table 7.53 presents the risk assessment for the introduction of IMS.

Table 7.53: Table 7.53: Risk assessment for the introduction of IMS

Summary	
Summary of risks	Reduction in native marine species diversity and abundance, displacement of native marine species, socio-economic impacts on commercial fisheries and changes to conservation values of protected areas.

Extent of risk	Localised (isolated locations if there is no spread) to widespread (if colonisation and spread occurs).		
Duration of risk	Short-term (IMS is detected and eradicated, or IMS does not survive long enough to colonise and spread) to long-term (IMS colonises and spreads).		
Level of certainty of risk	HIGH – the impacts associated with IMS introduction are well known and the vectors of introduction are known. Regulatory guidelines controlling these vectors have been established.		
Risk decision framework context	A – nothing new or unusual, represents business as usual, well understood activity, good practice is well defined.		
Risk Assessment (unmitigated)			
Likelihood	Consequence Severity	Risk rating	
Rare	Major	Significant	
Environmental Controls and Performance Measurement			
EPO	EPS	Measurement criteria	
Project-specific controls			
Vessels used to undertake the survey do not introduce IMS.	ConocoPhillips Australia undertakes a vessel contractor pre-qualification assessment in accordance with its Marine Risk Management Standard (GM-STD-MA-003) to ensure vessel biofouling controls meet these EP requirements.	Vessel contractor pre-qualification audit report (e.g., CMID) verifies the vessel meets the requirements outlined in this table.	
Biofouling			
Vessels do not introduce IMS to the operational area.	Vessels are managed in accordance with the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (AQIS, 2009) and the to ensure they present a low biofouling risk. This means: • Biofouling risk is assessed. • Conducting in-water inspection by divers or inspection in drydock if deemed necessary (based on risk assessment). • Cleaning of hull and internal seawater systems, if deemed necessary. • Anti-fouling coating status taken into account, with antifouling renewal undertaken if deemed necessary.	Biofouling assessment report prior to mobilising to site confirms acceptability to enter operational area.	
	Vessels >400 gross tonnes carry a current IAFS Certificate that is complaint with Marine Order Part 98 (Anti-fouling Systems).	IAFS Certificate is available and current.	
	Vessels are managed in accordance with the Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species (IMO, 2011), which involves	Vessel contractor Biofouling Management Plan and Biofouling Record Book are available and current.	

	ensuring that vessels: • Maintain a Biofouling Management Plan; • Maintain a Biofouling Record Book; • Install and maintain an anti-fouling system; • Undertake in-water inspections (and in-water hull cleaning, if appropriate); and • Instruct crews on the application of biofouling management procedures.	
	Immersible equipment is cleaned (e.g., biofouling is removed from acoustic sources and streamers) prior to initial use.	Records are available to verify that immersible equipment was cleaned prior to use.
	Vessels fulfil the requirements of the Australian Ballast Water Management Requirements (DAWR, 2017, v7). This includes requirements to: • Carry a valid Ballast Water Management Plan (BWMP). • Submit a Ballast Water Report (BWR) through the Maritime Arrivals Reporting System (MARS). • If intending to discharge internationally-sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival. • If intending to discharge Australian-sourced ballast water, seek a low-risk exemption through MARS. • Hold a Ballast Water Management Certificate (BWMC). • Ensure all ballast water exchange operations are recorded in a Ballast Water Record System (BWRS).	BWMP is available and current.
		BWR (or exemption) is submitted prior to entry to the activity area.
		A valid BWMC is in place.
		An up-to-date BWRS is in place.
		An electronic pre-arrival report (ePAR) is available and signed off by DAWE.

	As above, except a BWR is not required for domestic journeys (i.e., when moving between Australian ports and 200 nm of the coastline). Note: ballast water management is not required between Australian ports if: • Ballast water is taken up and discharged in the same place. • Potable water is used as ballast. • Ballast water was taken up on the high seas only. • The vessel receives a risk-based exemption from ballast water management.	As above, except for the BWR.
Reporting		
Known or suspected non-compliance with biosecurity measures are reported to regulatory agencies.	Non-compliant discharges of domestic ballast water are to be reported to the DAWE immediately (contact details in Section 8.11).	Incident report notes that contact was made with the DAWE regarding non-compliant ballast water discharges.
Risk Assessment (residual)		
Likelihood	Consequence Severity	Risk rating
Remote	Major	Medium
Demonstration of ALARP		
A 'medium' residual risk rating is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the risk to the point that any additional, alternative, or improved control measures fail to lower the risk any further.		
Demonstration of Acceptability		
Criteria	Demonstration	
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.	
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.	
Stakeholder engagement	Stakeholders have not raised concerns about the introduction and/or spread of IMS.	

Legislative context	The EPS outlined in this EP align with the requirements of:
	• *Biosecurity Act 2015* (Cth):
	  • Chapter 4 (Managing biosecurity risk).
	  • Chapter 5, Part 3 (Management of discharge of ballast water).
	• *Protection of the Sea (Harmful Anti-fouling Systems) Act 2006* (Cth):
	  • Part 2 (Application or use of harmful anti-fouling systems).
	  • Part 3 (Anti-fouling certificates and anti-fouling declarations).
	  • Marine Order 98 (Marine pollution – anti-fouling systems).	

Industry practice	The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.	

	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this activity are in line with the management measures listed for the introduction of IMS in Section 4.7.6 of the guidelines: • Developing an IMS Management Plan (where applicable). • Complying with the International Convention on the Control of Harmful Anti-fouling Systems on Ships. • Ensuring vessels of appropriate class have IFAS certificates. • Ensuring compliance with local regulatory guidelines.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There are no guidelines for offshore activities with regard to minimising the risk of introducing IMS.
	Effective planning for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of the EPS for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	There are no guidelines regarding preventing the introduction of IMS.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	There is no guidance regarding preventing the introduction of IMS.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • Reduce the risk of introduction of marine pests to ALARP and to an acceptable level. • Reduce the impacts to benthic communities to ALARP and to an acceptable level.
	IMS-specific	
	Australian Ballast Water Management Requirements (DAWR, 2017, v7)	The EPS in this table reflect the guidance regarding ballast water management in the DAWR guide.

	Anti-Fouling and In-Water Cleaning Guidelines (DoA/DoE, 2015).	The EPS in this table reflect the general guidance regarding managing fouling in the DoA/DoE guidelines, which have since been updated in the aforementioned DAWR (2019) quarantine guide.
	Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species (IMO, 2011)	The EPS in this table reflect the guidance regarding minimising the transfer of IMS from biofouling.
	National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (DAFF, 2009)	The EPS in this table reflect the guidance regarding biofouling management in the DAFF guide.
Environmental context	MNES	
	AMPs (Section 5.1.1)	The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (DNP, 2013) identifies IMS and diseases translocated by shipping, fishing vessels and other vessels as a threat to the AMP network. The implementation of the EPS listed here make it unlikely that IMS will be introduced to the survey area and spread to nearby AMPs.
	Wetlands of international importance (Section 5.1.4)	The risk of introducing IMS is highly unlikely to affect Ramsar wetlands.
	TECs (Section 5.1.6)	The risk of introducing IMS is highly unlikely to affect TECs.
	NIWs (Section 5.1.8)	The risk of introducing IMS is highly unlikely to affect NIWs.
	Nationally threatened and migratory species (Section 5.5)	The threatened and migratory species within the EMBA are all highly mobile species. There are no EPBC Act-listed benthic species listed as occurring in the survey area; these are generally more susceptible to the effects of IMS than mobile fauna.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	This hazard does not intersect any state marine parks. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.

	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	The National Strategic Plan for Marine Pest Biosecurity (2018-2023) (DAWR, 2018) has five objectives. The EPS listed in this table are aligned with the plan's objective to minimise the risk of marine pest introductions, establishment and spread (noting that the other four objectives do not apply to the survey).
		See Appendix 2 for additional detail regarding the impacts of non-routine activities on the management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
	Is there a threat of serious or irreversible environmental damage?	Possibly. But the EPS aim to avoid this.
	Is there scientific uncertainty as to the environmental damage?	Yes. Individual species fill different ecological niches and understanding how one or more species are likely to behave outside their native habitat is generally unknown until it occurs.
Environmental Monitoring		
• None required.		
Record Keeping		
• Vessel contractor pre-qualification reports. • Biofouling risk assessment. • Ballast water risk assessments. • BWMP. • BWR.	• BWMC. • BWRS. • IAFS Certificates. • DAWE-signed ePARs.	

7.12. RISK 5 – MDO Release

7.12.1. Causal Pathway

A release of MDO may occur from the survey or support vessels. An MDO release may occur as a result of:

- A vessel-to-vessel collision;
- Vessel refuelling; and
- Equipment failure.

DNV (2011) indicates that for the period 1982-2010, there were no spills over 1 tonne (1 m3) for offshore vessels caused by collisions or fuel transfers.

AMSA's annual reports for the last five years (2014/15 to 2018/19) indicate there have been no significant

MDO pollution incidents resulting from vessel collisions or groundings.

MDO properties, behaviour and environmental fate

The following points summarise the nature and behaviour of MDO, based on NOAA (2012) and APASA (2012):

- MDO is dominated by n-alkane hydrocarbons that give diesel its unique compression ignition characteristics and usually consist of carbon chain C11-C28 but may vary depending upon specifications (e.g., winter vs. summer grades).
- While MDOs are generally considered to be non-persistent oils, many can contain a small percentage (approximately 3-7%) by volume of hydrocarbons that are classified as 'persistent' under the International Oil Pollution Compensation (IOPC) Fund definition (i.e., greater than 5% boiling above 370°C) (see Table 7.55).
- Diesel fuels are light, refined petroleum products with a relatively narrow boiling range, meaning that when spilled on water, most of the oil evaporates or naturally disperses quickly (hours to days).
- Diesel fuels are much lighter than water, so it is not possible for diesel oil to sink and accumulate on the seabed as pooled or free oil.
- Dispersion into the sea by the action of wind and waves can result in 25–50% of the loss of hydrocarbons from surface slicks and dissolution (solubility of hydrocarbons) can account for 1-10% loss from the surface. While the majority of the MDO evaporates quickly, it is common for the residues of MDO spills after weathering to contain n-alkanes, iso-alkanes and naphthenic hydrocarbons.
- Minor quantities of PAHs will be present.
- When spilled on water, MDO spreads very quickly to a thin film and generally has a low viscosity that can result in hydrocarbons becoming physically dispersed as fine droplets into the water column when winds exceed 10 knots.
- Droplets of MDO that are naturally or chemically dispersed sub-surface behave quite differently to oil on the sea surface. Diesel droplets will move 100% with the currents under water but on the surface are affected by both wind and currents.
- Natural dispersion of MDOs will reduce the hydrocarbons available to evaporate into the air. Although this reduces the volume of hydrocarbons on the water surface, it increases the level of hydrocarbons able to be inhaled.
- This increased hydrocarbon vapour exposure can affect any air breathing animal including whales, dolphins, seals and turtles.
- The environmental effects of MDOs spills are not as visually obvious as those of heavy fuel oils (HFO) or crude oils. Diesel oil is considered to have a higher aquatic toxicity in comparison to many other crudes oils due to the:
  - High percentage of toxic, water-soluble components (such as BTEX and PAH);
  - Higher potential to naturally entrain in the water column (compared to HFO);
  - Higher solubility in water; and
  - Higher potential to bioaccumulate in organisms.
- Diesel fuel oils are not very sticky or viscous compared to black oils. When diesel oil strands on a shoreline, it generally penetrates porous sediments quickly, but is also washed off quickly by waves.
- In open water, diesel oil spills are so rapidly diluted that fish kills are rarely observed (this is more likely in confined, shallow waters).

Oil Spill Trajectory Modelling

To understand the risks posed by a MDO spill, ConocoPhillips Australia commissioned RPS to undertake OSTM using the scenario of a release of 373 m3 of MDO at the sea surface over six hours at random locations within the operational area (RPS, 2020), using the MDO properties outlined in Table 7.54.

Table 7.55 presents the physical characteristics of the typical MDO, verifying its volatile nature (i.e., it is quick to weather).

Table 7.54: Summary of the MDO spill OSTM inputs

Characteristic	Details
Density (kg/m^3)	829.1 at 15°C
API	37.6
Dynamic viscosity (cP)	4.0 at 25°C
Pour point (°C)	-14
Oil property category	Group II
Oil persistence classification	Light persistent oil

Table 7.55: Physical characteristics of MDO

	Volatiles	Semi-volatiles	Low Volatiles	Residual Oil
Boiling Point (°C)	< 180	180-265	265-380	> 380
MDO (%)	6.0	34.6	54.4	5.0
Persistence	Non-persistent			Persistent

Table 7.56 outlines the key OSTM inputs for the MDO spill scenario (Table 7.28 lists and justifies the spill thresholds used in the OSTM).

Table 7.56: Summary of the MDO spill OSTM inputs

Parameter	Details
Oil Type	MDO
Total spill volume	373 m^3
Release type	Sea surface
Release duration	6 hours
Release rate	Instantaneous
Weather conditions	Annualised
Simulation duration	28 days
Surface oil concentration thresholds (g/m^2)	1-10 g/m^2 – low exposure 10-50 g/m^2 – moderate exposure >50 g/m^2 – high exposure
Shoreline load threshold (g/m^2)	10 g/m^2 – low exposure 100 g/m^2 – moderate exposure 1,000 g/m^2 – high exposure
Dissolved aromatic dosages to assess potential exposure (ppb)	10 ppb – low exposure 50 ppb – moderate exposure 400 ppb – high exposure
Entrained oil dosages to assess potential exposure (ppb)	10 ppb – low exposure 100 ppb – high exposure

Spill Location

For this assessment, the 100 spills were modelled from 100 randomly selected release locations within the operational area situated approximately 5.5 - 10 km apart. Each spill simulation had the same information (i.e., spill volume, duration and oil composition), though different start times and location. This ensured that a range of wind and current conditions were accounted for across the operational area and in turn, movement and weathering of the oil.

Spill Volume

AMSA's Technical Guidelines for preparing Contingency Plans for Marine and Coastal Facilities (AMSA, 2015, pg 24) indicates that an appropriate spill size for a vessel collision (a non-oil tanker) should be based on the volume of the largest tank. ConocoPhillips Australia has used this guidance in determining the volume to be modelled for this study. Given that the survey vessel has yet to be contracted, the exact volume of MDO to be carried cannot be provided. Analysis of the survey vessel contractors that have tendered for the work indicates that the largest single fuel tank holds 373 m3; hence, this volume was selected for modelling.

Sea Surface Results

A summary of the sea surface OSTM results for the MDO spill scenario is presented in Table 7.57 and illustrated in Figure 7.12. Floating oil at the low threshold was predicted at two AMPs (Apollo and Zeehan), one KEF (West Tasmania Canyons) and one MNP (Point Addis).

Figure 7.13: Trajectory and predicted zones of potential floating oil exposure for the single worst simulation. Results are based on a 373 m3 surface release of MDO over 6 hours tracked for 28 days, starting 08:00 am 25th June 2009.presents the largest predicted zone of floating oil exposure of the 100 simulations.

Weathering results for this MDO spill scenario are illustrated in Figure 7.14, indicating that evaporation accounts for approximately half of the MDO weathering and that this occurs rapidly

Table 7.57:Summary of the sea surface results for the MDO spill scenario

Receptor	Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (>50 g/m^2)	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (>50 g/m^2)
Apollo AMP	14	2	1	0.13	0.42	0.42
Zeehan AMP	23	14	14	0.04	0.04	0.04

Figure 7.12: Zones of potential exposure on the sea surface in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days

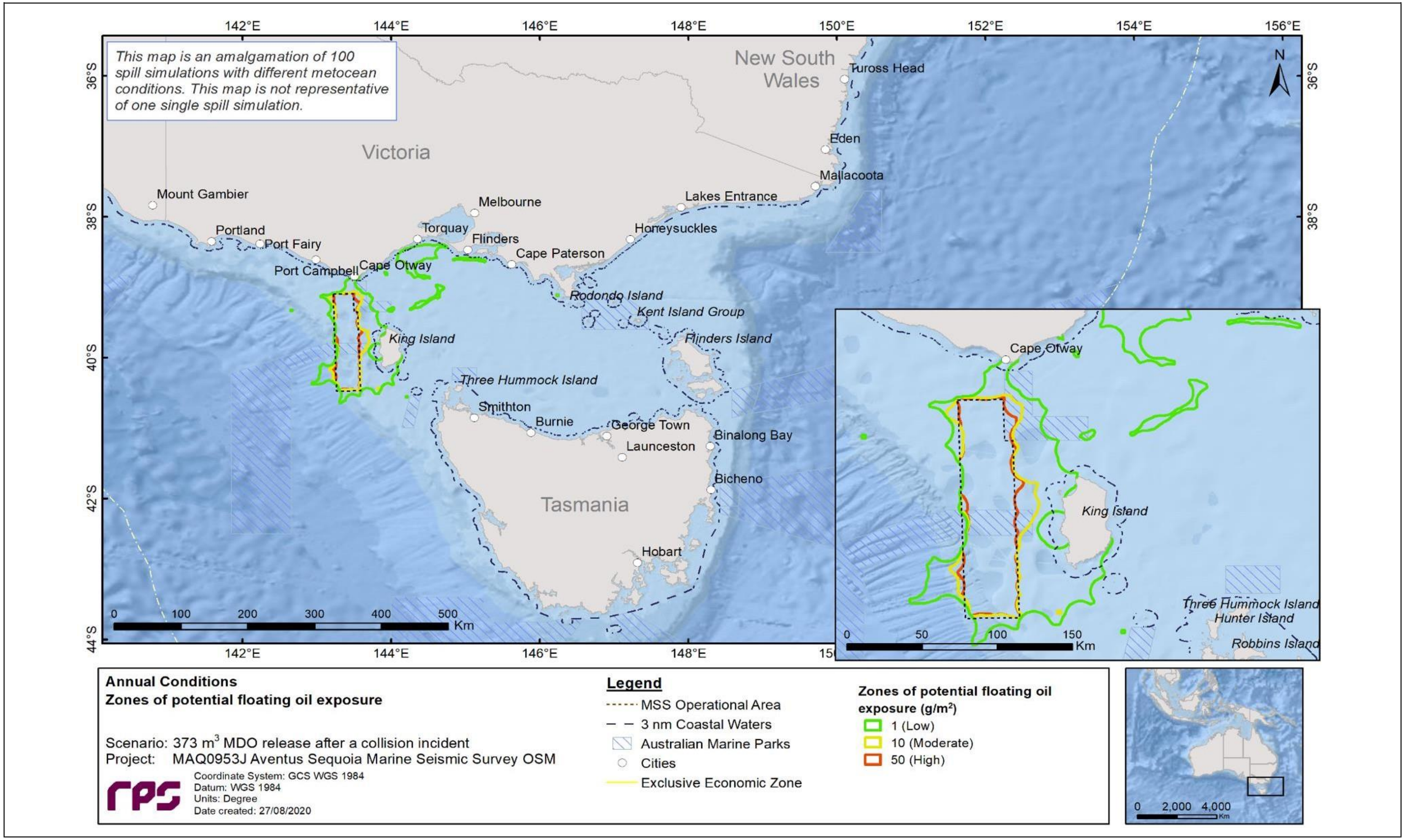


Figure 7.13: Trajectory and predicted zones of potential floating oil exposure for the single worst simulation. Results are based on a 373 m3 surface release of MDO over 6 hours tracked for 28 days, starting 08:00 am 25th June 2009.

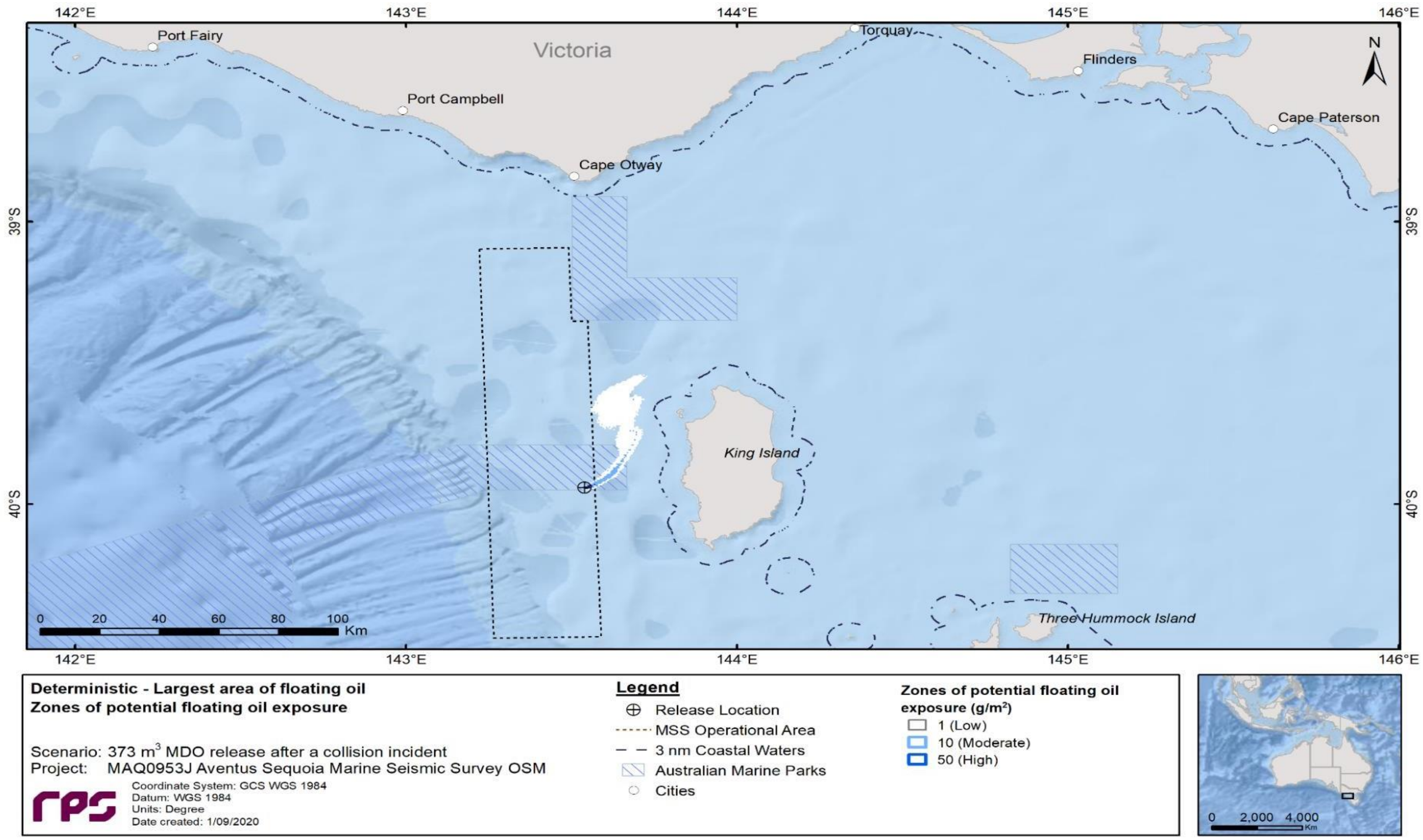
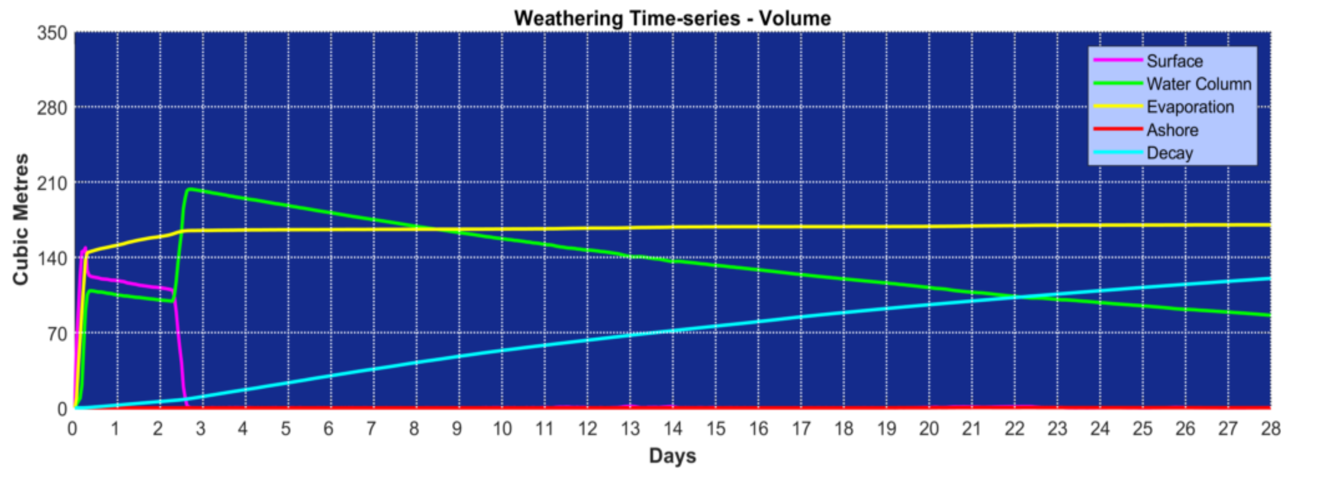


Figure 7.14: Predicted weathering and fates graph for the single spill trajectory. Results are based on a 373 m3 surface release of MDO over 6 hours, in the event of a vessel fuel tank rupture, tracked for 28 days, starting 08:00 am



Shoreline Results

A summary of the shoreline OSTM results for the vessel tank rupture scenario is presented in Table 7.58. The maximum potential shoreline loading results for this scenario are illustrated Figure 7.15. The stochastic modelling demonstrated potential oil accumulation on the western, northern and south-eastern coastline of King Island and isolated areas along the Port Campbell, Cape Otway and Wilson Promontory coasts. The quickest time before shoreline accumulation was predicted as 1.67 days (40 hours) at Cape Otway. Shoreline contact at King Island was predicted, with the longest length of shoreline contacted above the low threshold being 18.5 km.

Figure 7.16 presents the largest extent of shoreline loading from a single spill simulation

Table 7.58: Summary of the shoreline contact results above 10 g/m2 in the event of a 373 m3 MDO spill over 6 hours and tracked for 28 days

Shoreline statistics		Results
Maximum probability of contact to any shoreline		16%
Absolute minimum time to shore		40 hours
Maximum volume of hydrocarbons ashore*		27.6 m^3
Average volume of hydrocarbons ashore^		9.6 m^3
10 g/m^2 loading	Maximum shoreline length	37.5 km
	Average shoreline length	8.9 km
100 g/m^2 loading	Maximum shoreline length	8.4 km
	Average shoreline length	2.5 km
1,000 g/m^2	Maximum shoreline length	-
	Average shoreline length	-

** Maximum volume ashore – the maximum peak volume to come ashore for defined receptors, or all shorelines, from a single simulation/trajectory.*

^ Average volume ashore – the average volume to come ashore for defined receptors, or all shorelines, from a single simulation/trajectory. Only non-zero values are considered.

Table 7.59 presents the probability of exposure to shoreline segments and protected areas sea surface waters from the MDO spill scenario.

Table 7.59: Summary of oil contact to shoreline sectors from a 373 m3 MDO release over 6 hours and tracked for 28 days based on 100 spill trajectories

Receptor (shoreline segment)	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)		
	Low	Mod	High	Low	Mod	High
Anser Island	1	-	-	6.50	-	-
Bass Coast	1	-	-	3.96	-	-
Circular Head	1	-	-	10.67	-	-
Colac Otway	3	-	-	1.67	2.00	-
Corangamite	1	1	-	7.13	10.25	-
Glennie Group	1	1	-	6.33	6.83	-
Kanowna Island	1	-	-	6.50	-	-
King Island	9	5	-	2.08	3.04	-
Skull Rock	1	-	-	6.13	-	-
South Gippsland	2	1	-	11.00	11.13	-
Surf Coast	1	1	-	8.96	9.83	-
Anglesea	1	1	-	8.96	9.83	-
Apollo Bay	1	1	-	1.75	2.08	-
Cape Liptrap (NW)	1	-	-	11.67	-	-
Cape Otway West	2	2	-	1.67	2.00	-
Cape Patton	1	1	-	1.92	2.21	-
Moonlight Head	1	1	-	7.58	10.25	-
Venus Bay	1	-	-	3.96	-	-
Wilsons Promontory (West)	1	1	-	11.00	11.13	-

Figure 7.15: Maximum potential shoreline loading in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days

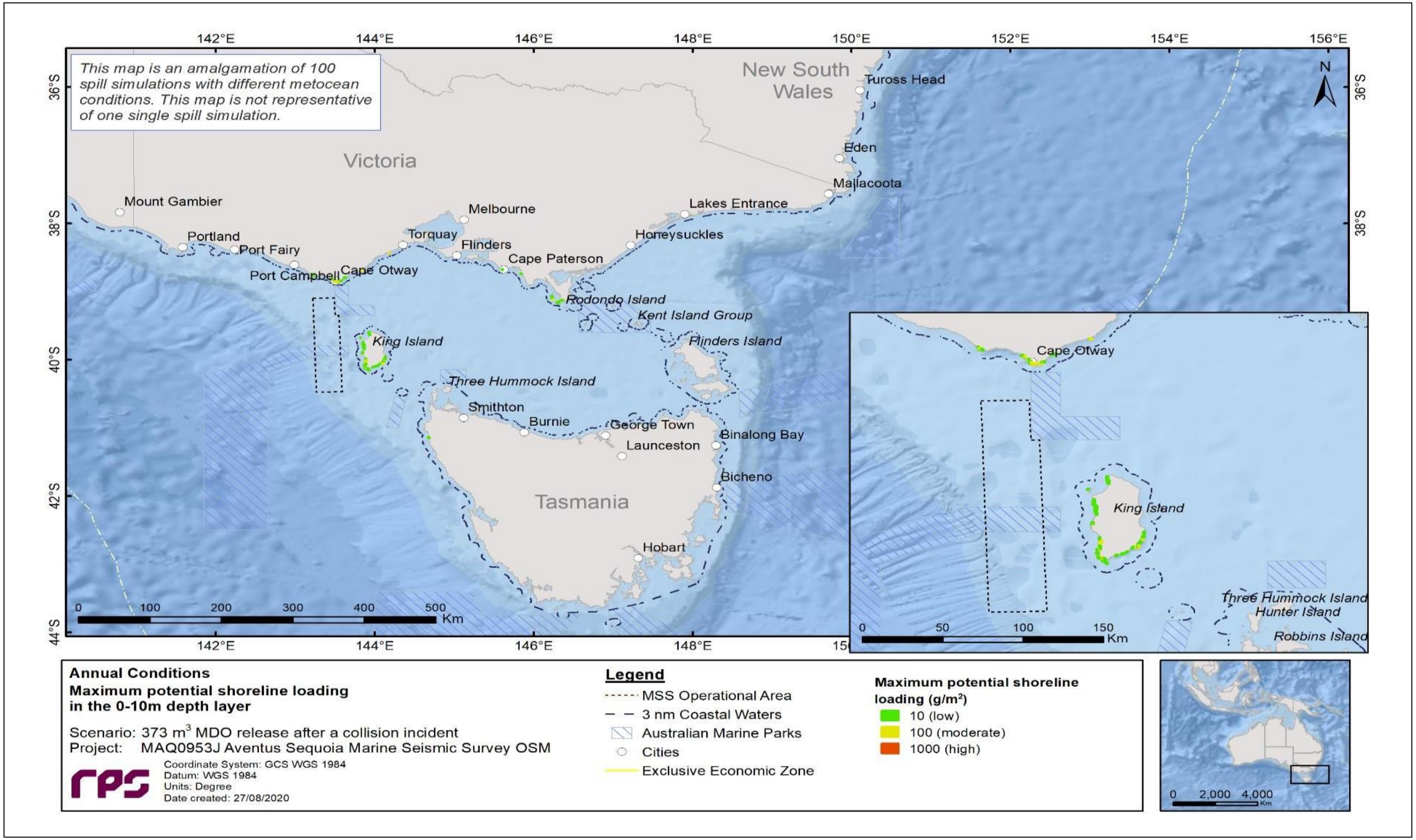
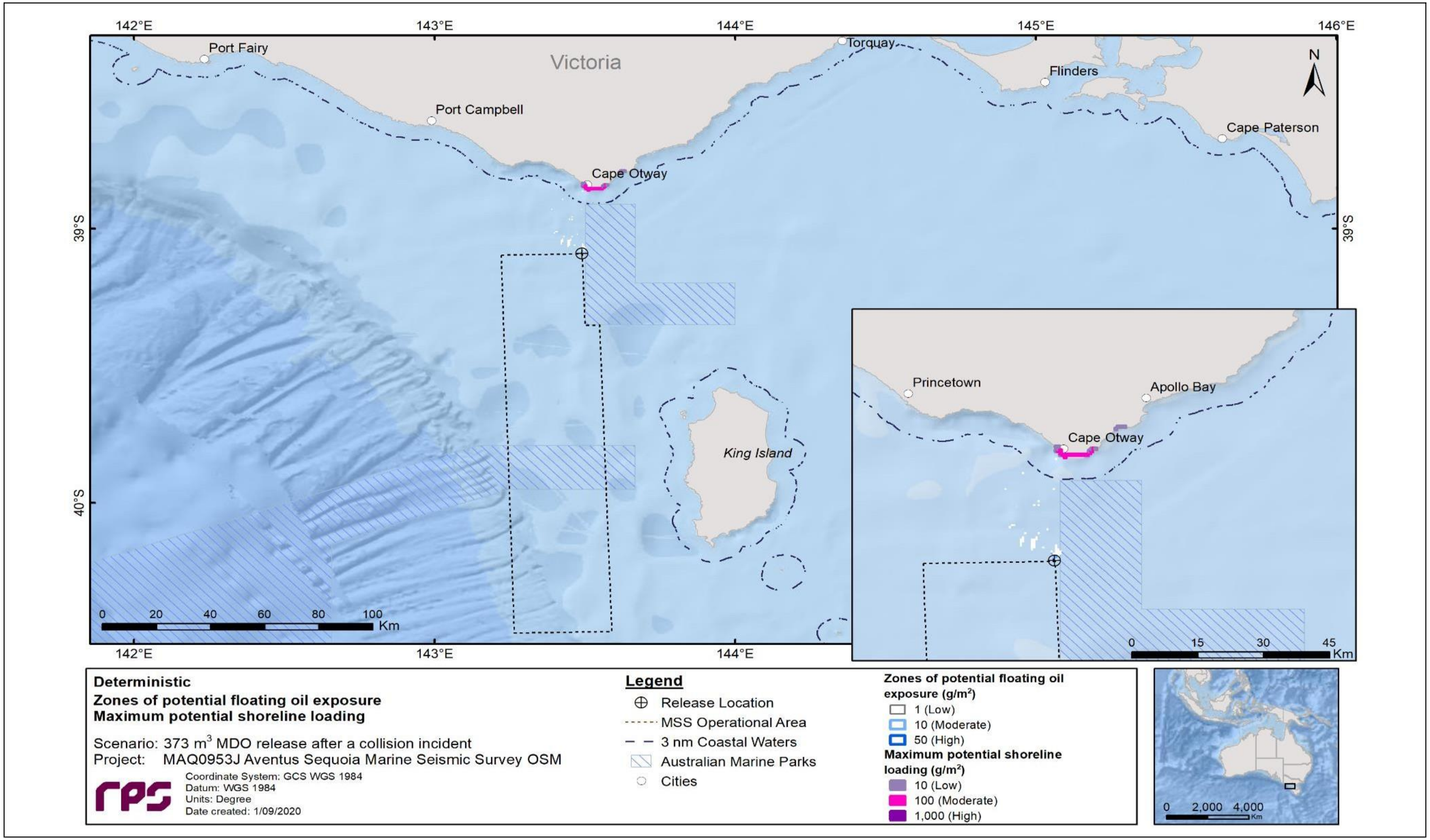


Figure 7.16: Predicted zones of potential shoreline loading from the single worst spill simulation for shoreline loading in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days, starting 25th April 2015



Entrained Hydrocarbon Results

Figure 7.17 and Figure 7.18 illustrate the zones of potential entrained hydrocarbon exposure at 0-10 m and 10 – 20 m below the sea surface, respectively. The results indicate that the maximum distance travelled from the release location is 742 km predominantly in an east-northeast direction for low exposure hydrocarbons and up to 236 km in an east direction for high exposure entrained hydrocarbons.

In the surface layer (0-10m), entrained hydrocarbon exposure at or above the low threshold was predicted at a wide range of receptors, including five AMPs and four KEFs. A summary of the entrained MDO OSTM results is presented in Table 7.60.

Table 7.60: Summary of exposure to receptors from entrained MDO based on a 373 m3 release over 6 hours and tracked for 28 days based on 100 spill trajectories during annualised conditions

Receptor	Probability (%) of entrained hydrocarbon concentrations at		Minimum time to receptor waters (days) at	
	Low 10-100 ppb	High > 100 ppb	Low 10-100 ppb	High > 100 ppb
AMP				
Apollo	22	10	0.04	0.04
Beagle	6	-	7.46	-
Boags	7	-	6.17	-
Franklin	8	1	2.71	3.00
Zeehan	24	13	0.04	0.04
Marine National Park				
Bunurong	2	1	3.13	3.33
Cape Howe	3	-	17.79	-
Point Addis	7	1	2.63	2.75
Point Hicks	1	-	19.63	-
Port Phillip Heads	1	-	13.71	-
Twelve Apostles	2	-	6.38	-
Wilsons Promontory	8	-	5.46	-
Marine Sanctuary (MS)				
Barwon Bluff	1	-	24.83	-
Marengo Reefs	5	-	1.71	-
Mushroom Reef	1	-	7.17	-
Point Danger	1	-	16.67	-
National Park **(NP)**				
Kent Group	2	-	16.29	-
Bunurong Marine Park	3	-	3.00	-
Wilsons Promontory Marine Park	3	-	5.79	-
Wilsons Promontory Marine Reserve	5	-	5.46	-
KEF				
Bonney Coast Upwelling	1	-	25.58	-
Canyons on the eastern continental slope	1	-	27.38	-
Upwelling East of Eden	4	-	14.50	-

Receptor	Probability (%) of entrained hydrocarbon concentrations at		Minimum time to receptor waters (days) at	
	Low 10-100 ppb	High > 100 ppb	Low 10-100 ppb	High > 100 ppb
West Tasmania Canyons	14	6	0.04	0.04
Ramsar Sites				
Lavinia	2	-	5.29	-
Port Phillip Bay (Western Shoreline) and Bellarine Peninsula	1	-	24.79	-
Westernport	1	-	7.63	-

Figure 7.17: Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days

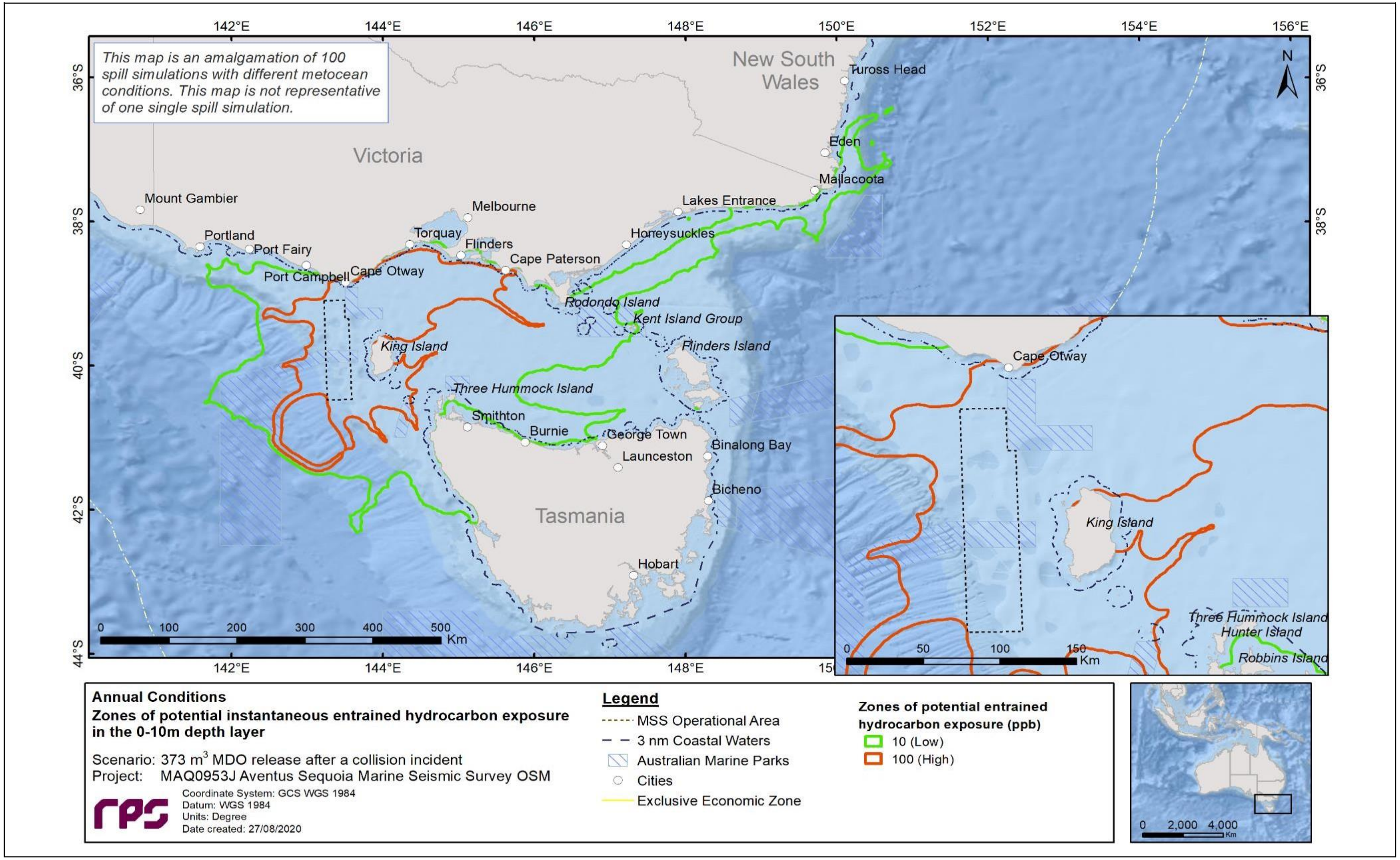
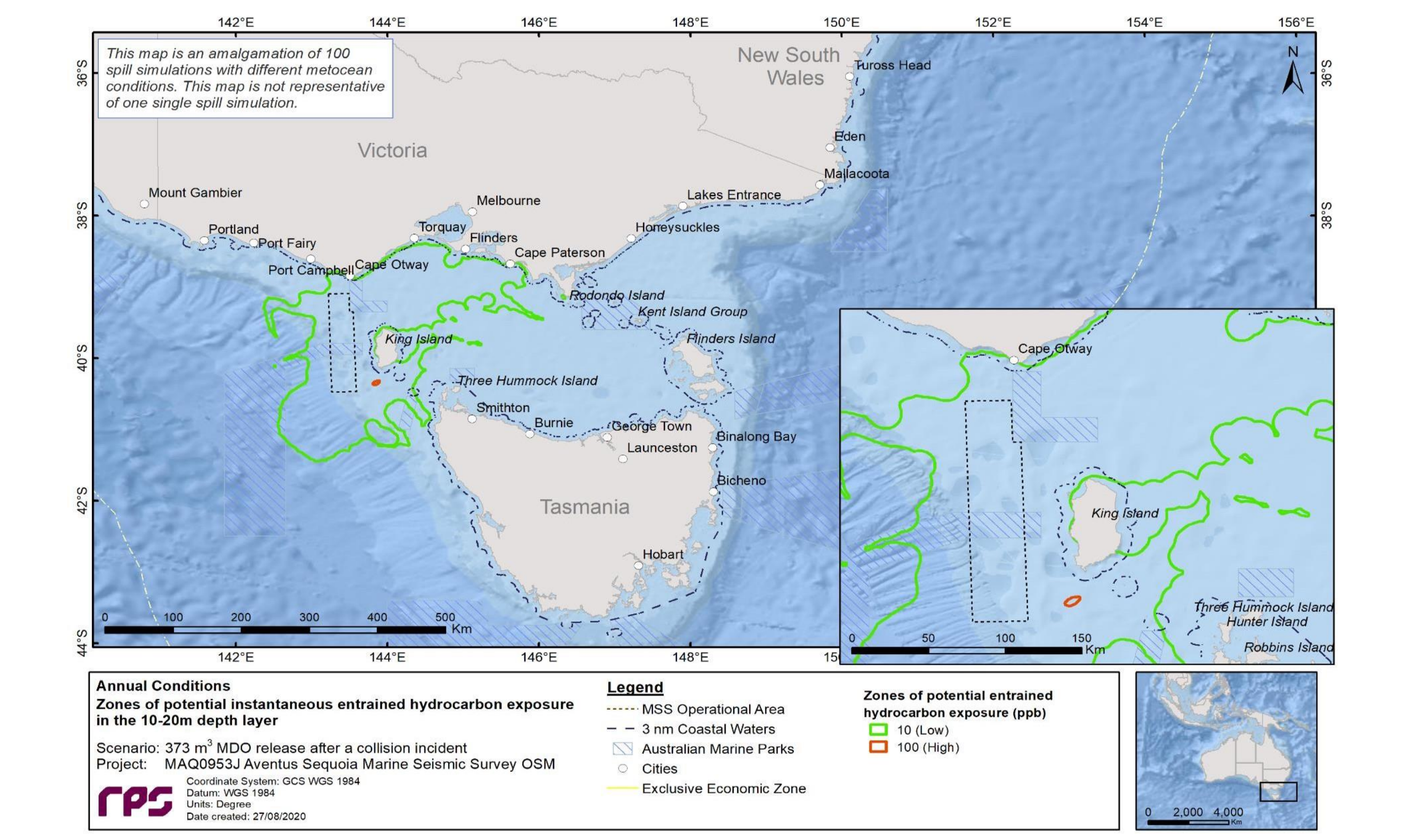


Figure 7.18: Zones of potential entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days



Dissolved Hydrocarbons Results

Table 7.61 summarises the OSTM results for dissolved hydrocarbons. Figure 7.19, Figure 7.20 and Figure 7.21 illustrate the zones of potential dissolved hydrocarbon exposure at 0-10 m, 10-20 m and 20-30 m below the sea surface, respectively. The results indicate that the maximum distance travelled from the release location is 251 km predominantly in an east-northeast direction for low exposure hydrocarbons and up to 211 km in the same direction for moderate exposure entrained hydrocarbons, with no contact with high exposure hydrocarbons.

No dissolved hydrocarbon exposure was predicted to occur below a depth of 10 m.

Table 7.61: Probability of exposure to receptors from dissolved MDO based on a 373 m3 release over 6 hours and tracked for 28 days

Receptor	Probability (%) of dissolved hydrocarbon concentration			Minimum time to receptor waters (days)		
	Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb	Low 10-50 ppb	Moderate 50-400 ppb	High ≥400 ppb
AMP						
Apollo	5	1	-	0.13	0.46	-
Franklin	1	-	-	3.38	-	-
Zeehan	6	1	-	0.04	0.04	-
KEF						
West Tasmania Canyons	4	1	-	0.04	0.13	-
MNP						
Bunurong	1	-	-	6.42	-	-
Point Addis	1	-	-	3.33	-	-

Figure 7.19:Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days

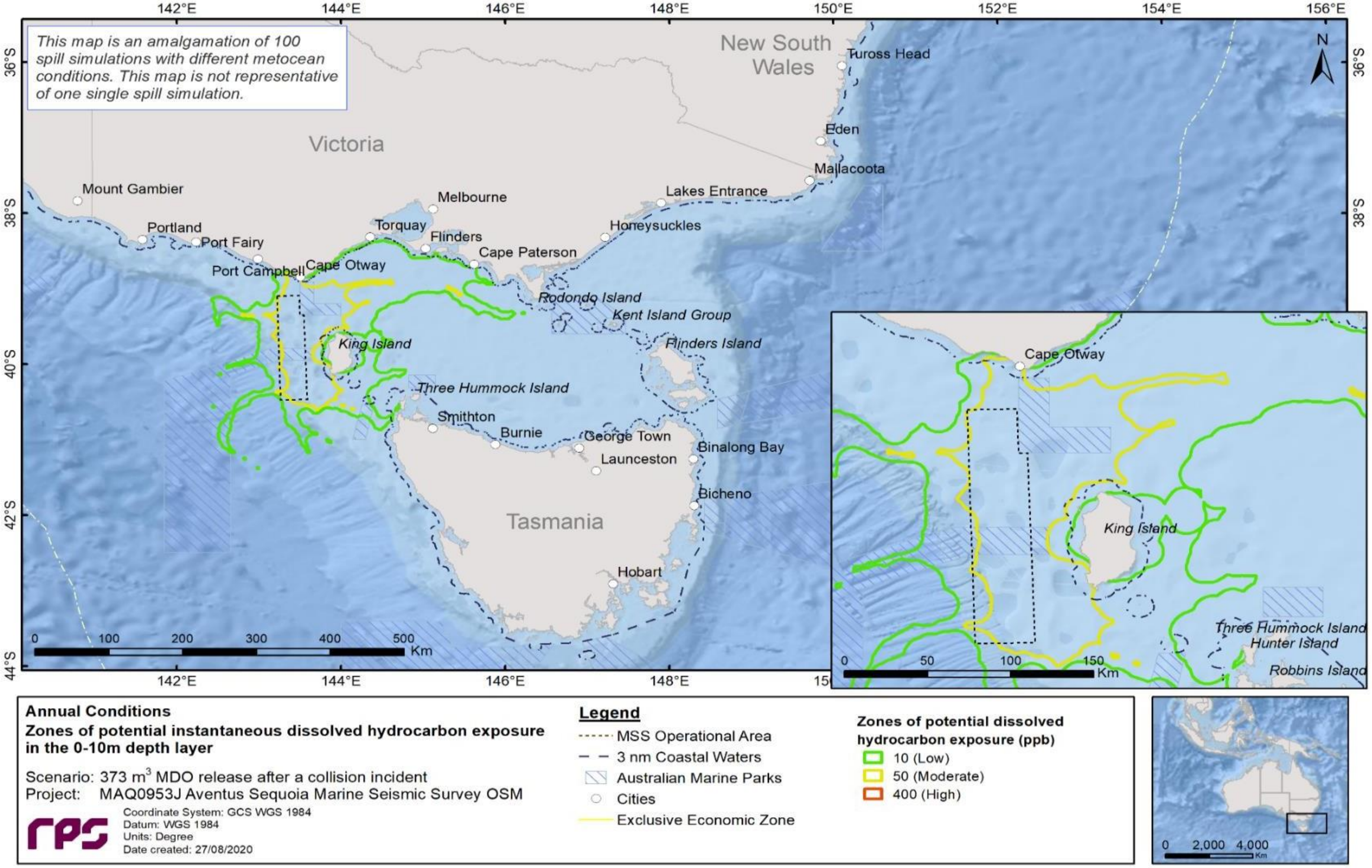

This map is an amalgamation of 100 spill simulations with different metocean conditions. This map is not representative of one single spill simulation.
Victoria
New South Wales
Tasmania
Mount Gambier
Portland
Port Fairy
Port Campbell
Cape Otway
Torquay
Melbourne
Flinders
Cape Paterson
Honeysuckles
Lakes Entrance
Mallacoota
Eden
Tuross Head
Rodondo Island
Kent Island Group
Flinders Island
King Island
Three Hummock Island
Hunter Island
Robbins Island
Smithton
Burnie
George Town
Launceston
Binalong Bay
Bicheno
Hobart
Annual Conditions
Zones of potential instantaneous dissolved hydrocarbon exposure in the 0-10m depth layer
Scenario: 373 m³ MDO release after a collision incident
Project: MAQ0953J Aventus Sequoia Marine Seismic Survey OSM
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
Date created: 27/08/2020
Legend
MSS Operational Area
3 nm Coastal Waters
Australian Marine Parks
Cities
Exclusive Economic Zone
Zones of potential dissolved hydrocarbon exposure (ppb)
10 (Low)
50 (Moderate)
400 (High)

Figure 7.20: Zones of potential dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days

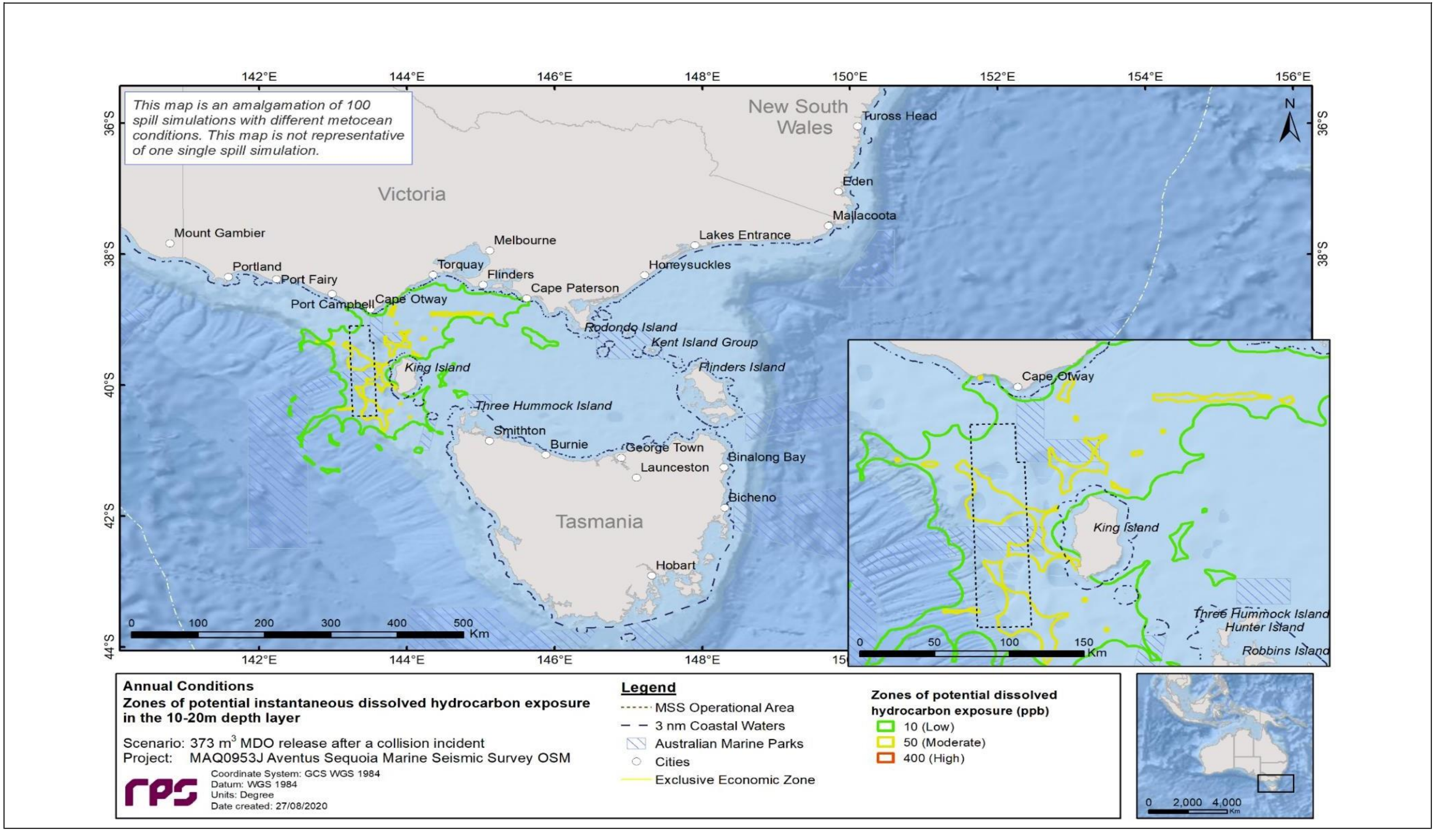
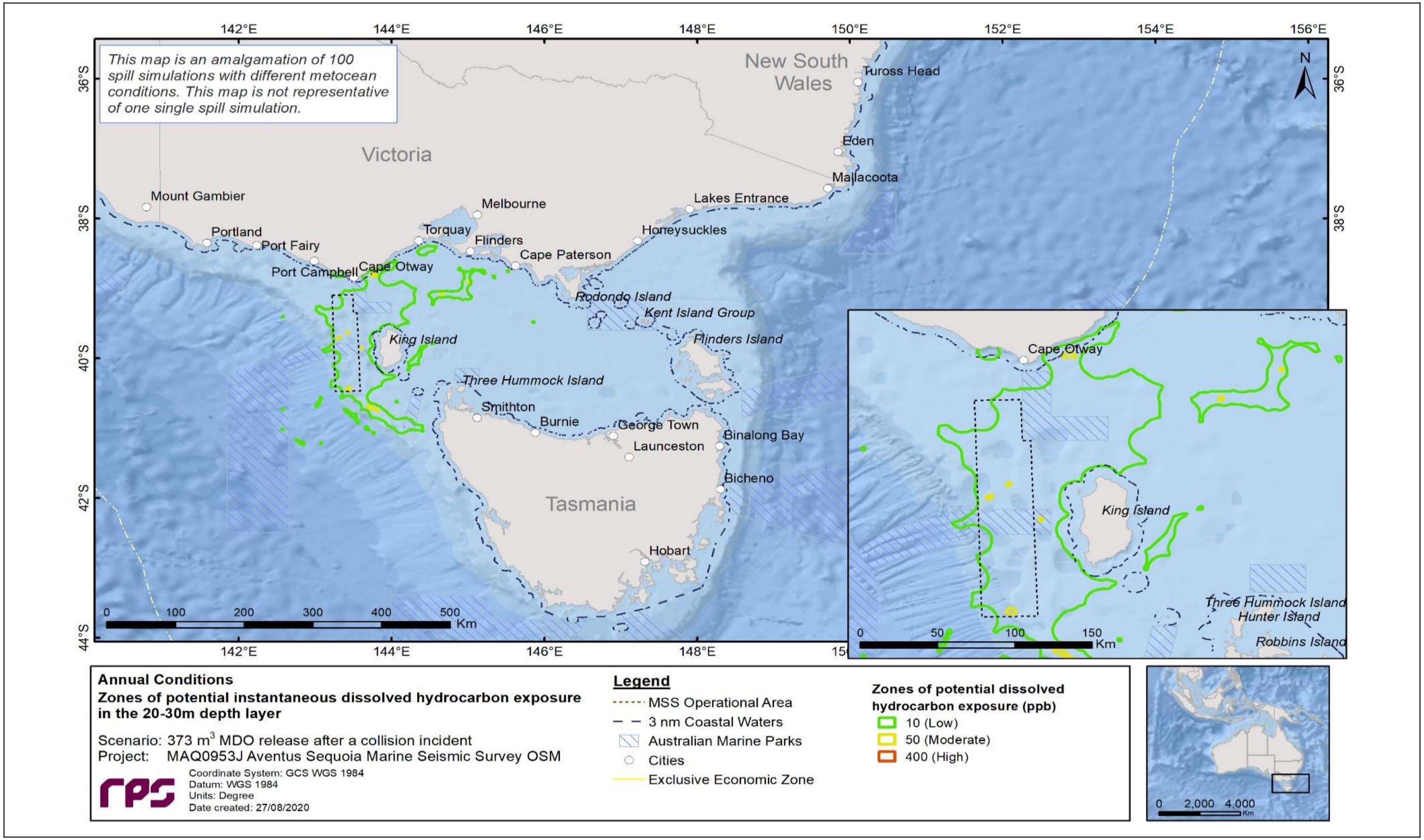


Figure 7.21: Zones of potential dissolved hydrocarbon exposure at 20-30 m below the sea surface in the event of a 373 m3 surface release of MDO over 6 hours and tracked for 28 days



7.12.2. Potential Environmental Risks

The known and potential impacts of an MDO spill include:

- A temporary and localised reduction in water quality;
- Injury or death of exposed marine fauna and seabirds;
- Habitat damage where the spill reaches shorelines;
- Damage to water filtering equipment at the Victorian desalination plant (at Wonthaggi), contamination of water supply and disruption to the supply of water services; and
- Disruption to the functions, interests or activities of other users (e.g., commercial fisheries).

7.12.3. EMBA

The EMBA for a 373 m^3 spill of MDO (sea surface, shoreline, entrained and dissolved aromatics) is illustrated in Figure 7.11 to Figure 7.21. Receptors most at risk within this EMBA, whether resident or migratory, are:

- Plankton;
- Fish;
- Cetaceans;
- Pinnipeds;
- Turtles;
- Avifauna; and
- Shoreline habitats.

7.12.4. Evaluation of Environmental Risk

Table 7.62 provides the criteria used to determine the sensitivity of receptors within the EMBA. The evaluation of environmental risks to these receptors (including fauna, marine parks and fisheries) resulting from the MDO release is presented in Table 7.62 to Table 7.74

Table 7.62: Criteria used to determine receptor sensitivity in the EMBA

Sensitivity	Protected areas	Species status	BIA	Coastal sensitivity	Receptors in the EMBA
Low	State - no marine protected areas. Cth - multiple use zones are the dominant component of the protected area.	Species not threatened (or limited to only a few species of a particular faunal grouping). Present in the EMBA only occasionally or as vagrants. Populations known to recover rapidly from disturbance.	No BIA (or limited to only a few species of a particular faunal grouping).	Low sensitivity habitat, such as fine-grained beaches, exposed wave-cut platform and exposed rocky shores, with rapid recovery from oiling (~ 1 year or less). Public recreation beaches not present or not widely used. No harbours or marinas.	• Benthic assemblages. • Plankton. • Pelagic fish. • Macroalgae. • Sandy beaches. • Rocky shores.
Medium	State – no marine protected area. Cth - little to no special purpose zonation.	Species may be threatened (or some species of a particular faunal grouping). Species may or may not be present at time of activity. Some susceptibility to oiling. Populations may take a moderate time to recover from oiling.	Some intersection with one or more BIAs, generally for distribution or foraging rather than breeding.	Moderately sensitive habitat present, such as sheltered rocky rubble coasts, exposed tidal flats, gravel beaches, mixed sand and gravel beaches, with a medium recovery period from oiling (~2-5 years). Public recreation beaches present but not often used. No harbours or marinas.	• Marine reptiles. • Seabirds.
High	State - marine protected area present. Cth - special purposes zones are the dominant component of the protected area.	Species are threatened (or most species of a particular faunal grouping). Species known to be present at time of activity. Known to be susceptible to oiling. Populations may take a long time to recover from oiling.	Significant intersection with one or more BIAs, particularly with regard to breeding or migration.	Sensitive habitat present, such as mangrove, salt marshes, and sheltered tidal flats, with long recovery periods from oiling (> 5 years). Public recreation beaches present that are widely used. Busy harbours or marinas.	• Cetaceans. • Pinnipeds. • Shorebirds. • Commercial fishing. • Marine parks.

Table 7.63: Potential risks of MDO release on benthic fauna

General sensitivity to oiling – benthic fauna	
Sensitivity rating of benthic species and communities:	Low
A description of benthic fauna in the EMBA is provided in:	Section 5.5.1

Surface hydrocarbons

Benthic species are generally protected from exposure to surface hydrocarbon. The primary modes of exposure for benthic communities in oil spills include:

- Direct exposure to dispersed oil (e.g., physical smothering) where bottom discharges stay at the ocean bottom;
- Direct exposure to dispersed and non-dispersed oil (e.g., physical smothering) where oil sinks down from higher depths of the ocean;
- Direct exposure to dispersed and non-dispersed oil dissolved in sea water and/or partitioned onto sediment particles; and
- Indirect exposure to dispersed and non-dispersed oil through the food web (e.g., uptake of oiled plankton, detritus, prey, etc.) (NRDA, 2012). Adult marine

invertebrates and larvae usually reside within benthic substrates and pelagic waters, rarely reaching the water's surface in their life cycle (to breed, breathe and feed). Therefore, surface hydrocarbons are not considered to pose a high risk to marine invertebrates except at locations where surface oil reaches shorelines.

Acute or chronic exposure, through surface contact, and/or ingestion can result in toxicological risks. However, the presence of an exoskeleton (e.g., crustaceans) will reduce the impact of hydrocarbon absorption through the surface membrane. Other invertebrates with no exoskeleton and larval forms may be more prone to impacts from pelagic hydrocarbons.

Water column/seabed hydrocarbons

Entrained and dissolved hydrocarbons can have negative impacts on marine invertebrates and associated larval forms, while impacts to adult species is reduced as a result of the presence of an exoskeleton. Localised impacts to larval stages may occur which could impact on population recruitment that year. If invertebrates are contaminated by hydrocarbons, tissue taint can remain for several months, although taint may eventually be lost. For example, it has been demonstrated that it took 2-5 months for lobsters to lose their taint when exposed to a light hydrocarbon (NOAA, 2002).

Exposure to microscopic oil droplets may also impact aquatic biota either mechanically (especially filter feeders) or act as a conduit for exposure to semi-soluble hydrocarbons (that might be taken up by the gills or digestive tract) (McCay-French, 2009). Toxicity is primarily attributed to water soluble PAHs, specifically the substituted naphthalene (C_2 and C_3) as the higher C-ring compounds become insoluble and are not bioavailable.

ANZECC/ARMCANZ (2000) identifies the following 96-hr LC50 concentrations for naphthalene (a key primary PAH dissolved phase toxicant in crude oils):

- For the bivalve mollusc, *Katelysia opima*, a concentration of 57,000 ppb; and
- For six species of marine crustaceans, a concentration between 850 and 5,700 ppb.

Other possible impacts from the presence of dispersed and non-dispersed oil include effects of oxygen depletion in bottom waters due to bacterial metabolism of oil (and/or dispersants), and light deprivation under surface oil (NRDA, 2012).

shoals (Heyward *et al*., 2010), which occur about 20-30 m below the water line in otherwise deep waters (generally >150 m water depth). Later sampling indicated the presence of low-level severely degraded oil at some shoals, though in the absence of pre-impact data, this could not be directly linked to the Montara spill. Levels of hydrocarbons in the sediments were, in any case, several orders of magnitude lower than levels at which biological effects become possible (Heyward *et al*., 2012; Gagnon & Rawson, 2011). Studies undertaken since the Macondo well blowout in the Gulf of Mexico (GoM) in 2010 have shown that fewer than 2% of the more than 8,000 sediment samples collected exceeded the EPA sediment toxicity benchmark for aquatic life, and these were largely limited to the area close to the wellhead (BP, 2015). Studies of offshore benthic seaweeds in the northwest GoM prior to and after the Macondo well blowout at Sackett and Ewing banks (in water depths of 55-75 m) found a dramatic die-off of seaweeds after the spill (60 species pre-spill compared with 10 species post-spill) (Felder *et al*., 2014). Benthic decapod assemblages (crabs, lobsters, prawns) associated with the seaweeds and benthic substrate also showed a strong decline in abundance at both banks post-spill (species richness on Ewing Bank reduced by 42% and on Sackett Bank by 29%), though it is noted that these banks are exposed to influences from Mississippi River discharges that vary year to year, so definitive links to the oil spill are not possible. It is noted, however, that petroleum residues were observed on Ewing Bank and it is possible that this may have caused localized mortalities, reduced the fecundity of surviving female decapods or reduced recruitment (Felder *et al*., 2014). Felder *et al* (2014) also notes that freshly caught soft-sediment decapod samples caught in early and mid-2011 near the spill site exhibited lesions that were severe enough to cause appendage loss and mortality. Water quality in benthic habitats exposed to entrained hydrocarbons would be expected to return to background conditions within weeks to months of contact. Several studies have indicated that rapid recovery rates may occur even in cases of heavy oiling (Committee on Oil in the Sea, 2003).			
Potential risks to benthic fauna from MDO release			
Sea Surface	Water column – dissolved phase	Water column – entrained phase	Shorelines
Not applicable.	Only contact at the low and moderate threshold was predicted in waters 0-10 m, 10-20 m and 20-30 m below the surface. There is no predicted exposure to the high threshold for dissolved hydrocarbons. In nearshore waters (0-10 m) where there is interaction with the benthic environment, there is a possibility of moderate threshold exposure at King Island and the Colac Otway coast There is a possibility of low threshold exposure at the Hunter Island Group, Circular Head and Phillip Island. The consequence to benthic fauna or habitats exposed to hydrocarbons at the low threshold is **negligible** and **minor** at the moderate threshold.	Contact at the low and high thresholds was predicted in waters 0-10 m and 10-20 m below the surface. In nearshore waters, where there is interaction with the benthic environment, there is possibility of contact of high threshold entrained hydrocarbons at King Island, Colac Otway coast and in Tasmanian state waters around numerous islands with predominantly rocky shorelines and presumably rocky seabeds. At the high threshold in nearshore waters, benthic fauna may experience sub-lethal and toxicity impacts. The consequence to benthic fauna or habitats exposed to hydrocarbons at the low threshold is **negligible** and **minor** at the high threshold.	Not applicable.

Table 7.64: Potential risks of MDO release on macroalgal communities

General sensitivity to oiling – macroalgal communities	
Sensitivity rating of macroalgal species and communities:	Low
A description of macroalgal species and communities in the EMBA is provided in:	Section 5.5.3

Macroalgae are generally limited to growing on intertidal and subtidal rocky substrata in shallow waters to 10 m depth. As such, they may be exposed to subsurface and entrained and dissolved hydrocarbons, however are susceptible to surface hydrocarbon exposure more so in intertidal habitats as opposed to subtidal habitats. 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 CO_2 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 to the algae. 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 contamination) 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, which impacts 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).

The toxicity of macroalgae to hydrocarbons varies for the different macroalgal life stages, with water-soluble hydrocarbons more toxic to macroalgae (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 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.

Potential risks to macroalgal communities from MDO release			
Surface oiling	Water column – dissolved phase	Water column – entrained phase	Shoreline
Floating vegetation in western Bass Strait may be exposed to limited areas of moderate and high threshold hydrocarbons at the sea surface. The nature of the spill in this scenario (occurring in western Bass Strait waters >20 m deep) means the consequence to macroalgal communities is minor.	Only contact at the low and moderate threshold was predicted in waters 0-10 m, 10-20 m and 20-30 m below the surface. There is no modelled exposure to the high threshold for dissolved hydrocarbons. In nearshore waters (0-10 m), where there is greater risk of interaction with macroalgal communities, there is a possibility of moderate threshold exposure at King Island and the Colac Otway coast There is a possibility of low threshold exposure, which is unlikely to result in ecological impact, at the Hunter Island Group, Circular Head and Phillip Island. Due to the low concentrations and physical properties of the hydrocarbons and the well-mixed nature of the waters of the EMBA, coating of macroalgae by hydrocarbons is considered highly unlikely. Thus, the consequence to macroalgal communities from exposure to moderate threshold hydrocarbons is minor.	Contact at the low and high thresholds was predicted in waters 0-10 m and 10-20 m below the surface. In nearshore waters, where there is greater risk of interaction with macroalgal communities, there is possibility of contact of high threshold entrained hydrocarbons at King Island, Colac Otway coast and in Tasmanian state waters around numerous islands with predominantly rocky shorelines and presumably rocky seabed. Due to the low concentrations and physical properties of the hydrocarbons and the well-mixed nature of nearshore waters, coating of macroalgae and prolonged exposure to hydrocarbons is considered highly unlikely. Thus, the consequence to macroalgal communities from exposure to high threshold hydrocarbons is minor.	Shoreline accumulation of hydrocarbons at the low threshold is unlikely to have an ecological impact. There are no areas of exposure to high threshold hydrocarbons, which are likely to have an ecological impact. Areas of predicted moderate shoreline loading are limited to the Colac Otway coast, King Island and Wilsons Promontory. At this threshold, there may be ecological impacts to macroalgae stranded on the shoreline. However, wave- action at the shoreline will naturally disperse and weather the hydrocarbons quickly. Therefore, the consequence of exposure to moderate threshold shoreline loading to macroalgal communities is minor.

Because MDO will be highly weathered and in small volumes if it reached the sites of possible occurrence of the Giant Kelp Marine Forests TEC a spill will not have a ‘significant’ impact on the Giant Kelp Marine Forests TEC (see Section 5.1.6) when assessed against the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013), which are:

- Reduce the extent of an ecological community.
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.
- Adversely affect habitat critical to the survival of an ecological community.
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community’s survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.

- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.
    - Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: Assisting invasive species, that are harmful to the listed ecological community, to become established, or
    - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.
- Interfere with the recovery of an ecological community.

Table 7.65: Potential risk of MDO release on plankton

General sensitivity to oiling – plankton	
Sensitivity rating of plankton:	Low
A description of plankton communities in the EMBA is provided in:	Section 5.5.2
Plankton is found in nearshore and open waters beneath the surface in the water column. These organisms migrate vertically through the water column to feed in surface waters at night (NRDA, 2012). As they move close to the sea surface it is possible that they may be exposed to both surface hydrocarbons but to a greater extent, hydrocarbons dissolved or entrained in the water column. Phytoplankton is typically not sensitive to the impacts of oil, though they do accumulate it rapidly due to their small size and high surface area to volume ratio (Hook *et al*., 2016). If phytoplankton is exposed to hydrocarbons at the sea surface, this may directly affect their ability to photosynthesize and would have implications for the next trophic level in the food chain (e.g., small fish) (Hook *et al*., 2016). In addition, the presence of surface hydrocarbons may result in a reduction of light penetrating the water column, which could affect the rate of photosynthesis for phytoplankton in instances where there is prolonged presence of surface hydrocarbons over an extensive area such that the phytoplankton was restricted from exposure to light. Oil can affect the rate of photosynthesis and inhibit growth in phytoplankton, depending on the concentration range. For example, photosynthesis is stimulated by low concentrations of oil in the water column (10-30 ppb), but become progressively inhibited above 50 ppb. Conversely, photosynthesis can be stimulated below 100 ppb for exposure to weathered oil (Volkman *et al*., 2004). Zooplankton (microscopic animals such as rotifers, copepods and krill that feed on phytoplankton) are vulnerable to hydrocarbons due to their small size and high surface area to volume ratio, along with (in many cases) their high lipid content (that facilitates hydrocarbon uptake) (Hook *et al.,* 2016). Water column organisms that come into contact with oil risk exposure through ingestion, inhalation and dermal contact (NRDA, 2012), which can cause immediate mortality or declines in egg production and hatching rates along with a decline in swimming speeds (Hook *et al*., 2016). Plankton is generally abundant in the upper layers of the water column and acts as the basis for the marine food web, meaning that a MDO spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Variations in the temporal scale of oceanographic processes typical of the ecosystem have a greater influence on plankton communities than the direct effect of spilt hydrocarbons. This is because reproduction by survivors or migration from unaffected areas would be likely to rapidly replenish any losses from permanent zooplankton (Volkman *et al*., 2004). Field observations from oil spills show minimal or transient effects on marine plankton (Volkman *et al*., 2004). Once background water quality conditions have re-established, the plankton community will take weeks to months to recover (ITOPF, 2011a), allowing for seasonal influences on the assemblage characteristics.	

Potential risks to plankton from MDO release	
Surface oiling & water column	Shoreline

Plankton found in open water of the EMBA is expected to be widely represented in Bass Strait and the offshore Otway region. Plankton in the upper water column is likely to be directly (e.g., through smothering and ingestion) and indirectly (e.g., toxicity from decrease in water quality and bioaccumulation) affected by dissolved, entrained and floating hydrocarbons. Once background water quality conditions are rapidly re-established following the natural weathering and dispersion of the hydrocarbons, plankton populations are expected to recover rapidly due to recruitment of plankton from surrounding waters and reproduction by survivors. The consequence of an MDO spill on plankton populations is **minor**.	Not applicable.

Table 7.66: Potential risk of MDO release on pelagic fish

General sensitivity to oiling – pelagic fish	
Sensitivity rating of pelagic fish:	Low
A description of pelagic fish in the EMBA is provided in:	Section 5.5.4

The behaviours and habitat preferences of fish species determine their potential for exposure to hydrocarbons and the resulting impacts. Demersal species may be susceptible to oiled sediments, particularly species that are site-restricted. Pelagic species that occupy the water column are more susceptible to entrained and dissolved hydrocarbons, however generally these species are highly mobile and as such are not likely to suffer extended exposure due to their patterns of movement. The exception would be in areas such as reefs and other seabed features where species are less likely to move away into open waters (i.e., they area site-attached).

Fish are exposed to hydrocarbon droplets through a variety of pathways, including:

- Direct dermal contact (e.g., swimming through oil or waters with elevated dissolved hydrocarbon concentrations and other constituents, with diffusion across their gills (Hook *et al*., 2016));
- Ingestion (e.g., directly or via food base, fish that have recently ingested contaminated prey may themselves be a source of contamination for their predators); and
- Inhalation (e.g., elevated dissolved contaminant concentrations in water passing over the gills).

Exposure to hydrocarbons at the surface or entrained or dissolved in the water column can be toxic to fish. Studies have shown a range of impacts including changes in abundance, decreased size, inhibited swimming ability, changes to oxygen consumption and respiration, changes to reproduction, immune system responses, DNA damage, visible skin and organ lesions, and increased parasitism. However, many fish species can metabolise toxic hydrocarbons, which reduces the risk of bioaccumulation of contaminants in the food web (and human exposure to contaminants through the consumption of seafood) (NRDA, 2012).

Sub-lethal impacts in adult fish include altered heart and respiratory rates, gill hyperplasia, enlarged liver, reduced growth, fin erosion, impaired endocrine systems, behavioural modifications and alterations in feeding, migration, reproduction, swimming, schooling and burrowing behaviour (Kennish, 1996). However, fish are highly mobile and unlikely to remain in the area of a spill for long enough to be exposed to sub-lethal doses of hydrocarbons.

Fish are most vulnerable to hydrocarbon discharges during their embryonic, larval and juvenile life stages. Eggs and larvae of many fish species are highly sensitive to oil exposure, resulting in decreased spawning success and abnormal larval development (see Table 7.33 'Plankton').

Since fish and sharks do not generally break the sea surface, the impacts of surface hydrocarbons to fish and shark species are unlikely to occur. Near the sea surface, fish are able to detect and avoid contact with surface slicks meaning fish mortalities rarely occur in the event of a hydrocarbon spill in open waters (Volkman *et al*., 2004). As a result, wide-ranging pelagic fish of the open ocean generally are not highly susceptible to impacts from surface hydrocarbons. Adult fish kills reported after oil spills occur mainly to shallow water, near-shore benthic species (Volkman *et al*., 2004).

Hydrocarbon in the water column can physically affect reef fish (that have high site fidelity and cannot move out of harm's way) exposed for an extended duration (weeks to months) by coating of gills, leading to lethal and sub-lethal effects from reduced oxygen exchange and coating of body surfaces that may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food, leading to reduced growth (Volkman *et al*., 2004).

The threshold value for species toxicity in the water column is based on global data from French et al. (1999) and French-McCay (2002, 2003), which showed that species sensitivity (fish and invertebrates) to dissolved aromatics exposure >4 days (96-hour LC50) under different environmental conditions varied from 6 to 400 µg/L (ppb), with an average of 50 ppb. This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae). Based on scientific literature, a minimum threshold of 6 ppb over 96 hours or equivalent was used to assess in-water low exposure zones, respectively (Engelhardt, 1983; Clark, 1984; Geraci and St Aubin, 1988; Jenssen, 1994; Tsvetnenko, 1998). French- McCay (2002) indicates that an average 96-hour LC50 of 50 ppb and 400 ppb could serve as an acute lethal threshold to 50% and 97.5% to biota, respectively.

Studies of oil impacts on bony fishes report that light, volatile oils are likely to be more toxic to fish. Many studies conclude that exposure to PAHs and soluble compounds are responsible for the majority of toxic impacts observed in fish (e.g., Carls *et al*., 2008; Ramachandran *et al*., 2004). A range of lethal and sub-lethal effects to fish in the larval stage has been reported at water-accommodated fraction (WAF) hydrocarbon concentrations (48– hour and 96-hour exposures) of 0.001 to 0.018 ppm during laboratory exposures (Carls *et al*., 2008; Gala, 2001). In contrast, wave tank exposures reported much higher lethal concentrations (14-day LC50) up to 1.9 ppm for herring embryos and up to 4.3 ppm for juvenile cod (Lee *et al*., 2011).

Toxicity in adult fish has been reported in response to crude oils, HFO and diesel (Holdway, 2002; Shigenaka, 2011). Uptake of hydrocarbons has been demonstrated in bony fish after exposure to WAF of between 24 and 48 hours. Danion et al (2011) observed PAH uptake of 148 µg/kg-1 after 48-hour exposures to PAH from Arabian Crude at high concentrations of 770 ppm. Davis et al (2002) report detectable tainting of fish flesh after a 24-hour exposure at crude concentrations of 0.1 ppm, marine fuel oil concentrations of 0.33 ppm and diesel concentrations of 0.25 ppm. The majority of studies, either from laboratory trials or of fish collected after spill events (including the Hebei Spirit, Macondo, and Sea Empress spills) find evidence of elimination of PAHs in fish tissues returning to reference levels within two months of exposure (Challenger and Mauseth, 2011; Davis *et al*., 2002; Gagnon & Rawson, 2011; Gohlke *et al*., 2011; Jung, 2011; Law, 1997; Rawson *et al*., 2011).

The toxicity of dissolved hydrocarbons and dispersed oil to fish species has been the subject of a number of laboratory studies (AMSA, 1998). Generally, concentrations in the range of 0.1–0.4 mg/L dispersed oil have been shown to cause fish deaths in laboratory experiments (96-hour LC50). No reported studies of the impacts of oil spills on cartilaginous fish (including sharks, rays and sawfish) were found in the literature. It is not known how the data on the sensitivity of bony fishes would relate to toxicity in cartilaginous fishes.

The assessment of effects on fish species in the Timor Sea as a result of the Montara well blowout (a light gas condensate), conducted from November 2009 to November 2010 undertaken by Gagnon & Rawson (2011), found that of the species studied (mostly goldband snapper *Pristipomoides multidens*, red emperor *Lutjanus sebae*, rainbow runner *Elegatis bipinnulata* and Spanish mackerel *Scomberomorus commerson*), all 781 specimens were in good physical health at all sites. Results show that:

- Phase 1 study (November 2009, immediately after the blowout ceased) - indicated that in the short-term, fish were exposed to and metabolised petroleum hydrocarbons, however no consistent adverse effects on fish health or their reproductive activity were detected
- Phase 2 study (March 2010, 5 months after the blowout ceased) – indicated continuing exposure to petroleum hydrocarbons, as detected by elevated liver detoxification enzymes and PAH biliary metabolites in three out of four species collected close to the MODU, and elevated oxidative DNA damage.

• Phase 3 study (November 2010, 12 months after the blowout ceased) – showed a trend towards a return to reference levels with often, but not always, comparable biomarker levels in fish collected from reference and impacted sites. This evidence of exposure to petroleum hydrocarbons at sites close to the spill location suggest an ongoing trend toward a return to normal biochemistry/physiology (Gagnon & Rawson, 2011). The main finding of the Gagnon & Rawson (2011) study concluded that there were no detectable petroleum hydrocarbons found in the fish muscle samples, limited ill effects were detected in a small number of individual fish, and no consistent adverse effects of exposure on fish health could be detected within two weeks following the end of the well release. Notwithstanding, fishes from close to the Montara well, collected seven months after the discharge began, showed continuing exposure to hydrocarbons in terms of biomarker responses. Two years after the discharge, biomarker levels in fishes had mostly returned to reference levels, except for liver size. However this was potentially attributed to local nutrient enrichment, or to past exposure to hydrocarbons. Fishes near Heyward Shoal, approximately 100 km southwest of the Montara well, had elevated biomarker responses indicating exposure to hydrocarbons, but were collected close to the Cornea natural hydrocarbon seep. Studies on the Montara discharge have shown recovery in terms of the abundance and composition of fishes, and toxicological and physiological responses of fishes. Sampling from January 2010 to June 2011 by the University of South Alabama and Dauphin Island Sea Lab found no significant evidence of diseased fish in reef populations off Alabama or the western Florida Panhandle as a result of the Macondo well blowout in the GoM (BP, 2014). No reports of oil spills in open waters have been reported to cause fish kills (though mortality in aquaculture pens has), which is likely to be because vertebrates can rapidly metabolise and excrete hydrocarbons (Hook et al., 2016). Recovery of fish assemblages depends on the intensity and duration of an unplanned discharge, the composition of the discharge and whether dispersants are used, as each of these factors influences the level of exposure to potential toxicants. Recovery would also depend on the life cycle attributes of fishes. Species that are abundant, short-lived and highly fecund may recover rapidly. However less abundant, long-lived species may take longer to recover. The range of movement of fishes will also influence recovery. The nature of the receiving environment would influence the level of • impact on fishes.		
Potential risks to pelagic fish from MDO release		
Sea surface	Water column	Shoreline
Moderate and high threshold exposure MDO is predicted at the sea surface. Fish species in the water column and syngnathid species associated with rafts of floating seaweed may come into contact with surface oil. The maximum distance of moderate exposure threshold from the release site (representing the point at which harmful effects may be encountered) represents a small area of the sea surface in	There is up to a 13% probability of high exposure to entrained hydrocarbons at Zeehan AMP. This threshold of exposure represents the possibility of sublethal impacts to chronically exposed fish species. However, NOAA (2013) and ITOPF (2011a) state that hydrocarbon spills in open water are so rapidly diluted that fish kills are rarely observed. Fish such as the great white shark, shortfin mako and porbeagle shark	Not applicable.

Table 7.67: Potential risk of MDO release on cetaceans

General sensitivity to oiling – cetaceans	
Sensitivity rating of cetaceans:	High
A description of cetaceans in the EMBA is provided in:	Section 5.5.6

Whales and dolphins can be exposed to the chemicals in oil through:

- Internal exposure by consuming oil or contaminated prey;
- Inhaling volatile oil compounds when surfacing to breathe;
- Dermal contact, by swimming in oil and having oil directly on the skin and body; and
- Maternal transfer of contaminants to embryos (NRDA, 2012; Hook *et al*., 2016). The effects

of this exposure include:

- Hypothermia due to conductance changes in skin, resulting in metabolic shock (expected to be more problematic for non-cetaceans in colder waters);
- Toxic effects and secondary organ dysfunction due to ingestion of oil;
- Congested lungs;
- Damaged airways;
- Interstitial emphysema due to inhalation of oil droplets and vapour;
- Gastrointestinal ulceration and haemorrhaging due to ingestion of oil during grooming and feeding;
- Eye and skin lesions from continuous exposure to oil;
- Decreased body mass due to restricted diet; and
- Stress due to oil exposure and behavioural changes.

French-McCay (2009) identifies that a 10-25 µm oil thickness threshold has the potential to impart a lethal dose on marine species, however also estimates a probability of 0.1% mortality to cetaceans if they encounter these thresholds based on the proportion of the time spent at surface. Direct surface oil contact with hydrocarbons is considered to have little deleterious effect on whales, possibly due to the skin's effectiveness as a barrier to toxicity, and effect of oil on cetacean skin is probably minor and temporary (Geraci & St Aubin, 1988). Cetaceans in particular have mostly smooth skins with limited areas of pelage (hair covered skin) or rough surfaces such as barnacled skin. Oil tends to adhere to rough surfaces, hair or calluses of animals, so contact with hydrocarbons by whales and dolphins may cause only minor hydrocarbon adherence.

The physical impacts from ingested hydrocarbon with subsequent lethal or sub-lethal impacts are both applicable to entrained oil. However, the susceptibility of cetaceans varies with feeding habits. Baleen whales (such as blue, southern right and humpback whales) are not particularly susceptible to ingestion of oil in the water column, but are susceptible to oil at the sea surface as they feed by skimming the surface. Oil may stick to the baleen while they 'filter feed' near slicks. Sticky, tar-like residues are particularly likely to foul the baleen plates. The inhalation of oil droplets, vapours and fumes is a distinct possibility if whales surface in slicks to breathe. Exposure to hydrocarbons in this way could damage mucous membranes, damage airways or even cause

death. Toothed whales and dolphins may be susceptible to ingestion of dissolved and entrained oil as they gulp feed at depth. There are reports of declines in the health of individual pods of killer whales (a toothed whale species), though not the population as a whole, in Prince William Sound after the Exxon Valdez vessel spill (heavy oil) (Hook et al., 2016). It has been stated that pelagic species will avoid hydrocarbon, mainly because of its noxious odours, but this has not been proven. The strong attraction to specific areas for breeding or feeding (e.g., use of the Warrnambool coastline as a nursery area for southern right whales) may override any tendency for cetaceans to avoid the noxious presence of hydrocarbons. So weathered or tar-like oil residues can still present a problem by fouling baleen whales feeding systems. Dolphin populations from Barataria Bay, Louisianna, USA, which were exposed to prolonged and continuous oiling from the Macondo oil spill in 2010, had higher incidences of lung and kidney disease than those in the other urbanised environments (Hook et al., 2016). The spill may have also contributed to unusually high perinatal mortality in bottlenose dolphins (Hook et al., 2016). As highly mobile species, in general it is very unlikely that cetaceans will be constantly exposed to concentrations of hydrocarbons in the water column for continuous durations (e.g., >96 hours) that would lead to chronic toxicity effects.		
Potential risks to cetaceans from MDO release		
Surface oiling	Water column	Shoreline
The OSTM predicts that low, moderate and high zones of exposure to sea surface hydrocarbon will overlap the foraging BIA for pygmy blue whales. It is possible that pygmy blue whales may be present in the EMBA depending on the time of year that the spill occurs. However, due to the impact of underwater sound on pygmy blue whales, the survey will be conducted at a time when they are unlikely to be present in the Bass strait and Otway regions (September-October). If present, these species (and other cetaceans) may be exposed to oil in the manner described in this table. If large quantities of zooplankton (key prey species, though unlikely to occur in such proximity to the shoreline) exposed to the spill were ingested, chronic toxicity impacts may occur. Biological consequences of physical contact with localised areas of low concentrations of hydrocarbons at the sea surface are unlikely to lead to any long-term population impacts, with temporary skin irritation and very light	The OSTM shows a large area of dissolved and entrained phase hydrocarbons at low threshold would occur through Bass Strait and the Otway region. At the low threshold, water quality triggers are exceeded, but there are no toxicity or ecological effects to cetaceans. The extent of area affected by the dissolved hydrocarbons at the moderate threshold is up to 211 km from the centre of the operational area and up to 236 km for entrained hydrocarbons at the high threshold. Highly mobile and transient species such as cetaceans, along with the water depths of the EMBA, moving through a geographically and temporally limited area of hydrocarbons at the moderate or high exposure makes it unlikely that individual cetaceans would experience any toxicity effects of the MDO nor would population level impacts be likely. As described by the oceanographic data presented in Section 5.4, the well-mixed waters of central Bass Strait are likely to assist in weathering of the hydrocarbons. The OSTM predicts that 140 m3 (37%) of the spilled MDO will evaporate after one day.	Not applicable.

fouling/matting of baleen plates likely to occur (it is unknown whether the latter would affect feeding ability). Therefore, the consequence to cetacean populations from MDO at the sea surface while migrating or foraging in the EMBA at the time of the spill, is minor.	The oceanographic conditions, the light nature of the hydrocarbon and the low concentration of hydrocarbons in the water column means the consequence to cetacean populations from an MDO spill is minor.	
This hydrocarbon spill scenario will not have a 'significant' impact on threatened cetacean species (see Section 5.5.6) when assessed against the EPBC Act *Significant Impact Guidelines 1.1* (DoE, 2013), which are:		
• Lead to a long-term decrease in the size of a population.	A spill would not lead to a long-term decrease in the size of a population given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO and the low likelihood of a large portion of a cetacean population being present in the spill area at any one time.	
• Reduce the area of occupancy of the species.	Given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO, the area of occupancy may be temporarily reduced (noting that cetaceans may not necessarily avoid a spill at the surface or in the water column), but there will be no long-term reduction in the area of occupancy.	
• Fragment an existing population into two or more populations.	In the event of an MDO spill, cetaceans have access to an expansive area of unpolluted waters. A spill would not be expected to split up a single population into two or more populations. A spill does not move quickly enough to result in a migrating population splitting to avoid a spill.	
• Adversely affect habitat critical to the survival of a species.	The water quality of the survey area and EMBA would be temporarily reduced in the event of an MDO spill. However, only a small portion of the MDO entrains or dissolves in the water column where cetaceans spend the majority of their time (apart from surfacing to breath). The survey area and EMBA form only a small portion of cetacean migration routes, so this habitat is not critical to their survival; they would be exposed to MDO for a very short period of time if a spill occurred during migration (minutes to hours).	
• Disrupt the breeding cycle of a population.	Most of the cetacean species known to occur in the survey area and EMBA are not known to breed within the survey area or the EMBA. Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, it is highly unlikely that the breeding cycle of a cetacean population will be disrupted.	

• Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The water quality of the survey area and EMBA would be temporarily reduced in the event of an MDO spill. Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, the duration of reduced water quality will be temporarily. Marine habitat will not be modified, destroyed, removed, isolated or decreased to the extent that one or more cetacean species will decline.
• Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	The endangered cetaceans that may migrate through the survey area and EMBA are the pygmy blue whale and southern right whale (there are no critically endangered cetaceans listed on the databases informing this assessment). An MDO spill is highly unlikely to result in the introduction and spread of IMS that are harmful to these species. Vessels that may be involved in the 'monitor and evaluate' spill response strategy will be subject to strict IMS controls to ensure that ballast water is of 'low risk' and that hulls are free of IMS.
• Introduce disease that may cause the species to decline.	The risks of toxic impacts to individual cetaceans or populations is minor due to the rapid weathering of MDO. The small extent of a single spill further reduces the risk to a small area. As such, it is unlikely that there would be a large number of 'oiled' cetaceans that may then become susceptible to disease.
• Interfere with the recovery of the species.	For all the reasons outlined above, an MDO spill will not interfere with the recovery of a cetacean species.

Table 7.68: Potential risk of MDO release on pinniped

General sensitivity to oiling – pinnipeds	
Sensitivity rating of pinnipeds:	High
A description of pinnipeds in the EMBA is provided in:	Section 5.5.7
Pinnipeds (Australian fur-seal and New Zealand fur-seal) are potentially impacted by hydrocarbons at the sea surface, water column and shoreline. Sea surface oil Pinnipeds are vulnerable to sea surface exposures given they spend much of their time on or near the surface of the water, as they need to surface every few minutes to breathe and regularly haul out on to beaches. Pinnipeds are also sensitive as they will stay near established colonies and haul- out areas, meaning they are less likely to practice avoidance behaviours. This is corroborated by Geraci and St. Aubins (1988) who suggest seals, sea- lions and fur-seals have been observed swimming in oil slicks during a number of documented spills. Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. As a result of exposure to surface oils, pinnipeds, with their relatively large, protruding eyes are particularly vulnerable to effects such as irritation to mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, and anal and urogenital orifices. Hook *et al* (2016) reports that seals appear not to be very sensitive to contact with oil, but instead to the toxic impacts from the inhalation of volatile components. For some pinnipeds, fur is an effective thermal barrier because it traps air and repels water. Petroleum stuck to fur reduces its insulative value by removing natural oils that waterproof the pelage. Consequently, the rate of heat transfer through fur seal pelts can double after oiling (Geraci & St. Aubin, 1988), adding an energetic burden to the animal. Kooyman et al (1976) suggest that in fact, fouling of approximately one-third of the body surface resulted in 50% greater heat loss in fur seals immersed in water at various temperatures. Fur-seals are particularly vulnerable due to the likelihood 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. Davis and Anderson (1976) observed two gray seal pups drowning, their "flippers stuck to the sides of their bodies such that they were unable to swim". However, pinnipeds other than fur-seals are less threatened by thermal effects of fouling, if at all. Oil has no effect on the relatively poor insulative capacity of sea-lion and bearded and ringed seal pelts; oiled Weddell seal samples show some increase in conductance (Oritsland, 1975; Kooyman *et al*., 1976; 1977). In-water oil Ingested hydrocarbons can irritate or destroy epithelial cells that line the stomach and intestine, thereby affecting motility, digestion and absorption. However, pinnipeds have been found to have the enzyme systems necessary to convert absorbed hydrocarbons into polar metabolites, which can be excreted in urine (Engelhardt, 1982; Addison & Brodie, 1984; Addison *et al*., 1986). Geraci & St. Aubin (1988) suggest that a small phocid weighing 50 kg might have to ingest approximately 1 litre of oil to be at risk. Volkman et al (1994) report that benzene and naphthalene ingested by seals is quickly absorbed into the blood through the gut, causing acute stress, with damage to the liver considered likely. If ingested in large volumes, hydrocarbons may not be completely metabolised, which may result in death. Shoreline oil Breeding colonies (used to birth and nurse until pups are weaned) are particularly sensitive to hydrocarbon spills (Higgins & Gass, 1993). Pinnipeds are further at risk because of their tendency to stay near established colonies and haul-out areas and consequently are unlikely to practice oil avoidance behaviours.	

ITOPF (2011a) report that species that rely on fur to regulate their body temperature (such as fur-seals) are the most vulnerable to oil as the animals may die from hypothermia or overheating, depending on the season, if the fur becomes matted with oil. It is reported that most pinnipeds scratch themselves vigorously with their flippers and do not lick or groom themselves, so are less likely to ingest oil from skin surfaces (Geraci & St. Aubin, 1988). However, mothers trying to clean an oiled pup may ingest oil. All pinnipeds examined to date have the enzyme systems necessary to convert absorbed hydrocarbons into polar metabolites, which can be excreted in urine (Engelhardt, 1982; Addison and Brodie, 1984; Addison *et al*., 1986). The long-term Environmental Impact and Recovery report for the Iron Barren oil spill (in Tasmania, 1995) concluded that "The number of seal pups born at Tenth Island in 1995 was reduced when compared to previous years. There was a strong relationship between the productivity of the seal colonies and the proximity of the islands to the oil spill wherein the islands close to the spill showed reduced pup production and those islands more distant to the oil spill did not" (Tasmanian SMPC, 1999). Pinnipeds are further at risk because they appear to rely on scent to establish a mother-pup bond (Sandegren, 1970; Fogden, 1971), and consequently oil-coated pups may not be recognisable to their mothers. This is only theorised, with studies and research indicating interaction between mothers and oiled pups were normal (Davis and Anderson, 1976; Davies, 1949; Shaughnessy & Chapman, 1984). Australian sea-lions have 'naturally poor recovery abilities' due to 'unusual reproductive biology and life history' (TSSC, 2005). Due to the extreme philopatry of females and limited dispersal of males between breeding colonies, the removal of only a few individuals annually may increase the likelihood of decline and potentially lead to the extinction of some of the smaller colonies. Extinction of breeding colonies has the potential to further reduce genetic diversity and the already limited genetic flow between colonies. This, in turn, may weaken the genetic resilience of the species and impact on its ability to cope with other natural or anthropogenic impacts. In addition, the extreme philopatry of females suggests that extinction of breeding colonies may lead to a contraction of the range of the species as re-colonisation of breeding sites via immigration is limited. For the reasons outlined above, small breeding colonies are under particular pressure of survival from even low levels of anthropogenic mortality.		
Potential risks to pinnipeds from MDO release		
Surface oiling	Water column	Shoreline
The foraging range for New Zealand fur-seals, Australian sea-lions and Australian fur-seals may be temporarily exposed to low, moderate and high concentration of hydrocarbons at the sea surface. As fur-seals forage for prey within the water column rather than at the sea surface, exposure to oil at the sea surface will only result when resting at the surface. Moderate and high concentrations do not reach shorelines where seals are likely to be entering and exiting the water. Depending on the duration of time spent at the sea surface,	Given that fur-seals forage for prey within the water column, exposure to hydrocarbons (either via ingestion of contaminated prey or direct contact with oil droplets) may occur, however the low concentrations modelled are below those likely to impart permanent injury or mortality to pinniped populations in Bass Strait and the Otway region. The zones of dissolved hydrocarbons meeting the moderate threshold and entrained hydrocarbons meeting the high threshold are	Exposure to hydrocarbons at the low threshold is unlikely to have an ecological impact. Moderate threshold shoreline hydrocarbons may contact shorelines that are utilised by fur- seals on the south coast of King Island and off the west coast of Wilsons Promontory. Given the brief time that MDO will

exposure may result in irritation to mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, and anal and urogenital orifices. Given the very small area of MDO at moderate and high exposure levels on the sea surface predicted from a single spill, as well as the rapid evaporation from the sea surface (days), acute or chronic toxicity impacts are not likely for multiple individuals. The highly mobile nature of the pinniped species likely to be present means areas on the sea surface impacted by moderate and high hydrocarbon exposure can be avoided. Given the generally brief time spent at the sea surface by pinnipeds and the rapid weathering of the MDO, the consequence of an MDO spill to multiple individuals and populations present in Bass Strait is minor.	small in comparison to the wider area available to pinnipeds for foraging and their known range of occupation. This means there is a low probability that pinnipeds would be feeding exclusively on prey found in these areas of higher hydrocarbon thresholds for long periods of time. The area potentially affected by hydrocarbons represents a relatively small area in which fur-seals are known to forage in Bass Strait and the Otway region and is unlikely to be habitat critical to their survival. Because of this, the consequence to fur-seals from an MDO spill is minor.	remain at the moderate threshold and its limited extent, the consequence of an MDO spill to multiple individuals and populations present in Bass Strait is minor.

Table 7.69: Potential risk of MDO release on marine reptiless

General sensitivity to oiling – marine reptiles	
Sensitivity rating of marine reptiles:	Medium
A description of marine reptiles in the EMBA is provided in:	Section 5.5.8
Marine reptiles can be exposed to hydrocarbon through ingestion of contaminated prey, inhalation or dermal exposure (Hook *et al*., 2016). Sea turtles are vulnerable to the effects of oil at all life stages—eggs, post-hatchlings, juveniles, and adults in nearshore waters. Several aspects of sea turtle biology and behaviour place them at particular risk, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large pre-dive inhalations. Effects of oil on turtles include increased egg mortality and developmental defects, direct mortality due to oiling in hatchlings, juveniles, and adults; and negative impacts to the skin, blood, digestive and immune systems, and salt glands. Oil exposure affects different turtle life stages in different ways. Each turtle life stage frequents a habitat with notable potential to be impacted during an oil spill. Thus, information on oil toxicity needs to be organized by life stage. Turtles may be exposed to chemicals in oil in two ways: Internally – eating or swallowing oil, consuming prey containing oil-based chemicals, or inhaling of volatile oil related compounds; and Externally – swimming in oil or dispersants, or oil or dispersants on skin and body. Records of oiled wildlife during spills rarely include marine turtles, even from areas where they are known to be relatively abundant (Short, 2011). An exception to this was the large number of marine turtles collected (613 dead and 536 live) during the Macondo spill in the GoM, although many of these animals did not show any sign of oil exposure (NOAA, 2013). Of the dead turtles found, 3.4% were visibly oiled and 85% of the live turtles found were oiled (NOAA, 2013). Of the captured animals, 88% of the live turtles were later released, suggesting that oiling does not inevitably lead to mortality. Impacts to sea snakes during marine hydrocarbon spills are known from limited assessments, undertaken following the Montara spill in the Timor Sea in 2009. Two dead sea snakes were collected during the incident, one of which was concluded to have died as a result of exposure to the oil, with evidence of inhaled and ingested oil and elevated concentrations of PAHs in muscle tissues. The second snake showed evidence of ingestion by oil but no accumulation in tissues or damage to internal organs and it was concluded that the oil was unlikely to be the cause of death (Curtin University, 2009; 2010). There is potential for contamination of turtle eggs to result in similar toxic impacts to developing embryos as has been observed in birds. Studies on freshwater snapping turtles showed uptake of PAHs from contaminated nest sediments, but no impacts on hatching success or juvenile health following exposure of eggs to dispersed weathered light crude (Rowe *et al*., 2009). However, other studies found evidence that exposure of freshwater turtle embryos to PAHs results in deformities (Bell *et al*., 2006, Van Meter *et al*., 2006). Turtles may experience oiling impacts on nesting beaches and eggs through chemical exposure, resulting in decreased survival to hatching and developmental defects in hatchlings. Turtle hatchlings may be more vulnerable to smothering as they emerge from the nests and make their way over the intertidal area to the open water (AMSA, 2015). Hatchlings that contact oil residues while crossing a beach can exhibit a range of effects including impaired movement and bodily functions (Shigenaka, 2003). Hatchlings sticky with oily residues may also have more difficulty crawling and swimming, rendering them more vulnerable to predation. Ingested oil may cause harm to the internal organs of turtles. Oil covering their bodies may interfere with breathing because they inhale large volumes of air to dive. Oil can enter cavities such as the eyes, nostrils, or mouth. Turtles may experience oiling impacts on nesting beaches when	

they come ashore to lay their eggs, and their eggs may be exposed during incubation, potentially resulting in increased egg mortality and/or possibly developmental defects in hatchlings.		
Potential risks to marine reptiles from MDO release		
Surface oiling	Water column	Shoreline
Some individual marine reptiles may come into contact with low, moderate and high hydrocarbon exposure on the sea surface. At the moderate and high concentrations, toxicity impacts may occur including sub-lethal impacts including irritation of skin or cavities. However, due to the absence of turtle BIAs in Bass Strait and the Otway region and the low number of turtles foraging or migrating through Bass Strait in general, the consequence of an MDO spill to threatened turtle individuals and populations is **minor**.		There are no turtle nesting sites on the southern Victorian coast, offshore islands or Tasmanian shorelines. Thus, the consequence of an MDO spill to threatened turtle individuals and populations is **minor**.

Table 7.70: Potential risk of MDO release on seabirds and shorebirds

General sensitivity to oiling – seabirds and shorebirds	
Sensitivity rating of seabirds:	High
Sensitivity rating of shorebirds:	High
A description of seabirds and shorebirds in the EMBA is provided in:	Section 5.5.9
Seabirds and shorebirds are sensitive to the impacts of oiling, with their vulnerability arising from the fact that they cross the air-water interface to feed, while their shoreline habitats may also be oiled (Hook *et al*., 2016). Species that raft together in large flocks on the sea surface are particularly at risk (ITOPF, 2011a). Birds foraging at sea have the potential to directly interact with oil on the sea surface some considerable distance from breeding sites in the course of normal foraging activities. Species most at risk include those that readily rest on the sea surface (such as shearwaters) and surface plunging species such as terns and boobies. As seabirds are top order predators, any impact on other marine life (e.g., pelagic fish) may disrupt and limit food supply both for the maintenance of adults and the provisioning of young. In the case of seabirds, direct contact with hydrocarbons is likely to foul plumage, which may result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair water-proofing (ITOPF, 2011a). A bird suffering from cold, exhaustion and a loss of buoyancy (resulting from fouling of plumage) may dehydrate, drown or starve (ITOPF, 2011a; DSEWPC, 2011; AMSA, 2013). It may also result in impaired navigation and flight performance (Hook *et al*., 2016). Increased heat loss as a result of a loss of water-proofing results in an increased metabolism of food reserves in the body, which is not countered by a corresponding increase in food intake, and may lead to emaciation (DSEPWC, 2011). The greatest vulnerability in this case occurs when birds are feeding or resting at the sea surface (Peakall *et al*., 1987). In a review of 45 marine hydrocarbon spills, there was no correlation between the numbers of bird deaths and the volume of the spill (Burger, 1993). Toxic effects of hydrocarbons on birds may result where the oil is ingested as the bird attempts to preen its feathers, and the preening process may spread the oil over otherwise clean areas of the body (ITOPF, 2011a). Whether this toxicity ultimately results in mortality will depend on the amount of hydrocarbons consumed and other factors relating to the health and sensitivity of the bird. Birds that are coated in oil also suffer from damage to external tissues including skin and eyes, as well as internal tissue irritation in their lungs and stomachs. Breeding seabirds may be directly exposed to oil via a number of potential pathways. Any direct impact of oil on terrestrial habitats has the potential to contaminate birds present at the breeding sites (Clarke, 2010). Bird eggs may also be damaged if an oiled adult sits on the nest. Fresh crude was shown to be more toxic than weathered crude, which had a medial lethal dose of 21.3 mg/egg (Clarke, 2010). Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos. Engelhardt (1983), Clark (1984), Geraci & St Aubin (1988) and Jenssen (1994) indicated that the threshold thickness of oil that could impart a lethal dose to some intersecting wildlife individual is 10 µm (~10 g/m^2). Scholten et al (1996) indicates that a layer 25 µm thick would be harmful for most birds that contact the slick. Shorebirds are likely to be exposed to oil when it directly impacts the intertidal zone due to their feeding habitats. Shorebird species foraging for invertebrates on exposed sand and mud flats at lower tides will be at potential risk of both direct impacts through contamination of individual birds (ingestion or soiling of feathers) and indirect impacts through the contamination of foraging areas that may result in a reduction in available prey items (Clarke, 2010). Penguins may be especially vulnerable to oil because they spend a high portion of their time in the water and readily lose insulation and buoyancy if	

their feathers are oiled (Hook et al., 2016). The Iron Baron vessel spill (325 tonnes of bunker fuel in Tasmania in 1995) is estimated to have resulted in the death of up to 20,000 penguins (Hook et al., 2016).		
Potential risks to seabirds and shorebirds from MDO release		
Surface oiling	Water column	Shoreline
Most of the seabird species described in Section 5.5.9 that may occur in the EMBA forage over an extensive area and are distributed over a wide geographic area. Seabirds plunge diving through the sea surface for prey are most likely to encounter the low concentration of hydrocarbons due to its broader extent than moderate and high concentrations. Seabirds rafting, resting, diving or feeding at sea have the potential to come into contact with oil. However, the low threshold level of exposure is not expected to result in the lethal impacts of feather matting and hypothermia. However, contact at the high threshold is expected to impart toxicity and ecological impacts.Given the extensive ocean foraging habitat available to species such as albatross and petrel, the small area and temporary nature of the hydrocarbon release on the sea surface (<3 days) makes it unlikely that a spill will limit their ability to forage for unaffected prey, nor will the unlikely event of exposure at the sea surface result in permanent injury or mortality. Therefore, the consequence to seabirds is **minor**.	The zones of dissolved hydrocarbons meeting the moderate threshold and entrained hydrocarbons meeting the high threshold during an MDO spill are relatively small in comparison to the Bass Strait and Otway region. It is these small areas where sub-lethal or toxic effects to birds may occur. There is a low probability that seabirds would be feeding exclusively or predominantly on fish found in these areas of higher hydrocarbon thresholds, meaning there is low probability of seabirds themselves experiencing sub-lethal or toxic impacts as a result of consuming hydrocarbon-tainted fish. Therefore, the consequence to seabirds is **minor**	The shorebird species described in Section 5.5.9 are not likely to be exposed to the moderate concentrations of hydrocarbons due to the small average length of shoreline (2.5 km) predicted to be exposed at this concentration. There is no predicted exposure at the high threshold for shoreline loading and shoreline loading at the low exposure threshold is unlikely to result in ecological impacts to shorebird species.The shorebird species (e.g., plovers, godwits, curlews, etc.) prefer varying habitats including tidal flats, open saltmarsh, freshwater wetlands, open grasslands and sandy beaches. These habitats are largely not contacted by the moderate threshold hydrocarbons. Rather, coastlines potentially exposed to moderate threshold shoreline loading are rocky and located on the Cape Otway coast, the west coast of King Island and on islands off the west coast of Wilsons Promontory. The King Island coastline is a recognised Important Bird Area (IBA) which supports hooded plovers and includes Lavinia State Reserve (not intersected by shoreline loading), which supports orange-bellied parrots and endemic subspecies of bush birds. Due to the proximity of the IBA and isolated areas of potential moderate shoreline loading on the IBA, the consequence of an MDO spill to shorebird species is moderate.
This hydrocarbon spill scenario will not have a ‘significant’ impact on migratory shorebird species (see Section 5.5.9) when assessed against the EPBC Act *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act-listed migratory shorebird species Policy Statement 3.21* (DoEE, 2017b), which are:		
• Loss of habitat.	The sandy beaches of the EMBA will not be lost in the event of an MDO spill.	
• Degradation of habitat leading to a substantial reduction in migratory shorebird numbers.	Shoreline quality will temporarily decrease but given the behaviour of MDO and nature of the shoreline, there will be no long-term degradation.	

• Increased disturbance leading to a substantial reduction in migratory shorebird numbers.	MDO will rapidly percolate through sandy beach sediments, resulting in only short-term disturbance. The most likely shoreline response option will be to monitor and evaluate (rather than actively undertake a clean-up), further reducing the potential for disturbance to shorebirds.
• Direct mortality of birds leading to a substantial reduction in migratory shorebird numbers.	Depending on the nature of the spill, how it weathers and the location of shoreline loading, there is a low risk of direct mortality of birds. No one area of the EMBA, particularly the shoreline closest to the survey area, has high concentrations or a high percentage of a population of any migratory shorebird species. As such, a substantial reduction in migratory shorebird numbers is highly unlikely to occur.
This hydrocarbon spill scenario will not have a 'significant' impact on threatened seabird species (see Section 5.5.9) when assessed against the EPBC Act *Significant Impact Guidelines 1.1* (DoE, 2013), which are:	
• Lead to a long-term decrease in the size of a population.	A spill would not lead to a long-term decrease in the size of a population given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO and the low likelihood of a large portion of a seabird population being present in the spill area at any one time.
• Reduce the area of occupancy of the species.	Given the small area of 'swept ocean' from a single spill, the rapid weathering of MDO and the abundance of suitable nearby habitat, sea surface water quality will temporarily decrease and therefore the area of occupancy will be temporarily reduced but there will be no long-term reduction in the area of occupancy.
• Fragment an existing population into two or more populations.	In the event of an MDO spill, seabirds have access to an expansive area of unpolluted waters. A spill would not fragment an existing population given the small area of 'swept ocean' from a single spill.
• Adversely affect habitat critical to the survival of a species.	The marine waters of the survey area and EMBA are not critical to the survival or any seabirds. Similar marine habitat occurs all through Bass Strait and the Southern Ocean.
• Disrupt the breeding cycle of a population.	Most of the seabird species known to occur in the survey area and EMBA (e.g., albatross, petrels, shearwaters) breed outside of Australia or well beyond the EMBA. Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, it is highly unlikely that the breeding cycle of a seabird population will be disrupted.
• Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Given the small area of 'swept ocean' from a single spill and the rapid weathering of MDO, the quality of marine waters in the area of the spill will be temporarily reduced. However, marine habitat will not be modified, destroyed, removed, isolated or decreased to the extent that one or more seabird species will decline.

	Most of the seabird species known to occur in the Project area and EMBA (e.g., albatross, petrels, shearwaters) breed outside of Australia or well beyond the EMBA. This being the case, it is unlikely for adults to bring contaminated prey back to nests to feed chicks. For the species that do breed in Australian waters and parts of the EMBA, it is unlikely that MDO or MDO- affected prey would be brought back to the nest in quantities significant enough to result in mortality of chicks and the loss of a generation.
• Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	There are several EPBC Act-listed endangered and critically endangered seabirds that may occur in the survey area and/or EMBA. An MDO spill is highly unlikely to result in the introduction and spread of IMS that are harmful to these species. Vessels that may be involved in the 'monitor and evaluate' spill response strategy will be subject to strict IMS controls to ensure that ballast water is of 'low risk' and that hulls are free of IMS.
• Introduce disease that may cause the species to decline.	The risks of toxic impacts to individual birds or populations is minor due to the rapid weathering of MDO. The small extent of a single spill further reduces the risk to a small area. As such, it is unlikely that there would be a large number of 'oiled' birds that may then become susceptible to disease.
• Interfere with the recovery of the species.	For all the reasons outlined above, an MDO spill will not interfere with the recovery of a seabird species.
The activity will not impact on the objectives of the Draft Wildlife Conservation Plan for Seabirds (DAWE, 2019), which are: 1) International cooperation and collaboration occur to support the survival of seabirds and their habitats outside Australian jurisdiction. 2) Seabirds and their habitats are protected and managed in Australia. 3) The long-term survival of seabirds and their habitats is achieved through supporting priority research programs, coordinating monitoring, on- ground management and conservation. 4) Awareness of the importance of conserving seabirds and their habitats is increased through a strategic approach to community education and capacity building to support monitoring and on-ground management.	

Table 7.71: Potential risk of MDO release on sandy beaches

General sensitivity to oiling – sandy beaches	
Sensitivity rating of sandy beaches (environmental):	Low
Sensitivity rating of sandy beaches (socio-economic):	Medium
A description of sandy beaches in the EMBA is provided in:	Section 5.4.8
Sandy beaches are regularly exposed to wave action and have low sediment total organic carbon and therefore generally a low abundance of marine life (Hook *et al*., 2016). The low concentration of total organic carbon and large particle size of sand means that any MDO deposited on the beach would not be retained. However, sandy beaches are important socio-economically, so an MDO spill reaching this type of shoreline may attract attention that is disproportionate to its sensitivity (Hook *et al*., 2016). Depth of penetration in sandy sediment is influenced by: Particle size - penetration is great in coarser sediments (such as beach sand) compared to mud (in estuaries and tidal flats). Oil viscosity – MDO quickly penetrates sandy sediments. Drainage – coarse beach sands allow for rapid drainage (it may reach depths greater than one metre in coarse well-drained sediments). Animal burrows and root pores - penetration into fine sediments is increased if there are burrows of animals such as worms, or pores left where plant roots have decayed. Areas of heavy oiling (>1,000 g/m^2 threshold) would likely result in acute toxicity, and death, of many invertebrate communities, especially where oil penetrates into sediments through animal burrows (IPIECA, 1999). However, these communities would be likely to rapidly recover (recruitment from unaffected individuals and recruitment from nearby areas) as oil is removed from the environment. The results of exposure to oil may be acute (e.g., die off of amphipods and replacement by more tolerant species such as worms or chronic (i.e., gradual accumulation of oil and genetic damage) (Hook *et al*., 2016). For example, following the Sea Empress spill (in west Wales, 1996) many amphipods (sandhoppers), cockles and razor shells were killed. There were mass strandings on many beaches of both intertidal species (such as cockles) and shallow sub-tidal species. Similar mass strandings occurred after the Amoco Cadiz spill (in Brittany, France, 1978) (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. Opportunists such as some species of worm may actually show a dramatic short-term increase following an oil spill (IPIECA, 1999). Long-term depletion of sediment fauna could have an adverse effect on birds or fish that use tidal flats as feeding grounds (IPIECA, 1999). In March 2014, small volumes of crude oil from an unidentified source (confirmed to not be offshore oil and gas production facilities) washed up along a 7-km section of sandy beach on the Victorian Gippsland coast as small (a few millimetres thick) granular balls (Gippsland Times, 2014; ABC News, 2014). AMSA (2014b) reported that no impacts were observed over the course of two months following the incident. The Macondo well blowout resulted in oil washing up on sandy beaches of the Alabama coastline. The natural movement of sand and water through the beach system continually transformed and re-distributed oil within the beach system, and 18 months after the event, mobile remnant oil remained in various states of weathering buried at different depths in the beaches (Hayworth *et al*., 2011). Other results from beach sampling undertaken at Dauphin Island, Alabama, in May (pre-impact) and September 2011 (post-impact) found a large shift in the diversity and abundance of microbial species (e.g.,	

nematodes, annelids, arthropods, polychaetes, protists, fungi, algae and bacteria). Post-spill, sampling indicated that species composition was almost exclusively dominated by a few species of fungi. DNA analyses revealed that the 'before' and 'after' communities at the same sites weren't closely related to each other (Bik et al., 2012). Similar studies found that oil deposited on the beaches caused a shift in the community structure toward a hydrocarbonoclastic consortium (petroleum hydrocarbon degrading microorganisms) (Lamendella *et al*., 2014).
Potential risks to sandy beaches from MDO release
Shoreline
The shoreline predicted to be exposed to moderate MDO loading is exposed, mostly rocky shoreline and is subject to strong wave action. This would assist in natural degradation of MDO. Areas of low exposure to shoreline loading are not expected to exhibit environmental harm. Due to the exposed nature of the shoreline and the nature of MDO, long-term toxicity or smothering effects in areas of moderate MDO exposure are not expected and natural weathering should be sufficient to aid in recovering communities rapidly. No MDO shoreline loading at the high threshold is predicted in the OSTM. MDO entrained in the water column (in the top 10 m) at the low threshold (10-100 ppb) is predicted to intersect sandy shorelines within the Western Tasmanian Aboriginal Cultural Landscape, the Mornington Peninsula, Cape Patterson, East Gippsland and the southern-most sandy beaches of NSW in the EMBA. Given the distances of these beaches from the spill location, the MDO will be highly weathered and unlikely to result in any toxicity impacts to shoreline invertebrate communities or shoreline bird species feeding on such invertebrates. Intersection with the Western Tasmanian Aboriginal Cultural Landscape will not result in any impacts to the values of this landscape, given that these are terrestrial values, shoreward of the intertidal zone.

Table 7.72: Potential risk of MDO release on rocky shores

General sensitivity to oiling – rocky shores	
Sensitivity rating of rocky shores (environmental):	Low
Sensitivity rating of rocky shores (socio-economic):	Medium
A description of sandy beaches in the EMBA is provided in:	Section 5.4.7
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 hydrocarbons can become concentrated as it strands ashore. The same is true on stable boulder shores where the rich animal communities underneath the rocks are also the most vulnerable to hydrocarbon 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. At the other extreme, a gradually sloping boulder shore in a calm backwater of a sheltered inlet can trap enormous amounts of hydrocarbons, 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. Some shores are well known to act as natural collection sites for litter and detached algae and oil is carried there in the same way. 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). It is not long before the waves and tides that carried the hydrocarbons onto the shore gradually remove it again, but the rate of such weathering is dependent on many factors. The wave exposure, weather conditions and the shore characteristics are most important. For example, a patch of oil on a rock exposed to heavy wave action is not going to remain there for long. However, it could take many years for the limited water movement in a sheltered bay to remove oil trapped under boulders or in gullies and crevices. Gradual leaching of this oil could result in constant low-level pollution of, for example, a rock pool. Microbial breakdown of the oil is slower in cold or temperature environments than sub-tropical or tropical environments. The presence of silt and clay particles can assist with oil removal by the process of flocculation. Grazing animals such as marine snails may also remove significant amounts of oil. As the oil is weathered it becomes more viscous and less toxic, often leaving little but a small residue of tar on upper shore rocks. This residue can remain as an unsightly stain for a long time but it is unlikely to cause any more ecological damage. Oil tends not to remain on wet rock or algae but is likely to stick firmly if the rock is dry (IPIECA, 1995).	
Potential risks to rocky shores from MDO release	
Shoreline	
Rocky shores intersected by MDO at the low exposure threshold are not likely to experience ecological impact. Potential impacts arising from a MDO spill on the ecological, tourism, cultural and/or social values of rocky shores are more likely to occur than ecological impacts at low threshold exposure to MDO. There is a 5% probability of moderate shoreline loading on the King Island coast. Much of this coastline is comprised of rocky shores with cliff- dominated coastline present adjacent the survey area. The action of reflected waves off rocky shores, together with the predicted weathering of the MDO, means it is unlikely that toxicity or smothering effects to exposed fauna will occur on this type of shoreline. The MDO is likely to be continually washed off the substrate and into the water, leading to further weathering. Therefore, the consequence of an MDO spill on rocky shores is **minor**	

Table 7.73: Potential risk of MDO release on commercial fishing

General sensitivity to oiling – commercial fishing	
Sensitivity rating of commercial fisheries:	High
A description of commercial fisheries operating in the EMBA is provided in:	Section 5.7.5
Commercial fishing has the potential to be impacted through exclusion zones associated with the spill, the spill response and subsequent reduction in fishing effort. Exclusion zones may impede access to commercial fishing areas, for a short period of time, and nets and lines may become oiled. The impacts to commercial fishing from a public perception perspective however, may be much more significant and longer term than the spill itself. Fishing areas may be closed for fishing for shorter or longer periods because of the risks of the catch being tainted by oil. Concentrations of petroleum contaminants in fish and crustacean and mollusc tissues could pose a significant potential for adverse human health effects, and until these products from nearshore fisheries have been cleared by the health authorities, they could be restricted for sale and human consumption. Indirectly, the fisheries sector will suffer a heavy loss if consumers are either stopped from using or unwilling to buy fish and shellfish from the region affected by the spill. Impacts to fish stocks have the potential for reduction in profits for commercial fisheries, and exclusion zones exclude fishing effort. Davis et al (2002) report detectable tainting of fish flesh after a 24-hour exposure at crude concentrations of 0.1 ppm, marine fuel oil concentrations of 0.33 ppm and diesel concentrations of 0.25 ppm. The Montara spill (as the most recent [2009] example of a large hydrocarbon spill in Australian waters) occurred over an area fished by the Northern Demersal Scalefish Managed Fishery (with 11 licences held by 7 operators), with goldband snapper, red emperor, saddletail snapper and yellow spotted rockcod being the key species fished (PTTEP, 2013). As a precautionary measure, the WA Department of Fisheries advised the commercial fishing fleet to avoid fishing in oil-affected waters. Testing of fish caught in areas of visible oil slick (November 2009) found that there were no detectable petroleum hydrocarbons in fish muscle samples, suggesting fish were safe for human consumption. In the short-term, fish had metabolised petroleum hydrocarbons. Limited ill effects were detected in a small number of individual fish only (PTTEP, 2013). No consistent effects of exposure on fish health could be detected within two weeks following the end of the well release. Follow up sampling in areas affected by the spill during 2010 and 2011 (PTTEP, 2013) found negligible ongoing environmental impacts from the spill. Since testing began in the month after the Macondo well blowout in the Gulf of Mexico (GoM) (2010), levels of oil contamination residue in seafood consistently tested 100 to 1,000 times lower than safety thresholds established by the USA FDA, and every sample tested was found to be far below the FDA's safety threshold for dispersant compounds (BP, 2015). FDA testing of oysters found oil contamination residues to be 10 to 100 times below safety thresholds (BP, 2014). Sampling data shows that post-spill fish populations in the GoM since 2011 were generally consistent with pre-spill ranges and for many shellfish species, commercial landings in the GoM in 2011 were comparable to pre-spill levels. In 2012, shrimp (prawn) and blue crab landings were within 2.0% of 2007-09 landings. Recreational fishing harvests in 2011, 2012 and 2013 exceeded landings from 2007-09 (BP, 2014). In the event of a MDO spill, a temporary fisheries closure may be put in place by the VFA (or voluntarily by the fishers themselves). Oil may foul the hulls of fishing vessels and associated equipment, such as gill nets. A temporary fisheries closure, combined with oil tainting of target species (actual or perceived), may lead to financial losses to fisheries and economic losses for individual licence holders. Fisheries closures and the flow on losses from the lack ofincome derived from these fisheries are likely to have short-term but widespread socio-economic consequences, such as reduced	

employment (in fisheries service industries, such as tackle and bait supplies, fuel, marine mechanical services, accommodation and so forth).			
Potential risks to commercial fishing from MDO release			
Fishery	Surface oiling	Water column	Shoreline
General	A short-term fishing exclusion zone may be implemented by AFMA or the Victorian or Tasmanian fishing authorities. Given the temporary nature of any surface slick and the low fishing intensity in the EMBA, there are unlikely to be any significant impact on fisheries in terms of lost catches (and associated income).	OSTM predicts large areas may be exposed to dissolved and entrained hydrocarbons at the low exposure threshold, and small areas at the moderate dissolved and high entrained exposure thresholds. A short-term fishing exclusion zone may be implemented by AFMA or the Victorian or Tasmanian fishing authorities. The areas of moderate dissolved and high entrained exposure thresholds represent very small areas available to commercial fishing. The hydrocarbons are predicted to weather quickly and the area would return to pre-spill conditions rapidly.	Vessels use local ports, many of which are not included within the EMBA. Where the EMBA includes moored fishing vessels, some staining or coasting of vessel hulls may occur.
Commonwealth fisheries (those known to fish within the MDO spill EMBA)			
Scallop	No impact due to their benthic habitat.	The spill EMBA intersects 47% of the total fishery area. Hydrocarbons are not expected to accumulate among benthic sediments in the EMBA due to the significant mixing of waters and dilution of the low concentration of hydrocarbons in the water column. The most intensely fished areas of the fishery, off the east coast of King Island in Commonwealth waters, are not exposed to dissolved or entrained hydrocarbons in the benthic layer. Therefore, the short- or long-term consequence to the fishery or its catch species is**minor**.	As per 'general'.
Southern squid jig	The most heavily fished areas of the fishery are located off the east coast of Tasmanian, which is outside the EMBA. Therefore, the consequence to the fishery is minor.	The spill EMBA intersects 4.84% of the total fishery area. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have a significant impact on the overall function of the fishery or its catch species and the consequence of the MDO spill is therefore minor.	As per 'general'.

SESS – gillnet & shark hook	Surface buoys marking gillnet locations may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of minor consequence to the fishery.	The spill EMBA intersects 8.57% of the total fishery area. Based on 2019-20 data, the EMBA intersects areas of low, moderate and high fishing intensity. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of moderate consequence to the overall function of the fishery or its catch species in the long-term.	As per 'general.'
SESS - Commonwealth trawl sector	Warp wires may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of minor consequence to the fishery.	The spill EMBA intersects 10.47% of the total fishery area.Based on 2019-20 data, the EMBA intersects areas of low, moderate and high fishing intensity. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of minor consequence to the overall function of the fishery or its catch species in the long-term.	As per 'general.'
SESS - scalefish hook sector	The most heavily fished areas of the fishery are located off the east coast of Tasmania, which is outside the EMBA. The area affected by hydrocarbons is among the least intensely fished area for the fishery. This is expected to be of minor consequence to the fishery.	The spill EMBA intersects 5.06% of the total fishery area. Based on 2019-20 data, the EMBA intersects areas subject to fishing. However, the areas of low, medium and high fishing intensity are located outside the EMBA. A temporary closure of the area affected by hydrocarbons may be implemented though this is not expected to have a significant impact on the overall function of the fishery or its catch species and is therefore a minor consequence.	As per 'general.'
Southern bluefin tuna	The most heavily fished areas are north of Eden in NSW and around Kangaroo Island in SA. Both are outside the EMBA. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is	The spill EMBA intersects 1.49% of the total fishery area. Based on 2019-20 data, the EMBA intersects areas of reported catch only. A temporary closure of the area affected by hydrocarbons may be implemented though this is not expected to have a significant impact on the	As per 'general.'

	expected to be of minor consequence to the fishery.	overall function of the fishery or its catch species and is therefore a minor consequence.	
Eastern tuna and billfish fishery	The most heavily fished areas are north of Eden in NSW to Cairns in QLD. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of minor consequence to the fishery.	The spill EMBA intersects 3.39% of the total fishery area. Based on 2019-20 data, the EMBA intersects areas of low intensity fishing effort. A temporary closure of the area affected by hydrocarbons may be implemented though this is not expected to have a significant impact on the overall function of the fishery or its catch species and is therefore a minor consequence.	As per 'general.'
Small pelagic fishery	Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of minor consequence to the fishery.	The spill EMBA intersects 3.91% of the total fishery area. Based on 2019-20 data, the EMBA intersects areas of reported catch only. A temporary closure of the area affected by hydrocarbons may be implemented though this is not expected to have a significant impact on the overall function of the fishery or its catch species and is therefore a **minor** consequence.	As per 'general.'
Victorian Fisheries (those known to fish within the MDO spill EMBA)			
Scallop	No impacts due to their benthic habitat.	The spill EMBA intersects 60.21% of the total fishery area. Hydrocarbons are not expected to accumulate among benthic sediments in areas fished for scallops. Therefore, the consequence to this fishery and its catch species is **minor**.	As per 'general.'
Abalone	No impacts due to their benthic habitat.	The spill EMBA intersects 47.26% of the total fishery area. The most heavily fished areas of the fishery are located off the east coast of Victoria, which is exposed to areas of low exposure entrained hydrocarbons. A temporary closure of the area affected by hydrocarbons may be implemented. This is expected to be of **minor** consequence to the overall function and long-term viability of the fishery or its catch species.	As per 'general'.

Rock lobster	No impacts due to their benthic habitat. There is a low risk of rock lobster pot buoys accumulating hydrocarbons if they are set at the time of a spill. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of **minor** consequence to the fishery.	The spill EMBA intersects 44.9% of the total fishery area. The OSTM indicates the maximum extent of low to high exposure of the benthic layer to entrained hydrocarbons (in 0-10 m water depths) occurs in the nearshore environment along the Colac and Otway coast sections. These waters are likely to be fished for rock lobster where rocky reef is present, which occurs in discontinuous sections parallel to the coastline.Impacts to this fishery may eventuate in the form of a temporary and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. The consequence to this fishery is therefore **moderate**	As per 'general.'
Giant crab	No impacts due to their benthic habitat. There is a low risk of giant crab pot buoys accumulating hydrocarbons if they are set at the time of a spill. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of **minor** consequence to the fishery.	The spill EMBA intersects 44.9% of the total fishery area. Hydrocarbons are not expected to accumulate among benthic sediments in the EMBA due to the significant mixing of waters and dilution of the low concentration of hydrocarbons in the water column. A temporary closure of the area affected by hydrocarbons may be implemented though this is not expected to have a significant impact on the overall function of the fishery or its catch species. Therefore, the short- or long-term consequence to the fishery or its catch species is **minor**.	As per 'general.'
Wrasse	No impacts due to their pelagic habitat.	The spill EMBA intersects 22.86% of the total fishery area.The entrained and dissolved hydrocarbons intersects large areas of the wrasse fishery. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence to the overall function of the fishery or its catch species.	As per 'general'.

Ocean access Ocean purse seine	No impacts due to their pelagic habitat.	This fishery has access to the entire Victorian coastline (except for bays and reserves), so only a part of the available fishing grounds are exposed to high threshold entrained MDO. There are no areas of high exposure to dissolved hydrocarbons. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of **minor** consequence to the overall function of the fishery or its catch species.	As per 'general.'
Inshore trawl	No impacts to fish due to their benthic habitat. Warp wires may accumulate hydrocarbons if they are set at the time of a spill. Vessel hulls may accumulate hydrocarbons if they travel through a slick. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of minor consequence to the fishery.	This fishery has access to the entire Victorian coastline (except for bays and reserves), so only a part of the available fishing grounds are exposed to high threshold entrained and moderate threshold dissolved hydrocarbons. This fishery may be subject to a temporary (e.g., days to a few weeks) and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. This is expected to be of minor consequence to the overall function and long-term viability of the fishery or its catch species.	As per 'general.'
Tasmanian Fisheries (those known to fish within the MDO release EMBA)			
Scalefish	No impacts due to their pelagic habitat.	The spill EMBA intersects 35.65% of the total fishery area. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have a significant impact on the overall function of the fishery or its catch species and the consequence of the MDO spill is therefore **minor**.	As per 'general.'

Giant crab	No impacts due to their benthic habitat. There is a low risk of giant crab pot buoys accumulating hydrocarbons if they are set at the time of a spill. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of **minor** consequence to the fishery.	The spill EMBA intersects 30.58% of the total fishery area. Hydrocarbons are not expected to accumulate among benthic sediments in the EMBA due to the significant mixing of waters and dilution of the low concentration of hydrocarbons in the water column. A temporary closure of the area affected by hydrocarbons may be implemented though this i not expected to have a significant impact on the overall function of the fishery or its catch species. Therefore, the short- or long-term consequence to the fishery or its catch species is **moderate**.s	As per 'general.'
Southern rock lobster	No impacts due to their benthic habitat. There is a low risk of rock lobster pot buoys accumulating hydrocarbons if they are set at the time of a spill. The oiled surfaces may themselves be a source of secondary contamination until they are cleaned. This is expected to be of minor consequence to the fishery.	The spill EMBA intersects 30.58% of the total fishery area. The OSTM indicates the maximum extent of low to high exposure of the benthic layer to entrained hydrocarbons (in 0-10 m water depths) occurs in the nearshore environment along the King Island coast. These waters are likely to be fished for rock lobster where rocky reef is present, which occurs in discontinuous sections parallel to the coastline. Impacts to this fishery may eventuate in the form of a temporary and precautionary exclusion from fishing grounds until water quality monitoring verifies the absence of residual hydrocarbons. The consequence to this fishery is therefore moderate.	As per 'general.'
Octopus	No impacts due to their benthic and pelagic habitat.	The spill EMBA intersects 35.65% of the total fishery area. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have a significant impact on the overall function of the fishery or its catch species and the consequence of the MDO spill is therefore minor.	As per 'general.'

Abalone	No impacts due to their benthic habitat.	The spill EMBA intersects 32.04% of the total fishery area.Hydrocarbons are not expected to accumulate among benthic sediments in the EMBA due to the significant mixing of waters and dilution of the low concentration of hydrocarbons in the water column. A temporary closure of the area affected by hydrocarbons may be implemented though this is not expected to have a significant impact on the overall function of the fishery or its catch species. Therefore, the short- or long-term consequence to the fishery or its catch species is minor.	As per 'general.'
Commercial dive	No impacts due to their benthic habitat.	The spill EMBA intersects 37.47% of the total fishery area. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have a significant impact on the overall function of the fishery or its catch species and the consequence of the MDO spill is therefore minor.	As per 'general.'

7.12.5. Risk Assessment

Table 7.74 presents the risk assessment for an MDO release.

Table 7.74: Risk assessment for an MDO release

Summary			
Summary of risks	Localised and temporary reduction in water quality. Potential toxicity impacts to marine life and avifauna. Temporary closures of fisheries.		
Extent of risks	EMBA is defined in Figure 7.12 to Figure 7.21		
Duration of risks	Short-term (several days, depending on level of contact, location and receptor).		
Level of certainty of risks	HIGH – the environmental impacts of spilled hydrocarbons are well understood.		
Risk decision framework context	B – new to the organisation or geographical area, infrequent or non-standard activity, some uncertainty, some partner interest, may attract media attention.		
Risk Assessment (unmitigated)			
Receptor	Consequence Severity	Likelihood	Risk rating
Benthic fauna	Minor	Remote	Low
Macroalgal communities	Minor	Remote	Low
Plankton	Minor	Remote	Low
Pelagic fish	Minor	Remote	Low
Cetaceans	Minor	Remote	Low
Pinnipeds	Minor	Remote	Low
Marine reptiles	Minor	Remote	Low
Seabirds	Minor	Remote	Low
Shorebirds	Moderate	Remote	Medium
Sandy beaches	Minor	Remote	Low
Rocky shores	Minor	Remote	Low
Commercial fisheries	Moderate	Remote	Medium
Public amenity (beaches, recreational fishing)	Moderate	Remote	Medium
Desalination plant	Moderate	Remote	Medium

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Preventative controls as per 'Displacement of or interference with third-party vessels' and 'Routine emissions – light.' Additional controls are provided here.		
Routine maritime practice		
Preparedness		

No MDO is spilled at sea during refuelling activities.	The vessel contractor Bunkering Procedure is implemented in order to prevent an MDO spill during transfers of MDO between a support vessel and the survey vessel. This will include (but is not limited to): • A JSA and PTW is signed off for each bunkering event, taking into account spill response considerations.	PTW and JSA records for bunkering indicate that spill considerations were taken into account.
	• Ensuring that the dry-break refuelling hose couplings assembly is in order to minimise the risk of a spill and hose floats are installed on the refuelling hose so that a hose leak is quickly and easily visible.	A completed pre-refuelling checklist confirms that dry-break refuelling hose couplings and hose floats are installed on the refuelling hose assembly.
	• Ensuring that communications (visual and/or audio) between the appropriate personnel is tested prior to bunkering commencing.	PTW indicates that communications were tested between both vessels.
	• Ensuring that fuel transfer hoses are replaced in accordance with the PMS or when they are visibly degraded.	Hose register and PMS indicates regular replacement of fuel hoses.
	• The bunkering operation is supervised at all times by trained and competent personnel.	Visual inspection (as noted in completed bunkering checklist) verifies that bunkering was supervised.
	• Ensuring that bunkering only commences during daylight hours and outside shipping lanes.	A completed pre-refuelling checklist confirms that bunkering commenced in daylight hours and in calm sea conditions.
	• Ensuring that tank level indicators and level alarms are provided in the control room for the bunkering tanks.	A completed pre-refuelling checklist confirms that the tank level alarms are functional.

No MDO is spilled at sea as a result of vessel-to- vessel collision.	In order to minimise the risk of vessel-to-vessel collisions, vessels will:
	• Comply with the requirements of:
	  • Navigation Act 2012 (Cth), Chapter 3, Part 3 (Seaworthiness of vessels).
	  • Marine Order 21 (Safety and emergency arrangements).
	  • Marine Order 30 (Prevention of Collisions).
	  • Marine Order 31 (SOLAS and non-
		Vessel audit/assurance reports (prepared or commissioned by ConocoPhillips Australia) verify that vessels contracted to ConocoPhillips Australia meet legislative safety requirements.

	SOLAS certification). • Marine Order 91 (Marine pollution prevention - oil). • Operate navigational lights and communication systems. • Maintain navigational lights and communication systems in accordance with their PMS. • Have trained and competent crew maintaining 24-hour visual, radar and radio watch for other vessels.	
	ConocoPhillips Australia notifies relevant stakeholders ahead of the MSS so that third-party marine users are aware of vessel location and timing.	Stakeholder correspondence and the stakeholder register verify that ConocoPhillips Australia made contact with relevant stakeholders about the timing and location of the MSS.
Vessel crews are prepared to respond to a spill.	The survey vessel has an approved SMPEP (or equivalent appropriate to class for support vessels) that is implemented in the event of a large MDO spill.	Current SMPEPs are available
		Spill incident report verifies that the actions were taken in accordance with the SMPEP.
	The survey vessel crew undertakes quarterly spill response drills (in accordance with the SMPEP and MARPOL (Annex I) requirements).	Survey contractor drill records verify that crews undertake quarterly spill response drills.
	In accordance with the SMPEP, oil spill response kits are available in relevant locations around the vessels, are fully stocked and are used in the event of hydrocarbon or chemical spills to deck.	Inspection/audit confirms that SMPEP kits are readily available on deck.
		Incident reports for hydrocarbon spills to deck record that the spill is cleaned up using SMPEP resources.
Spill response		
ConocoPhillips Australia is well prepared to respond to an MDO spill.	A ConocoPhillips Australia OPEP is in place and tested prior to survey start in a desktop exercise by those nominated in the plans to be part of the response strategies.	The OPEP is current.
		An OPEP training schedule is available and remains live.
		The OPEP training matrix is maintained as a live document and verifies that personnel nominated to assist in emergency response are up to date with their training.
		OPEP exercise report verifies that exercises were undertaken prior to survey start.

	The Vessel Master will authorise actions in accordance with the SMPEP (or equivalent for support vessels) in order to stop or reduce the flow of MDO to the sea.	Daily operations reports verify that the SMPEP was implemented.
Survey-specific controls		
Vessel crews are prepared to respond to a spill.	A desktop MDO spill response exercise is conducted prior to the survey commencing to test the interfaces between the oil spill response strategies.	Oil spill response exercise spreadsheet verifies that exercises have been undertaken.
Vessel crews promptly respond to a spill.	The spill response measures outlined in Chapter 8 are implemented to limit the release of a Level 2 or 3 MDO spill.	Daily operations reports verify that the spill response measures were implemented.
Recording and reporting		
Regulatory authorities are promptly made of aware of an MDO spill.	ConocoPhillips Australia will report an MDO spill to regulatory authorities within 2 hours of the spill or becoming aware of the spill.	Incident report verifies that contact with regulatory agencies was made within 2 hours.
Monitoring		
Characterise environmental impacts of a Level 2 or 3 MDO spill.	ConocoPhillips Australia will undertake operational and scientific monitoring in accordance with the OSMP described in Chapter 8.	Daily operations reports and overall study reports verify that the OSMP was implemented.

Risk Assessment (residual)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Minor	Improbable	Low
Macroalgal communities	Minor	Improbable	Low
Plankton	Minor	Improbable	Low
Pelagic fish	Minor	Improbable	Low
Cetaceans	Minor	Improbable	Low
Pinnipeds	Minor	Improbable	Low
Marine reptiles	Minor	Improbable	Low
Seabirds	Minor	Improbable	Low
Shorebirds	Moderate	Improbable	Low
Sandy beaches	Minor	Improbable	Low
Rocky shores	Minor	Improbable	Low
Commercial fisheries	Minor	Improbable	Low
Public amenity (beaches, recreational fishing)	Moderate	Improbable	Low
Desalination plant	Moderate	Improbable	Low
Demonstration of ALARP			

A 'low' residual risk rating is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the risk to the point that any additional, alternative, or improved control measures fail to lower the risk any further. However, because this hazard has a Decision Context of 'B', an ALARP analysis is presented below.		
Good practice		
Avoid/Eliminate	Vessels are needed to support the MSS, so the use of vessels cannot be avoided. The use of MDO for vessels cannot be eliminated. Substituting MDO for the use of another fuel, such as heavy fuel oil, would have a higher environmental impact than MDO if spilled.	
Change the likelihood	The Vessel master controls access into the exclusion zone, including approach directions and speed. This reduces the likelihood of a vessel- to-vessel collision and the consequence. Other measures in place to reduce the likelihood and consequence of an MDO spill are that vessels are equipped with navigation aids, are equipped with dynamic positioning and are manned by qualified and experienced personnel.	
Change the consequence		
Reduce the risk	Vessel-specific SMPEPs (or equivalent for support vessels) are in place and are implemented. The Sequoia OPEP is implemented in the event of a Level 2 or 3 spill.	
Engineering risk assessment		
The OSTM undertaken for the MDO release scenario is an engineering risk assessment that supports the consequence evaluation, spill response planning and development of the EPS listed in this table. Engineering controls that have been considered to reduce the risk of an MDO spill but not adopted are outlined below.		
Control	Control type	Analysis
Eliminate or substitute the use of MDO in vessels.	Eliminate	The use of MDO as vessel fuel cannot be eliminated. Substituting MDO for the use of another fuel, such as heavy fuel oil, would have a higher environmental impact than MDO if spilled.
Use a smaller survey vessel	Equipment	The market for survey vessels that are suitable for this survey is limited. The vessels must meet certain technical requirements that make them suitable for use.
Keep on-water spill response equipment (beyond SMPEP requirements) available on the survey vessel	Equipment	This option may allow for more rapid on-water response in the event of an MDO spill. There is very limited space available on the survey vessels and most vessels to store the necessary on- water equipment such as booms and skimmers. There are also significant costs (purchase, maintenance and training) for this equipment for both ConocoPhillips Australia and contracted vessel operators. This option does not guarantee a faster oil spill response because it is unlikely that vessel-based personnel will have the same level of on-water oil spill response training as ConocoPhillips Australia and AMSA-trained personnel. Without this training, they are more likely to put themselves and others in harm's way and may not

		respond to the spill itself in the most environmentally appropriate manner. These specialist tasks are best left to trained personnel.
Cost benefit analysis		
Incorporated into the engineering risk assessment above.		
Demonstration of Acceptability		
Criteria	Demonstration	
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.	
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.	
Stakeholder engagement	Through the public exhibition of the EP, some stakeholders have raised concerns about the risk of an MDO spill, with some stating that a large area of Bass Strait and the east coast of Australia could be affected and that King Island's pristine coastline could be impacted. The EIA and controls presented in this section indicates these concerns have been addressed.	

Legislative context	The EPS outlined in this EP align with the requirements of:
	• Navigation Act 2012 (Cth):
	  • Chapter 4 (Prevention of Pollution).
	• OPGGS Act 2006 (Cth):
	  • Section 572A-F (Polluter pays for escape of petroleum).
	• OPGGS(E):
	  • Part 3 (Incidents, reports and records).
	• OPGGS Regulations:
	  • Part 2.3 (Notifying reportable incidents).
	• Protection of the Sea (Prevention of Pollution by Ships) Act 1983 (Cth):
	  • Section 11A (SOPEP).
	  • POWBONS Act 1986 (Vic):
	• Section 10 (Duty to report certain incidents involving oil and oily mixtures).	

Industry practice	The consideration and adoption of the controls outlined in the below- listed codes of practice and guidelines demonstrates that BPEM is being implemented.	
	Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)	The EPS developed for this activity are in line with the management measures listed for spills from vessels in Section 4.7.2 of the guidelines: • Vessels having a SMPEP. • Vessels having radar fitted and maintaining appropriate lighting and navigation systems. • Having safety exclusion zones around facilities.

	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	No guidance is provided regarding preventing or managing an offshore MDO spill, other than having a spill contingency plan in place. An OPEP is in place for the Sequoia MSS.
	Effective planning for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of the EPS for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	The EPS listed in this table meet these guidelines with regard to: • Section 75 (Spills) - conducting a spill risk assessment, implementing personnel training and field exercises, ensuring spill response equipment is available. • Sections 76-79 (Spill response planning) - a spill response plan should be prepared.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	The EPS listed in this table meet these guidelines with regard to: • Section 8.6 (Hazardous materials): Ensuring that vessels carry a SMPEP, that spills are reported to local authorities and that oil spill response drills are conducted at regular intervals. • Section 8.8 (Vessel operations): Vessels must have oil absorbent materials available to respond to spills, and oil spills must be reported to local authorities.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore development and production objectives: • Reduce the risk of any unplanned release of material into the marine environment to ALARP and an acceptable level.
	MNES	

Environmental context	AMPs (Section 5.1.1)	There is a possibility of high exposure surface MDO intersecting the Apollo and Zeehan AMPs, which have the following major conservation values: • Benthic assemblages; • Cetaceans; and • Seabirds. As addressed in the Table 7.58, Table 7.59, Table 7.60 and Table 7.61, the consequence of an MDO spill on these conservation values is minor and not likely to result in long-term ecological impacts. See Appendix 1 for additional detail regarding the impacts of non-routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	There is a 2% probability of low exposure entrained MDO intersecting small portions of the Western Port Ramsar site, 1% probability of low exposure to entrained MDO with the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site and 2% probability of low exposure to entrained MDO at the Lavinia Ramsar site. They key values of these sites include resident and migratory shorebird and seabird populations (Table 7.70), sensitive macroalgal communities (e.g., seagrasses) (Table 7.63) and sandy shorelines (Table 7.71). Exposure at the low exposure level, there is unlikely to be any ecological impacts to the values and sensitivities of these Ramsar sites.
	TECs (Section 5.1.6)	The MDO EMBA does not intersect any TECs.
	NIWs (Section 5.1.8)	The MDO EMBA (entrained phase hydrocarbons) is predicted to intersect the following NIWs:

		• Lavinia Nature Reserve; • Western Port; • Powlett River Mouth; • Anderson Inlet; • Mud Islands; • Lake Connewarre State Wildlife Reserve; • Lower Aire River Wetlands; • Tamboon Inlet; • Thurra River; • Sydenham Inlet Wetlands; • Mallacoota Inlet Wetlands; and • Nadgee Lake and tributary wetlands. Low threshold entrained hydrocarbons are not predicted to have toxicological impacts on the waterbird populations and flora species at these sites.
	Nationally threatened and migratory species (Section 5.5)	Some nationally threatened species and migratory species have the potential to be present in the MDO spill EMBA, but as evaluated in the previous tables in this section, the consequences to individuals or populations of threatened and migratory species are **minor**.
	Other matters	
	State marine parks (Section 5.1.9, 5.1.10 and 5.1.11)	The MDO EMBA intersects the following state marine parks: • Twelve Apostles MNP; • Marengo Reefs MS; • Eagle Rock MS; • Point Addis MNP; • Point Danger MS; • Barwon Bluff MS; • Port Phillip Heads MNP; • Mushroom Reef MS; • Churchill Island MNP; • Bunurong MP/MNP; • Wilsons Promontory MP/MNP; • Beware Reef MS; • Cape Howe MNP; and • Point Hicks MNP. See **Appendix 1** for additional detail regarding the impacts of non-routine activities on the management aims of these state marine parks. Consequences to these parks from an MDO spill are all **minor**.

	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	Marine pollution is a threat identified for albatross and giant-petrels in the National recovery plan for threatened albatross and giant petrels 2011-2016 (DSEWPC, 2011a). Population monitoring is the suggested action to deal with marine pollution. The conservation advice and management plans for blue, humpback, sei and fin whales identify hydrocarbon spill as threats, though there are no specific aims to address this. See Appendix 2 for additional detail regarding the impacts of non-routine activities on the management aims of threatened species plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• As per the OPEP and OSMP.		
Record Keeping		
• Vessel assurance reports. • SMPEP (and equivalent for support vessels). • ERP. • Crew training records. • Oil spill response exercise records.	• Bunkering procedure. • Bunkering PTWs, JSAs, inspection checklists. • Incident reports.	

7.13. RISK 6 - Oil Spill Response Activities

This section assesses the environmental and socio-economic risks associated with potential response strategies that may be implemented in the event of an MDO spill. Implementation in the field is dependent on advice from AMSA, the Control Agency for the area involved. Not all oil spill response options are appropriate for every spill type – responses vary based on key factors such as hydrocarbon type (light oil, heavy oil, refined oil), volume, location, sea state and trajectory. Undertaking spill response activities typically involves additional vessels, equipment, materials and personnel which introduce new risks, and increases the likelihood of risks and scale of impacts already assessed in this EP.

Table 7.75: Sequoia 3DMSS MDO spill response options summarises the possible response strategies to a Level 2 or 3 MDO spill, and confirms whether or not they will be adopted based on an assessment of feasibility and effectiveness and strategic (pre-spill) NEBA. The objective of a strategic NEBA is to identify response strategies that will result in the lowest impact and maximum protection or recovery of the resources at risk within the EMBA, acknowledging that some response and clean-up activities may result in a negative impact compared to natural weathering or other strategies. Only those response strategies that are determined to be feasibility and effective are risk assessed in this section.

Table 7.75: Sequoia 3DMSS MDO spill response options

Response option	Effectiveness and feasibility analysis	Adopt?
Source control	Effectiveness Implementing the vessel-specific SMPEP is the preferred manned in which to control an MDO release (e.g., transfer MDO from the ruptured tank to an intact tank, where possible). Feasibility This response strategy is effective based on the assumption that the vessel is not damaged to the point where electronic and hydraulic systems fail.	**Yes.** Reduction in released volume has direct environmental benefit.
Monitor and Evaluate	Effectiveness MDO evaporates and disperses rapidly. MDO will be visible on the sea surface using satellite monitoring, vessel and aerial based observations. Feasibility Monitoring is a fundamental part of any hydrocarbon spill response to gain situational awareness of the nature and scale of the spill and the direction of movement. Trained personnel at AMSA and within the oil and gas industry (via AMOSC) are readily available to undertake this monitoring.	**Yes.** Predicting and monitoring spill trajectory has a fundamental benefit to situational awareness of the nature and scale of the spill.
Assisted Natural Dispersion	Effectiveness The use of motorised vessels to break up slicks using propeller wash creates an inherent safety risk because of the presence of an ignition source (MDO is highly volatile). Feasibility Mechanical dispersion could be undertaken in slightly weathered MDO once the volatiles have flashed off to disperse the MDO into the water column to create smaller droplets and enhance biodegradation (only if monitoring indicates the slick is moving to sensitive shorelines). The support vessels are able to undertake this task.	**Yes.** There is a direct net environmental benefit, particularly where the spill is headed towards sensitive receptors.
Chemical Dispersants	Effectiveness Although the use of dispersants is 'conditional' for Group II oil such as MDO, the potential spill volume and the natural tendency of spreading into very thin films is evidence that dispersant application will be an ineffective response. Dispersant droplets will penetrate through the thin oil layer and cause	**No.** Dispersants will have a net negative effect on the environment.

Response option	Effectiveness and feasibility analysis	Adopt?
	'herding' of the oil, which creates areas of clear water and could be mistaken for successful dispersion. Feasibility Dispersant use will have a net negative effect on the environment. Dispersants push the MDO into the water column, creating longer lasting impacts in the water column than allowing the MDO to weather naturally from the sea surface.	
Offshore Containment and Recovery	Effectiveness The high volatility of MDO creates inherent safety risks when attempting to contain and recover it mechanically. This response technique is dependent on adequate MDO thickness (generally >10 g/m2), calm seas and significant areas of unbroken surface slicks. Due to the low viscosity of MDO, the ability to contain and recover it is extremely limited. MDO evaporates faster than the collection rate of a thin surface film present. It spreads in less time than is required to deploy this equipment. Feasibility There is recoverable MDO (>10 g/m2) at the sea surface for this spill scenario, however it is unlikely to be effective because the areas of high MDO concentration would weather in less time than is required to deploy response equipment.	**No.** MDO spreads too thinly and quickly for this to be an effective response.
Protection and Deflection	Effectiveness Oceanic environments such as Bass Strait and the Otway region often do not present suitable conditions for the use of booming material (i.e., swell and waves deem this strategy ineffective). Feasibility A shoreline protection and deflection response is not feasible for this activity because: • Rocky shorelines present a high safety risk for response personnel in terms of access. • MDO stranded on rocky substrate will weather rapidly due to the action of waves against the rocks. • Shoreline loading is predicted only at the low threshold, which will not result in toxicity impacts to fauna at the shoreline. Environmental impacts are likely to be higher when implementing this response technique compared to	**No.** Potentially affected shorelines are mostly 'self-cleaning' and open ocean areas limit the effectiveness of this response.

Response option	Effectiveness and feasibility analysis	Adopt?
	allowing for natural degradation.	
Shoreline clean-up	<u>Effectiveness</u> This quick infiltration through sediments makes it very difficult to recover without also recovering vast amounts of shoreline sediments. <u>Feasibility</u> A shoreline clean-up response is not feasible for this activity because: Rocky shorelines present a high safety risk for response personnel in terms of access. • MDO stranded on rocky substrate will weather rapidly due to the action of waves against the rocks. • There is a very limited and remote length of shoreline predicted to be impacted by actionable MDO exposure thresholds in the event of an MDO spill. The maximum length of shoreline contact at the actionable threshold is 8.4 km. Environmental impacts are likely to be higher when implementing this response technique compared to the natural degradation.	**No.** MDO is highly volatile and will evaporate rapidly even after making shoreline contact. Potentially affected shorelines are mostly 'self-cleaning'. MDO also quickly infiltrates sand, where it is then remobilised by wave action (reworking) until it has naturally degraded.
Oiled Wildlife Response (OWR)	<u>Effectiveness</u> Because MDO evaporates and disperses rapidly, most fauna is unlikely to be exposed to sub-lethal or lethal hydrocarbon concentrations that warrant wildlife capture and treatment, especially at the sea surface. <u>Feasibility</u> The close proximity of the Phillip Island wildlife rescue centre to the affected shoreline makes an OWR response feasible. Hazing may be considered to disperse animals away from a slick (such as seabirds, shorebird, seals and dolphins) or any shoreline areas where MDO has not infiltrated beach sediments. Only DELWP, DPIPWE or AMSA officers (or those authorised by these agencies) are permitted to handle and treat oiled wildlife. This may limit the effectiveness and feasibility of this response in terms of the number of responders and therefore the number of affected fauna that could be treated.	**No.** More harm to wildlife could occur during the handling and treatment process than allowing for natural cleaning.

Based on Table 7.75, effective and feasible strategies that are expected to result in the low impact and high protection or recovery of resources at risk, that may be used to respond to a hydrocarbon spill during survey operations include:

- Source control;
- Monitor and evaluate; and

- Assisted natural dispersion.

7.13.1. Scope of Activity

Source Control

In the event of a vessel-based MDO release, the key method of source control is outlined in the vessel-specific SMPEP (or equivalent based on class). The key response measures typically involve:

- Moving further out to sea (away from shoreline sensitivities) if the vessel is still able to navigate; and
- Transferring MDO from the affected tank/s to non-affected tanks.

Monitor and Evaluate

Ongoing monitoring and evaluation of a hydrocarbon spill is critical for maintaining situational awareness and to complement and support the other response activities. In some situations, monitoring may be the primary response strategy if natural dispersion and weathering processes are effective in reducing the volume of hydrocarbons reaching sensitive receptors (as is likely to be the case in this scenario).

Operational monitoring includes the following:
Aerial observation (primarily by helicopter);

- Vessel-based observation;
- OSTM (computer-based and/or manual vector analysis); and
- Foot access along shorelines potentially at risk of contact (based on real-time OSTM).

Assisted Natural Dispersion

Assisted natural dispersion involves the use of motorised vessels to break up hydrocarbon slicks using propeller wash; essentially navigating a vessel in whatever pattern maximises travel through the slick to create smaller droplets and enhance biodegradation in the water column.

This activity is generally only necessary if monitoring indicates the slick is moving to sensitive shorelines.

7.13.2. Availability

Monitor and Evaluate

ConocoPhillips Australia (through its membership with AMOSC), the DJPR (Emergency Management Branch, EMB) and DPIPWE (EPA Tasmania) maintain operational monitoring capability as outlined in Table 7.76: Resources available for monitoring and evaluation.

Table 7.76: Resources available for monitoring and evaluation

Resource required	ConocoPhillips Australia resources	DJPR (EMB) resources	DPIPWE (EPA Tasmania resources)
Aviation	ConocoPhillips Australia will activate its contract with AMOSC to access helicopter and/or fixed aircraft to assist in spill monitoring.	Access to Emergency Management Victoria's (EMV's) State Aircraft Unit. Air support can be mobilised within 4 hours of request. Additionally, NatPlan resources can be activated.	A Memorandum of Understanding between the Tasmanian Fire Service (TFS) and EPA Tasmania details the agreement between parties and the response arrangements. Briefly, in addition to

Trained observers	ConocoPhillips Australia can request the assistance of AMOSC's Core Group personnel (>120 oil and gas industry personnel nation-wide) who are available 24/7 to respond to marine oil spills.	EMV's State Response Team (SRT) or AMSA Search and Rescue resources can be called upon but is unlikely to be required given the AMOSC resources available. These resources are available within 4 hours of request. The SRT has 10 State Emergency Service (SES) volunteers and one DEDJTR staff member that are trained in oil on water observation.	Control Agency roles, TFS will provide aircraft and aerial tactical response requirements including air attack supervisors for aerial dispersant application, air observers and aircraft staging areas in support of a marine incident
Vessel-based observations	Vessels of opportunity (VoO) based in ports nearest to the survey area would be engaged as required. VoO from ports slightly further afield, such as Geelong and Barry Beach would also be considered.		
OSTM	ConocoPhillips Australia will activate its contract with AMOSC to access 24/7 emergency OSTM. OSTM results can generally be provided within 4 hours of request.	Available via AMSA upon request, who are likely to contract RPS.	

Assisted Natural Dispersion

The same VoO outlined under 'monitor and evaluate' would be used to implement assisted natural dispersion.

7.13.3. Hazards

The hazards associated with each of the adopted response options are:

- Additional vessel activity (over a greater area than the operational area), resulting in additional routine emissions (air, noise) and routine discharges (sewage, putrescible waste, cooling water, etc); and
- Sound generated by helicopters. (Section 7.1)

7.13.4. Impacts and Risks of the Response Activities

The impacts and risks associated with the adopted response options are:

- Routine and non-routine impacts and risks associated with vessel operations (as outlined throughout this chapter); and
- Noise disturbance to marine fauna and shoreline species by aerial flights. (Section 7.1)

7.13.5. Evaluation of Environmental Impacts and Risks

Monitor and Evaluate

The impacts and risks associated with routine and non-routine vessel and helicopter activities are described and assessed throughout this chapter and are not repeated here. Foot access to beaches is not addressed in the EP and is therefore evaluated below.

Damage to shoreline habitat (such as sand dunes providing shorebird nesting habitat) may be caused if personnel veer from formed tracks. The noise, light and general disturbance created by shoreline monitoring activities (likely to involve foot traffic only, rather than vehicle traffic), may disturb the feeding, breeding, nesting or resting activities of resident and migratory fauna species that may be present. This is particularly the case for beach-nesting shorebirds, which may be present along some shorelines of the EMBA. Any erosion caused by responder access to sandy beaches, may also bury nests. In isolated instances, this is unlikely to have impacts at the population level.

The presence of stranded hydrocarbons may necessitate temporary beach closures (expected to be in the order of days, depending on the degree of oiling). This means recreational activities (such as swimming, walking, fishing) in affected areas will be excluded until access is again granted by the local government authority. However, given the remoteness of most of the islands potentially impacted by shoreline loading, this is likely to represent a minor impact to residents and tourists.

Assisted Natural Dispersion

The impacts and risks associated with routine and non-routine vessel activities are described and assessed throughout this chapter and are not repeated here.

7.13.6. Environmental Impact and Risk Assessment

Table 7.77: Risk assessment for hydrocarbon spill response activities presents the risk assessment for hydrocarbon spill response activities

Table 7.77: Risk assessment for hydrocarbon spill response activities

Summary			
Summary of risks	Increased risk of disturbance to marine and shoreline.		
Extent of risk	Localised – area immediately around vessel or aircraft.		
Duration of risk	Short-term (days to a week).		
Level of certainty of risk	HIGH – the impacts associated with vessel discharges and noise disturbance to fauna from vessels and helicopters are well understood, and controls are documented in legislation.		
Risk decision framework context	B – new to the organisation or geographical area, infrequent or non-standard activity, some uncertainty, some partner interest, may attract media attention.		
Risk Assessment (unmitigated)			
Receptor	Consequence Severity	Likelihood	Risk rating
Fauna disturbance	Negligible	Rare	Low
Fauna injury	Minor	Rare	Medium
Fauna death	Minor	Remote	Low
Environmental Controls and Performance Measurement			
EPO	EPS	Measurement criteria	
Survey-specific controls			
Preparedness			

Source control ConocoPhillips Australia and its vessel contractors are operationally ready to respond to a spill.	Vessels contracted to ConocoPhillips Australia activities have a current SMPEP (or as appropriate to class) in place.	Inspection/audit records verify current SMPEPs in place.
Monitor and evaluate ConocoPhillips Australia maintains capability to implement hydrocarbon spill monitoring and	Access to operational response capabilities is maintained through the survey vessel paying the required shipping levy and ConocoPhillips maintaining a current contract with AMOSC.	Survey vessel pays required shipping levy. Contract with AMOSC is available and current.
	AMSA undertakes regular testing of response arrangements and	AMSA response capabilities are maintained in a manner that
	equipment to ensure it is always ready to respond rapidly.	permits them to respond to spills rapidly (noted in annual reports).
	ConocoPhillips Australia undertakes a desktop drill prior to the survey commencing in order to test internal and external spill response communications and competencies.	Exercise drill report is available.
Response		
Source control The source of the release is stopped in the shortest time possible in accordance with established procedures.	MDO loss is managed through implementation of the vessel SMPEP (or equivalent according to class).	Incident logs verify that the SMPEP is implemented.
Monitor and evaluate Undertake visual observations to monitor spill behaviour and determine whether it is likely to reach sensitive receptors.	Visual observations from the support vessels are initiated immediately.	Incident report verifies that visual observations commenced immediately following a spill.
	The NatPlan is activated so that AMSA can commence undertaking monitoring activities.	Incident communications log verifies that AMSA was notified and asked to activate the NatPlan.

The trajectory of the spill is predicted based on the spill location in order to inform response strategies.	OSTM is undertaken in accordance with NatPlan requirements.	Incident records verify OSTM was undertaken.
Activity controls		
Monitor and evaluate Monitoring activities are undertaken in a manner that protects sensitive fauna and habitat.	Helicopters and other aircraft will maintain a buffer distances of 500 m around cetaceans in accordance with EPBC Regulations 2000 (Part 8).	Flight instructions document these constraints.
	Vessels will maintain buffer distances around whales and dolphins in accordance with The Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017) for those individuals not visibly affected by hydrocarbons (closer approaches may be necessary to determine impacts).	Incident reports note when cetaceans were sighted and what actions were undertaken.
	Environmental briefings are conducted for shoreline monitoring crews to identify site-specific risks and suitable controls.	Briefing records are available.

Risk Assessment (residual)			
Receptor	Consequence Severity	Likelihood	Risk rating
Fauna disturbance	Negligible	Remote	Low
Fauna injury	Minor	Remote	Low
Fauna death	Minor	Improbable	Low

Demonstration of ALARP	
A 'low' residual risk rating is considered to be ALARP and a 'lower order' impact. The routine maritime practices and survey-specific controls already in place have lowered the risk to the point that any additional, alternative, or improved control measures fail to lower the risk any further. However, because this hazard has a Decision Context of 'B', an ALARP analysis is presented below. Table 7.69 provides a guide as to the suitability of response techniques for MDO spills, including in the context of the OSTM undertaken for the MSS. This should be taken into account in this demonstration of ALARP.	
Good practice	
Avoid/Eliminate	Oil spill response activities will only be undertaken if the operational NEBA demonstrates that the net benefit of the response is greater than allowing the hydrocarbons to weather naturally.

Change the likelihood	The NatPlan will be used to guide the spill response activities. The use of trained AMSA, AMOSC and ConocoPhillips Australia personnel to monitor and respond to the spill reduces the likelihood and consequence of a poor response being implemented and creating more environmental damage than it prevents. This reduces the likelihood and consequence of additional environmental damage resulting from the response activities.
Change the consequence	
Reduce the risk	A pre-survey desktop emergency response exercise will be undertaken to ensure ConocoPhillips Australia and the survey contractor are aware of spill response risks and the measures in place to respond to a spill. This exercise reduces the risks associated with poor preparedness. ConocoPhillips Australia will have a emergancy response team competent in responding to incidents. ConocoPhillips Australia's contract with AMOSC reduces the risk of delays in instigating response measures (over and beyond those of AMSA).
Engineering risk assessment	
The OSTM undertaken for the MDO spill scenario is an engineering risk assessment (consequence modelling) and supports the development of the EPS listed in this table. The engineering control measures considered but not adopted because of the negative cost/benefit analysis are described below: • Use of autonomous underwater vehicles (AUV) – AUVs may be able to provide additional detail on hydrocarbons in the water column, but this does not assist with spill response options on the sea surface or at the shoreline. There are no practical means for removing hydrocarbons in the water column. • Night-time infrared monitoring – side looking airborne radar systems are required to be installed on specific aircraft or vessels. The costs of sourcing such vessels/aircraft is approximately $20,000 per day. Infrared may be used to provide aerial monitoring at night, however the benefit is minimal given trajectory monitoring (and infield monitoring during daylight hours) will provide good operational awareness. In addition to this, satellite imagery may be used at night to provide additional operational awareness.	
Cost benefit analysis	
Not applicable for an impact decision framework context of 'B'.	
Demonstration of Acceptability	
Criteria	Demonstration
Policy compliance	ConocoPhillips Australia HSE Policy objectives are met through implementation of this EP.
Management system compliance	Chapter 8 describes the EP implementation strategy employed for this activity.
Stakeholder engagement	Stakeholders have not raised concerns about hydrocarbon spill response activities.

<table>
<tr><td>Legislative context</td><td colspan="2">The EPS outlined in this EP align with the requirements of:
• OPGGS Act 2006 (Cth) and OPGGS(E);
• EPBC Regulations 2000;
• Flora and Fauna Guarantee Act 1988 (Vic);
• Wildlife Act 1975 (Vic);
• Emergency Management Act 2013 (Vic);
• Pollution of Waters by Oil and Noxious Substances Act 1987;
• Environmental Management and Pollution Control Act 1994; and
• Emergency Management Act 2006.</td></tr>
<tr><td rowspan="6">Industry practice</td><td colspan="2">The consideration and adoption of the controls outlined in the below-listed codes of practice and guidelines demonstrates that BPEM is being implemented.</td></tr>
<tr><td>Environmental management in the upstream oil and gas industry (IOGP-IPIECA, 2020)</td><td>The EPS listed in this table meet the relevant mitigation measures listed for offshore activities with regard to:
• Emergency preparedness and response – spill preparedness and emergency response measures are in place.</td></tr>
<tr><td>Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)</td><td>No guidance is provided regarding oil spill response activities, other than having a spill contingency plan in place.</td></tr>
<tr><td>Effective planning for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)</td><td>The four practices outlined in this document (see Section 3.7.4) have been considered (and adopted where practicable) in the development of the EPS for this EP and the survey design in general.</td></tr>
<tr><td>Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)</td><td>Guidelines met with regard to:
• Sections 76-79 (Spill response planning): A spill response plan should be prepared.</td></tr>
<tr><td>Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)</td><td>The EPS listed in this table meet these guidelines with regard to:
• Section 8.6 (Hazardous materials): Ensuring that vessels carry a SMPEP, that spills are reported to local authorities and that oil spill response drills are conducted at regular intervals.</td></tr>
</table>

		• Section 8.8 (Vessel operations): Vessels must have oil absorbent materials available to respond to spills, and oil spills must be reported to local authorities.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore development and production objectives: • To reduce the risk of any unplanned release of material into the marine environment to ALARP and to an acceptable level.
	Hydrocarbon spill-specific guidelines	
	NatPlan (AMSA, 2020).	AMSA will implement this plan in the event their resources are deployed. The EPS listed in this table complement the NatPlan.
	AMOSPlan (2017)	AMOSC will implement this plan in the event their resources are deployed. The EPS listed in this table complement AMOSPlan.
	Maritime Emergencies Plan NSR (EMV, 2016).	DJPR (EMB) will implement this plan in the event their resources are deployed. The EPS listed in this table complement the Marine Emergencies Plan NSR.
	Tasmanian Marine Oil and Chemical Spill Contingency Plan (TasPlan) (EPA Tasmania, 2019)	DPIPWE will implement this plan in the event their resources are deployed. The EPS listed in this table complement the TasPlan.
	Contingency planning for oil spills on water – Good practice guidelines for incident management and emergency response personnel (IPIECA/IOGP, 2015).	The EPS listed in this table are prepared cognisant of these guidelines, which discuss oil spill scenarios, various response techniques and the requirements for contingency plan preparation.
	Oil spill training - Good practice guidelines on the development of training programmes for incident management and emergency response personnel (IPIECA/IOGP, 2014).	The EPS listed in this table are prepared cognisant of these guidelines, in so far as training of ConocoPhillips Australia and contractor personnel in oil spill preparedness and response takes place and is overseen by an emergency response specialist.

	Aerial Observations of Marine Oil Spills (ITOPF, 2011b).	The EPS listed in this table related to monitoring were prepared cognisant of these guidelines, which describe monitoring techniques and outline the importance of monitoring in guiding on-water and shoreline response activities.
	Aerial Observations of Oil Spills at Sea (IPIECA/OGP, 2015).	
	In-water surveillance of oil spills at sea – Good practice guidelines for incident management and emergency response personnel (IPIECA/IOGP, 2016).	The EPS listed in this table are prepared cognisant of these guidelines, which indicate how specialised in-water oil surveillance is. ConocoPhillips Australia has rightfully deferred this task to the experts (such as AMOSC and AMSA) and will cover the cost of their work.
	Dispersants: surface application – Good practice guidelines for incident management and emergency response personnel (IPIECA/IOGP, 2016).	The EPS listed in this table are prepared cognisant of these guidelines, which discuss application methods, the limitations of dispersants and indicate that dispersant application is best suited to crude oils (not refined MDO, which is best left to weather naturally).
	Use of dispersants to treat oil spill – technical information paper 4 (ITOPF, 2011).	
	A guide to oiled shoreline assessment (SCAT) surveys (IPIECA/OGP, 2014).	The EPS listed in this table are prepared cognisant of these guidelines, which describe how shoreline assessments should be conducted and what information should be recorded in order to inform shoreline responses.
	Use of booms in oil pollution response –	This guideline has been used to inform the effectiveness and feasibility analysis for booming to determine the appropriateness of
	technical information paper 3(ITOPF, 2011).	this technique taking into consideration the hydrocarbon types and nature of the receiving environment.

	Clean-up of oil from shorelines – technical information paper 7 (ITOPF, 2011).	The EPS listed in this table are prepared cognisant of these guidelines, which describe various shoreline clean-up techniques and the response strategies most suitable for different shoreline types.
	Wildlife response preparedness – Good practice guidelines for incident management and emergency response personnel (IPIECA/IOGP, 2014).	The EPS listed in this table are prepared cognisant of these guidelines, which indicate how specialised OWR is. ConocoPhillips Australia has rightfully deferred this task to the experts (DELWP, DPIPWE, AMOSC personnel and/or Phillip Island Nature Park wildlife clinic oiled wildlife responders), and will cover the cost of their work.
	Key principles for the protection, care and rehabilitation of oiled wildlife (IPIECA/IOGP, 2017).	
	MNES	
	AMPs (Section 5.1.1)	Oil and chemical spills are a threat identified in the South-east Commonwealth Marine Reserve Network Management Plan 2013-2023. Spill response will not be undertaken in AMPs given that actionable surface oiling is not predicted. Vessel or aircraft-based monitoring activities will have no significant impacts on AMPs. See Appendix 1 for additional detail regarding the impacts of non-routine activities on the management aims of these AMPs.
	Wetlands of international importance (Section 5.1.4)	Spill response will not be undertaken in Ramsar wetlands given that surface oiling is not predicted. Vessel or aircraft-based monitoring activities will have no impacts on AMPs.
	TECs (Section 5.1.6)	Spill response will not be undertaken in areas where TECs exist. Vessel or aircraft-based monitoring activities will have no impacts on TECs.
	NIWs (Section 5.1.8)	Spill response will not be undertaken in NIWs given that surface oiling is not predicted. Vessel or aircraft-based monitoring activities will have no impacts on NIWs.

	Nationally threatened and migratory species (Section 5.5)	Some threatened and migratory species have the potential to be present in spill response areas, but given that the key response strategy is centred on monitoring and surveillance because of the volatile nature of the
		hydrocarbons, vessel or aircraft-based monitoring activities will have no significant impacts on threatened and migratory species.
	Other matters	
	State marine parks (Sections 5.1.9, 5.1.10 and 5.1.11)	Many of the Victorian marine and coastal reserve management plans list the protection of marine and terrestrial ecological communities and indigenous flora and fauna, particularly threatened species, as a management aim. Spill response may be undertaken in coastal marine parks given that shoreline loading is predicted to contact some parks. Land, vessel or aircraft-based monitoring activities will have no significant impacts on these marine parks or the management objectives of the parks' management plans. See Appendix 1 for additional detail regarding the impacts of routine activities on the management aims of state marine parks.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	• Marine pollution is a threat identified for albatross and giant-petrels in the National recovery plan for threatened albatross and giant petrels 2011-2016 (DSEWPC, 2011a). Population monitoring is the suggested action to deal with marine pollution. The risks posed by response operations do not impact this action. • The conservation advice and management plans for blue, humpback, sei and fin whales identify hydrocarbon spill as threats, though there are no specific aims to address this. • Oil spills and crushing or disturbance of eggs, chicks and nesting birds by human activities are identified as threats in the Conservation Advice for the Hooded Plover (DoE, 2014) and Conservation Advice for the Fairy Tern (DSEWPC. 2011b). Ensuring this threat is not exacerbated by shoreline clean-up activities has been addressed within the controls listed in this table.

		See Appendix 2 for additional detail regarding the impacts of non-routine activities on the management aims of threatened species plans. Aerial or vessel-based observations will not conflict with the management objectives of these plans.
ESD principles	The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).	
Environmental Monitoring		
• As per NatPlan requirements.		
Record Keeping		
• Contracts and agreements with third parties. • Equipment and service provider register. • Exercise drill reports. • Inspection/audit reports. • Incident and daily operations reports. • IAP.	• Operational NEBA. • Briefing records. • Photos. • OSMP implementation records and reports. • Oiled wildlife responder licence records. • Stakeholder notifications	

8. Implementation of Strategy

This section details the implementation strategy for the activity, as required under Regulation 14 of the OPGGS(E). The implementation strategy describes the arrangements for monitoring, review and reporting of environmental performance and the strategy to confirm that the Environmental Performance Standards (EPS) are implemented, maintained and effective for the in-force period of the Environment Plan (EP). This will allow environmental impacts and risks to be continually managed to a level that is ALARP and acceptable.

The implementation strategy includes roles, responsibilities, training and competency requirements for all personnel involved in the survey with relation to:

- Implementing controls;
- Managing non-conformance;
- Emergency response; and
- Meeting monitoring, auditing, and government reporting requirements.

The Sequoia 3DMSS will be conducted under the framework of the ConocoPhillips Health, Safety and Environment (HSE) Policy and the HSE Management System Standard. The survey will be supported by a bridging document linking ConocoPhillips and the survey contractor for the operation of the survey and support vessels.

The contractor will be required to have systems and procedures that align with the ConocoPhillips HSE Policy and the HSE Management System (HSEMS) Standard to ensure the survey's EPS are achieved.

8.1. ConocoPhillips Health, Safety and Environmental Management System Standard

The ConocoPhillips HSEMS Standard is a systematic process to identify, assess and manage the operational risks to the business, employees, contractors, stakeholders and environment. The routine application of a HSEMS provides on-going identification, prioritisation and control of these risks.

The ConocoPhillips HSEMS Standard establishes a risk-based, risk-appropriate, continuous improvement process for the implementation of the HSE Policy, leadership expectations and ConocoPhillips' values (Safety, People, Integrity, Responsibility, Innovation and Teamwork, also known as 'SPIRIT'). The SPIRIT values are presented in Figure 8.1

Figure 8.1: ConocoPhillips SPIRIT Values

The HSEMS is implemented through a hierarchy of policies and procedures that cascade from the corporate level through to the individual operating assets. The system has four distinct phases and 15 interrelated elements, as shown in Figure 8.2 and Table 8.1, with each phase of the process building on the previous phases:

- **PLAN:** identifies the hazards, risks, regulatory requirements and risk mitigation necessary for HSE effectiveness. The elements in this step also establish strategic plans, goals, and objectives.
- **DO:** describes the specific implementation tools needed to manage the risks and requirements identified in the PLAN phase.
- **ASSESS:** describes detailed monitoring and auditing to ensure that risks and requirements are being identified, assessed, and managed.
- **ADJUST:** requires review of the HSEMS, its implementation, and effectiveness to identify strengths, gaps, and opportunities for continuous improvement.

The 15 individual elements and their how they are implemented activity are described in Section 8.2 to Section 8.16.

Figure 8.2: Overview of ConocoPhillips HSEMS Phases and Elements

Table 8.1: ConocoPhillips HSEMS Elements

Element			
1	Policy and Leadership	9	Awareness, Training and Competency
2	Risk Assessment	10	Non-Conformance, Incident, Near Miss Investigation and Corrective Action
3	Legal Requirements and Standards of Operation	11	Communication
4	Strategic Planning, Goals and Objectives	12	Document Control and Records Management
5	Structure and Responsibility	13	Measuring and Monitoring
6	Programs and Procedures	14	Audits
7	Asset and Operating Integrity	15	Review
8	Emergency Preparedness		

8.2. Element 1: Policy and Leadership

This element defines expectations for the ConocoPhillips HSE policy and leadership requirements for supporting a strong HSE culture, ensuring compliance with HSE requirements and driving HSE excellence.

The ConocoPhillips HSE Policy, as presented in Figure 3.1, establishes the expectations, principles of operation and desired outcomes for the company and its subsidiaries. The policy is distributed to all company facilities and contracted parties and is displayed prominently at work sites. Inductions to the Sequoia 3DMSS will include presentation of the ConocoPhillips HSE Policy.

8.3. Element 2: Risk Assessment

This element defines the HSE risk management requirements for ConocoPhillips Australia and the activity.

ConocoPhillips Australia seeks to maintain the health and safety of its employees and minimise environmental impact through the active and progressive elimination of hazards and the reduction of risk in the workplace. This objective is achieved for the Sequoia 3DMSS through a systematic and integrated approach to risk management to reduce risks to a level that is ALARP and acceptable.

Chapter 6 illustrates the environmental risk assessment process for this activity. Chapter 7 provides the environmental risk assessment that was undertaken for this EP.

8.4. Element 3: Legal Requirements and Standards of Operation

This element establishes requirements for ConocoPhillips to maintain a process to monitor changing laws and regulations, to monitor changing site activities, and to assign responsibilities to help ensure compliance with legal requirements (e.g., laws, regulations, permits or project approvals and commitments made in permit applications) and standards of operation (e.g., relevant industry standards and/or design codes) applicable to the activity.

Chapter 3 of this EP details the key environmental legislation applicable to the activity. The acceptability discussion for each hazard assessed in Chapter 7 specifically details the legislation pertaining to each hazard. A Management of Change process will be used as per the description in Section 8.13.1.

8.5. Element 4: Strategic Planning, Goals and Objectives

This element establishes the requirements associated with HSE planning and goal setting. Planning at ConocoPhillips cascades from the Corporate level to individual functions, including HSE, Governance and Capital Projects.

The Sequoia 3DMSS HSE planning process will include the development and implementation of plans that area developed, resourced, communicated and measured to contribute to continuous HSE improvement and the reduction of HSE risk. These plans will be developed through consultation with both ConocoPhillips Australia and the survey contractor.

8.6. Element 5: Structure and Responsibility

This element establishes requirements to define and manage roles, responsibilities, accountabilities, employee engagement and interrelationships.

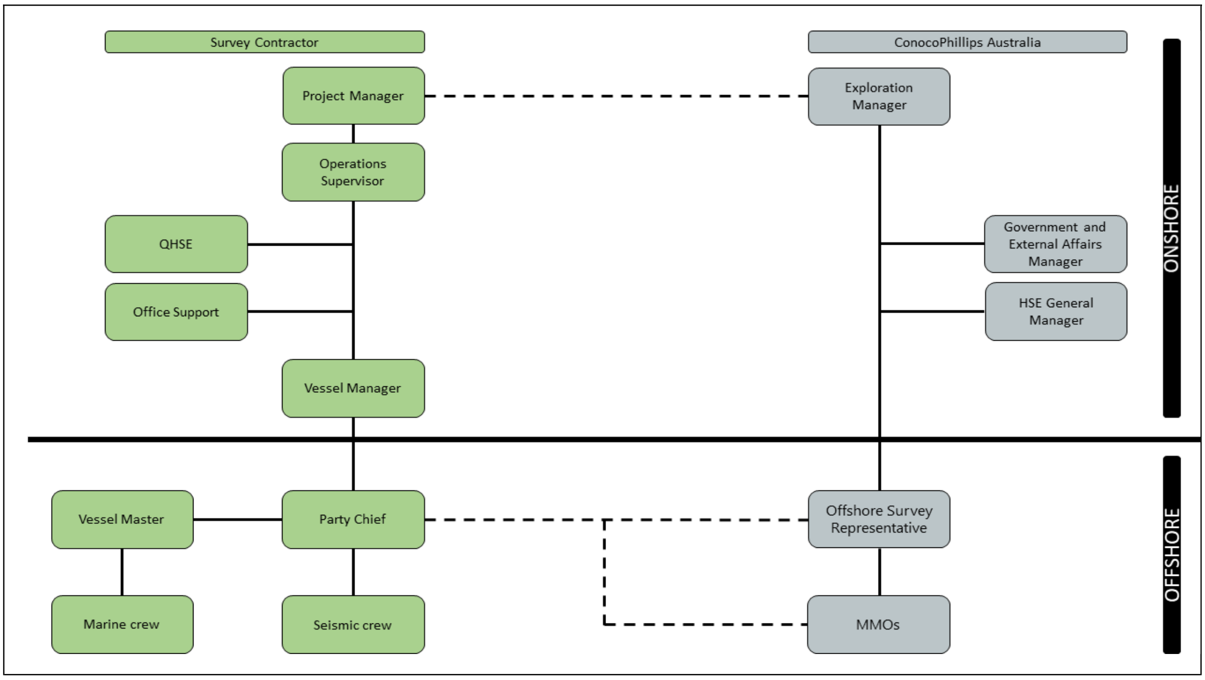
ConocoPhillips maintains a structured organisation to manage all HSE issues that impact on, or have the potential to impact on the Sequoia 3DMSS, including:

- Maintaining a specialist HSE team;
- Communicating organisation charts outlining the resourcing and management structure for ConocoPhillips Australia;
- HSE Committees that function at multiple levels to review and manage HSE related issues;
- Conducting management reviews of the ConocoPhillips HSEMS to assess resource needs;
- Implementing specific processes that identify and effectively communicate roles, responsibilities and accountabilities associated with critical equipment and systems including via inductions, on-boarding processes and competency training programs; and
- Documenting roles, responsibilities and accountabilities, as they relate to the HSEMS and the HSE Policy.

8.6.1. Organisational Structure

The organisation structure for the activity is illustrated Figure 8.3.

Figure 8.3: Sequoia 3DMSS organisation structure



8.6.2. Roles and Responsibilities

The roles and responsibilities of key team members are summarised in Table 8.2.

Table 8.2: Sequoia MSS roles and key environmental responsibilities

Role	Key environmental responsibilities
Onshore	
ConocoPhillips Australia President	Ensures: • ConocoPhillips Australia has the appropriate organisation in place to be compliant with regulatory and other requirements and this EP. • Policies and systems are in place to guide the company's environmental • performance. • Adequate resources are in place for the safe operation of all activities. • The HSEMS continues to meet the evolving needs of the organisation.
ConocoPhillips Exploration Manager	Ensures: • The activity is undertaken as per the Environmental Performance Objectives (EPO) of the EP. • Sufficient resources are allocated to implement management measures to achieve the EPS. • Stakeholder consultation is undertaken as per the requirements of the EP. • Change requests for the activity are managed and notifies the Client Site Representative, HSE General Manager and Marine Mammal Observers (MMOs) of any scope changes in a timely manner. • Liaison with regulatory authorities is undertaken as required. • The EP is reviewed as necessary and change requests are managed. • Environmental incident reporting meets regulatory requirements. • Corrective actions raised from environmental inspections/audits or incidents are monitored and closed out. • Necessary resources are provided to facilitate an emergency response strategy in the event of an incident. • The ConocoPhillips emergency response strategy is implemented in the event of an incident. • Results of the compliance audit during the survey are reviewed and makes recommendations for improvement where required. • That all reportable and recordable incidents are reported to NOPSEMA. • That a full induction to all activity personnel is provided, including details of the environmental sensitivities of the survey area and EPS detailed in this EP. • That an Environmental Performance Report (EPR) is prepared and submitted to NOPSEMA.

Role	Key environmental responsibilities
ConocoPhillips HSE General Manager	Ensures: • Compliance with HSE regulatory requirements. • An EP is prepared for the activity. • Records associated with the activity are maintained as per Section 8.13. • Personnel who have specific responsibilities pertaining to the implementation of this EP know their responsibilities and are competent to fulfil their designated role. • Environmental impacts and risks associated with the activity have been identified and any new or increased impacts or risks are managed via the Management of Change (MoC) process detailed in Section 8.13.1. • Incidents are managed and reported as per Section 8.11. • Any changes to equipment, systems and documentation where there may be a new, or change to, an environmental impact or risk or a change that may impact the EP are assessed in accordance with the MoC process detailed in Section 8.13.1 • Oil spill response arrangements for the activity are tested as per Section 8.9. • Audits and inspections are undertaken in accordance with Section 8.15. • Environmental and regulatory requirements are communicated to those who have specific responsibilities pertaining to the implementation of this EP. • The environmental component of the activity induction is prepared and presented. • Environmental incidents are reported and managed as per Section 8.11. • The monthly incident reports and end-of-activity EP environmental performance report are prepared and submitted to NOPSEMA. • Any new or changed environmental impact or risk or a change that may impact the EP is reviewed and documented as per Section 8.13.1. • Audits and inspections are undertaken as detailed in Section 8.16 and any actions from non-conformances or improvement suggestions tracked. • Reviews and revisions to the EP are made as per the requirements in Section 8.16. • Submits the Marine Mammal Observer (MMO) report to the DAWE.
ConocoPhillips Government and External Affairs Manager	Ensures: • A stakeholder engagement plan for the activity is prepared, implemented and maintained. • Stakeholder concerns and issues are promptly handled. • Ongoing engagement with relevant stakeholders for the duration of the activity is undertaken, as required.

Role	Key environmental responsibilities
Offshore	
ConocoPhillips Australia Offshore Representative	Ensures: • The activity is carried out in accordance with regulatory requirements and this EP. • Vessel personnel partake in the activity induction. • Vessel personnel are competent to fulfil their designated role. • HSE issues are communicated via mechanisms such as the daily report and daily pre-start meetings. • New or increased environmental impacts or risks are managed via the Management of Change (MoC) process detailed in Section 8.13.1. • HSE incidents are reported and investigated as per Section 8.11. • Emissions and discharges identified in Section 8.14.2 are recorded. • The ConocoPhillips HSE General Manager is informed of any changes to equipment, systems and documentation where there may be a new or change to an environmental impact or risk or a change that may impact the EP as per Section 8.13. • Weekly HSE vessel inspections as detailed in Section 8.16 are undertaken to ensure ongoing compliance with the EP and all environmentally critical plant and equipment are in good working order.
Vessel Master	Ensures: • Vessel operations are carried out in accordance with regulatory requirements and this EP. • Vessel personnel are competent to fulfil their designated role. • Personnel new to the vessel receive a vessel-specific induction. • Environmental incidents are reported to the ConocoPhillips Australia Offshore Representative within required timeframes as per Section 8.11. • Emissions and discharges identified in Section 8.14.2are recorded and provided to the ConocoPhillips Australia Offshore Representative. • The ConocoPhillips Australia Offshore Representative is informed of any changes to equipment, systems and documentation where there may be a new or change to an environmental impact or risk or a change that may impact the EP as per Section 8.13.1. • Oil spill response arrangements are in place and tested as per the vessel's Shipboard Marine Pollution Emergency Plan (SMPEP). • General and hazardous wastes are backloaded to port for disposal to a licenced waste facility. • Weekly HSE meetings are conducted.
Party Chief	Ensures: • That procedures and work instructions required for seismic operations are known, understood and followed by all vessel personnel. • That seismic crew are briefed about their role in supporting the MMOs to fulfil their duties. • Toolbox meetings are conducted. • Working codes and practices are implemented for all survey operations in accordance with industry standards

Role	Key environmental responsibilities
MMOs	Ensure: • That the EPBC Policy Statement 2.1 procedures and additional controls detailed in Section 7.1.5 and Section 7.10.5 are implemented throughout the survey. • A daily log of cetacean sightings is maintained. • Continuous liaison is maintained with the Party Chief and ConocoPhillips Australia Offshore Representative regarding MMO implementation issues. • An MMO report is prepared for submission to DAWE.
Vessel personnel	All vessel crew are responsible for: • Completing the ConocoPhillips HSE induction. • Reporting fauna sightings and interactions to the MMOs. • Reporting hazards and/or incidents via company reporting processes. • Adhering to vessel's HSEMS and this EP. • Undertaking tasks safely and without harm to themselves, others, equipment or the environment and in accordance with their training, operating procedures and work instructions. • Stopping any task that they believe to be unsafe or will impact on the environment.

8.7. Element 6: Programs and Procedures

This element establishes requirements to develop and implement programs and documented procedures to ensure compliance with legal requirements and standards of operation and to manage HSE risk. All ConocoPhillips' HSE procedures are maintained on the ConocoPhillips HSEMS intranet site and accessible to the business.

Documented ConocoPhillips programs and procedures, relevant to the activity, are established and maintained to manage significant risks and comply with legal requirements and standards of operation. These programs, processes and procedures are made easily accessible to relevant employees and contractors and are reviewed in accordance with a defined review schedule. ConocoPhillips employs competent people capable of identifying and implementing programs and procedures to facilitate HSE compliance and continuous improvement.

Work performed by certain contractors on behalf of ConocoPhillips Australia may use their own procedures provided they are aligned with ConocoPhillips HSEMS Standard.

8.8. Element 7: Asset and Operating Integrity

This element establishes standards for the development, implementation and maintenance of its Asset and Operating Integrity (A&OI) programs to:

- Properly manage risks associated with the activity including equipment failure or uncontrolled loss of primary containment; and
- Establish within ConocoPhillips Australia a clear understanding of its assets, failure mechanisms and their consequences/associated risks.

Plant and equipment that have been identified as a control measure for the purpose of managing potential environmental impacts and risks from the activity have an associated EPS that details the performance required of the plant and/or equipment as detailed in Chapter 7. During the contractor selection process and through ongoing inspections during the activity, ConocoPhillips Australia will ensure that the contractor maintains all environmentally critical plant and equipment in good working order.

8.9. Element 8: Emergency Preparedness

This element defines the Crisis Management and Emergency Response (CM&ER) planning and preparedness requirements for the activity.

During the response to an incident, ConocoPhillips has adopted the P.E.A.R.L principle to guide prioritisation of the response:

P – People (health and safety of responders, employees and the public).

E – Environment.

A – Assets.

R – Reputation of the company.

L – Livelihood.

All reasonably foreseeable crisis and emergency situations are identified via appropriate systematic review and analysis processes, with results documented in CM&ER processes and systems.

The Vessel specific Emergency Response Plan defines the initial actions, reporting requirements and management processes to be applied in the event of an emergency or crisis occurring during the Sequoia 3DMSS. This plan will integrate (and be bridged) with ConocoPhillips Australia Crisis and Incident Management Plan (ABUE-450-HS-N05-C-00119). Crisis and emergency response are managed by a hierarchy of teams within ConocoPhillips Australia (see Section 8.9.1).

8.9.1. Emergency Response Framework

The ConocoPhillips Australia crisis and emergency management arrangements uses a graduated tiered response framework which classifies incidents based on the significance of the consequences, the risks involved and potential for escalation. There are three integrated elements in this structure framework, which combine to effectively manage crisis events and emergencies at ConocoPhillips Australia facilities and business operations:

- Emergency Response Teams (ERT);
- Incident Management Team (IMT); and
- Crisis Management Team (CMT).

For the Sequoia 3DMSS, the ERT responsibilities and initial response processes will be managed via the vessel ERT with notification to the ConocoPhillips Australia IMT.

8.9.2. Marine Diesel Oil Spill Response Training

Quarterly training of vessel crew in Shipping Marine Pollution Emergency Plan (SMPEP) is a MARPOL requirement for vessels >400 gross tonnes (Annex 1, Regulation 37). During its contractor selection process, ConocoPhillips Australia will ensure that the chosen contractor has been implementing this requirement.

Vessel SMPEPs typically include vessel-specific procedures for managing pollution emergencies (Marine Diesel Oil (MDO) spill) resulting from incidents such as hull damage from a collision or grounding. The SMPEP includes information about initial response, reporting requirements and arrangements for the involvement of third parties having the appropriate skills and facilities to effectively respond to oil spill issues. The SMPEP will be the principal working document for the vessel and crew in the event of a MDO spill. The SMPEP describes specific emergency procedures including steps to control discharges for bunkering spills, hull damage, grounding and stranding, fire and explosion, collisions, vessel list, tank failure, sinking and vapour releases. The SMPEP also includes requirements for regular emergency response drills of the plan and revisions following drills or incidents.

8.9.3. Testing of Spill Response Arrangements

In accordance with Regulation 14(8A)(8C) of the OPGGS(E), emergency response arrangements for the Sequoia 3DMSS are tested:

- When they are introduced;
- When they are significantly amended; and
- Not later than 12 months after the most recent test.

Prior to commencing the survey, vessel contractor and ConocoPhillips Australia's spill response arrangements will be tested and have been incorporated into the 2020/21 drill schedules (culminating in a multi-agency drill exercise in mid-2021 to confirm preparedness for this activity). The outcomes of the exercise drills will be documented to assess the effectiveness of the exercise against its objectives and to record any lessons and actions. Any actions will be recorded and tracked to completion.

To test and continually improve preparedness, an emergency response drill/exercise schedule in accordance with ConocoPhillips Australia Crisis and Incident Management Plan has been scheduled to support the Sequoia 3DMSS.

8.9.4. Adverse Weather Protocols

It is the duty of the Vessel Master to act as the focal point for all actions and communications with regards to any emergency, including response to adverse weather or sea state, to safeguard his vessel, all personnel onboard and environment.

During adverse weather, the Vessel Master is responsible for the following:

- Ensuring the safety of all personnel onboard;
- Monitor all available weather forecasts and predictions;
- Initiating the vessel safety management system, vessel HSE procedures and/or vessel ERP;
- Keeping the Party Chief and ConocoPhillips Australia Offshore Representative fully informed of the prevailing situation and intended action to be taken;
- Assessing and maintaining security, watertight integrity and stability of vessel; and
- Proceeding to identified shelter location(s) as appropriate.

Other appropriate responsibilities shall be taken into consideration as dictated by the situation.

In addition to in-vessel VHF Marine Radio Weather Services, the survey contractor will obtain daily weather forecasting from the Bureau of Meteorology (and/or other services) to monitor weather within the operational area in the lead up to and for the duration of the survey.

8.9.5. Operational and Scientific Monitoring

Operational and scientific monitoring arrangements are in place in the event of a hydrocarbon spill during this activity and are summarised in Chapter 9.

8.10. Element 9: Awareness, Training and Competency

This element establishes the requirement that all employees, contractors and visitors have the necessary awareness, training and competency to perform their activities consistent with the ConocoPhillips HSE Policy, standards, and procedures.

ConocoPhillips Australia will adopt a process to confirm that employees and contractors have the required training and competency to fulfil their duties in a safe, environmentally and socially responsible manner. The system addresses:

- Employee selection and identification of training, competence and development needs;
- Contractor evaluation and management;
- Employee orientation;
- Operator or mechanical skills training and qualification;
- Development and maintenance of training resources and records; and
- Demonstration of competency.

8.10.1. Survey-specific Awareness and Training

To ensure that personnel are aware of the EP requirements for the survey, all vessel personnel will complete a project-specific HSE induction. Records of completion of the induction will be recorded. The induction will cover (but is not limited to):

- Description of the environmental sensitivities and conservation values of the survey area;
- Controls to be implemented to ensure impacts and risks are ALARP and of an acceptable level, including an overview of EPBC Policy Statement 2.1 procedures and controls associated with managing acoustic impacts;
- Requirement to follow procedures and use risk assessments/job hazard assessments to identify environmental impacts and risks and appropriate controls;
- Requirements for interactions with fishers and/or fishing equipment;
- Requirement for responding to and reporting safety and environmental hazards or incidents; and
- Overview of emergency response and spill management plans and vessel interaction procedures.

In addition to the project-specific induction, each person with specific responsibilities pertaining to the implementation of this EP will be made aware of their responsibilities, and the specific control measures required to maintain environmental performance and legislative compliance.

The vessel contractor will conduct its own company and vessel-specific inductions independently of the project-specific HSE induction.

8.11. Element 10: Non-conformance, Incident and Near Miss Investigation and Corrective Action

The purpose of this element is to ensure non-conformances, incidents and near misses are properly reported and investigated commensurate with associated risk, and to ensure that preventative and corrective actions are identified and tracked to closure.

Incident investigations will be documented using the survey contractor’s incident management database to track actions and enable sharing of learnings. ConocoPhillips Australia will be informed of all incidents and maintain its own database.

Non-conformances may be identified through audits, observations or incident reports. Actions to address non-conformances are developed following the same process applied to address root causes of incidents.

8.11.1. Recordable Incident Management

Regulation 4 of the OPGGS(E) regulations defines a 'recordable' incident as:

A breach of an EPO or EPS in the EP that applies to the activity that is not a reportable incident.

Routine monthly recordable incident reports, including 'nil' incident reports, will be prepared by ConocoPhillips Australia's HSE General Manager and submitted to NOPSEMA by the 15th of each month. These are reported using the NOPSEMA template Monthly environmental incident reports (N-03000-FM0928). Table 8.3 summarises the recordable incident reporting requirements.

Table 8.3: Sequoia MSS roles and key environmental responsibilities

Timing	Reporting requirements	Contact
By the 15th of each month	• All recordable incidents that occurred during the previous calendar month. • The date of the incident. • All material facts and circumstances concerning the incidents that the operator knows or is able to reasonably find out. • The EPO and/or EPS breached. • Actions taken to avoid or mitigate any adverse environmental impacts of the incident. • Corrective actions taken, or proposed to be taken, to stop, control or remedy the incident. • Actions taken, or proposed to be taken, to prevent a similar incident occurring in the future. • Actions taken, or proposed, to prevent a similar incident occurring in the future.	NOPSEMAsubmissions @nopsema.gov.au

8.11.2. Reportable Incident Management

Regulation 4 of the OPGGS(E) defines a 'reportable' incident as:

An incident that has caused, or has the potential to cause, moderate to significant environmental damage.

In the context of the Risk Matrix Standard, ConocoPhillips Australia interprets 'moderate to significant'

environmental damage to be those hazards identified through the EIA and ERA process (see Chapter 7) as having an unmitigated or residual impact consequence of 'moderate (3)' or greater. Impacts and risks with these ratings (as outlined throughout Chapter 7) are:

- Injury or death of individual megafauna from vessel strike/entanglement;
- Introduction of Invasive Marine Species (IMS); and
- MDO release (impacts to shorebirds, fisheries, public amenity and the desalination plant). Table 8.4 presents the reportable incident reporting requirements.

Table 8.4: Reportable incident reporting requirements

Table 8.4: Reportable incident reporting requirements

Timing	Requirements	Contact
Verbal notification		
Within 2 hours of becoming aware of incident	The verbal incident report must include: • All material facts and circumstances concerning the incident that the titleholder knows, or is able, by reasonable search or enquiry, to find out; • Any actions taken to avoid or mitigate any adverse environmental impacts of the reportable incident; and • The corrective action that have been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	• NOPSEMA – 1300 674 472
	Specifically for a Level 1, 2 or 3 MDO spill, as above.	As above, plus: • AMSA – 1800 641 792 (24 hrs) • DJPR – 0409 858 715 • DPIPWE – 03 6165 4599 • Transport for NSW – 0419 484 446
	Oiled wildlife	• DELWP – 1300 134 444 (24 hrs) DPIPWE - 03 6165 4599
	Suspected or confirmed IMS introduction	DAWE - 1800 803 772 (general enquiries)
	Injury or death of EPBC Act-listed fauna (e.g., vessel collision)	• DAWE – 1800 803 772 • Whale and dolphin emergency hotline – 1300 136 017 • AGL marine response unit – 1300 245 678

Timing	Requirements	Contact
Written notification		
Not later than 3 days after the first occurrence of the incident	A written incident report must include: • All material facts and circumstances concerning the incident that the titleholder knows, or is able, by reasonable search or enquiry, to find out; • Any actions taken to avoid or mitigate any adverse environmental impacts of the reportable incident; • The corrective action that have been taken, or is proposed to be taken, to stop, control or remedy the reportable incident; and • The action that has been taken, or is proposed to be taken, to prevent similar recordable incidents occurring in the future.	• NOPSEMA – submissions@nopsema.gov.au
Within 72 hours of the incident	As above, with regard to details of a vessel strike incident with a cetacean	• Upload information to DAWE online National Ship Strike Database (https://data.marinemammals.gov.au/report/shipstrike) • DELWP (Whale and Dolphin Emergency Hotline) – 1300 136 017 • Seals, Penguins or Marine Turtles – 136 186 (Mon-Fri 8am to 6pm) or AGL Marine Response Unit 1300 245 678.
Within 7 days of the incident	As above, with regard to impacts to MNES, specifically injury to or death of EPBC Act-listed species	• EPBC.Permits@environment.gov.au • DAWE 1800 803 772
Within 7 days of providing written report to NOPSEMA	As above.	• NOPTA – reporting@nopta.gov.au

8.11.3. Incident Investigation

Any non-compliance with the EPS outlined in this EP will be investigated and follow-up action will be assigned as appropriate.

The findings and recommendations of inspections, audits and investigations will be documented and distributed to relevant vessel and project personnel for review. Tracking the close-out actions arising from investigations is managed via the ConocoPhillips Australia and survey contractor’s incident management systems.

Investigation outcomes will be communicated to the project team via daily operations meetings and to the vessel crew during daily toolbox meetings and at weekly HSE meetings.

8.12. Element 11: Communication

This element sets the requirements for the communication of information within ConocoPhillips Australia and engagement with internal stakeholders and the survey contractor.

ConocoPhillips Australia actively seeks and obtains the cooperation and involvement of its personnel in promoting and improving HSE management and communication. Workers and technical experts are consulted when new HSE procedures or processes are developed or changes to the HSEMS occur (including risk management processes).

The ConocoPhillips Australia HSE General Manager has responsibility for ensuring that systems are in place to facilitate the communication of HSE issues to the survey and vessel crew. This is typically via the daily operations meeting and weekly HSE meetings.

8.12.1. Toolbox Talks and HSE Meetings

Environmental matters will be included in daily toolbox talks as required by the specific task being risk assessed (e.g., waste management).

Environmental issues will also be addressed in daily operations meetings and weekly HSE meetings, where each shift will participate with the ConocoPhillips Australia Offshore Representative, Party Chief and Vessel Master in discussing HSE matters that have arisen in the previous week, and issues to consider for the following week.

Records associated with project-specific training, environmental training, inductions and attendance at toolbox meetings will be recorded and maintained on board the vessel.

8.12.2. Internal Communications

The Vessel Master, Party Chief and ConocoPhillips Australia Offshore Representative are jointly responsible for keeping the marine and survey crews informed about HSE issues, acting as a focal point for personnel to raise issues and concerns and consulting and involving all personnel in the following:

- Issues associated with implementation of the EP;
- Any proposed changes to equipment, systems or methods of operation of equipment, where these may have HSE implications; and
- Any proposals for the continuous improvement of environmental protection, including the setting of environmental objectives and training schemes.

Table 8.5 outlines the key meetings that will take place onshore and offshore during survey acquisition.

Table 8.5: Project communications

Meeting	Frequency	Attendees
Onshore		
ConocoPhillips project team	Daily	All team members
Offshore		
Operations (inclusive of daily cetacean strategy meeting)	Daily	ConocoPhillips onshore project team, department heads, ConocoPhillips Australia Offshore Representative, Party Chief, MMOs
Pre-start safety meeting	Daily – prior to each shift	All personnel
Toolbox	Before each task	All personnel involved in task
HSE	Weekly	All personnel

8.13. Element 12: Document Control and Records Management

This element establishes the requirements for management and control of HSEMS documents and records.

The ConocoPhillips Document Control Procedure (ABUE-000-DC-N05-C-00001) is implemented to efficiently manage key documentation, including confirming that it remains accurate, current and available to required personnel. Documents and records, including procedures, work instructions and other information necessary to carry out work activities, are retained to corporate and legislative requirements. Documents are also periodically reviewed and revised as necessary, with current versions made available and obsolete documents removed or identified and retained (where necessary) for legal use.

In accordance with Regulations 27 and 28 of the OPGGS(E), documents and records relevant to the implementation of this EP are stored and maintained in the ConocoPhillips Australia Operations Document Management System for a minimum of five years. These records will be made available to NOPSEMA in electronic or printed form upon request.

8.13.1. Management of Change

The intent of Management of Change (MoC) is that all temporary and permanent changes to the organisation, personnel, systems, procedures, equipment, products and materials are identified and managed to ensure HSE risks arising from these changes remain at an acceptable level.

Changes to equipment, systems and documentation are managed in accordance with the Management of Change Overview Procedure (ABUE-000-SF-N05-C-00002) to ensure that all proposed changes are adequately defined, implemented, reviewed and documented by suitably competent persons. This process is managed using an electronic tracking database, which provides assurance that all engineering and regulatory requirements have both been considered and met before any change is operational. The MoC process includes not just plant and equipment changes, but also documented procedures where there is an HSE impact, regulatory documents and organisational changes that impact personnel in safety critical roles.

Not all changes require a MoC review. Each change is assessed on a case-by-case basis. The potential environmental impacts and/or risks are reviewed by a member of ConocoPhillips Australia to determine whether the MoC review process is triggered.

8.14. Element 13: Measuring and Monitoring

This element defines the requirements for measuring and monitoring ConocoPhillips Australia's HSE performance, providing assurance of compliance, assessing the effectiveness in meeting its goals and legal obligations, and identifying opportunities for improvement.

This EP provides the key means of satisfying this HSEMS element in relation to the activity.

8.14.1. Marine Mammal Observers

Only competent MMOs will be hired for the survey. The MMOs will provide an information session to control room operators and other essential personnel at the beginning of the survey regarding their fauna observation duties and the communication protocols required with the control room operators to ensure shutdowns and power downs occur efficiently.

In accordance with Part A of EPBC Policy Statement 2.1, cetacean sighting and compliance reports will be submitted to DAWE within 2 months of survey completion.

A daily cetacean strategy meeting involving the MMOs, ConocoPhillips Australia Offshore Representative and the control room operators will be held at the start and/or end of each day shift. The meeting will review cetacean observations from the previous 24 hours and discuss implications for the following day's operations. Based on observations from the previous 24 hours, the initial positioning of support vessels for the following day will be determined. This positioning may involve scouting the last known or observed location of cetaceans or scouting prior to acquisition of particular survey lines. Selection of acquisition lines for the following day will also be reviewed and, where practicable, selected to maximise the distance from the last observed locations of any whales.

8.14.2. Emissions and Discharges Records

ConocoPhillips Australia will maintain a quantitative record of emissions and discharges for the survey as required under Regulation 14(7) of the OPGGS(E). This includes emissions and discharges to air and water (from both planned and unplanned activities). Results are reported in the end-of-activity EP performance report submitted to NOPSEMA.

General and hazardous waste streams generated during the survey are backloaded to port for disposal to a licenced waste facility. Wastewater and putrescible wastes are managed as per MARPOL requirements as detailed in Chapter 7.

A summary of the environmental monitoring to be undertaken for the survey is presented in Table 8.6.

Table 8.6: Summary of environmental monitoring

Aspect	Monitoring parameter	Frequency	Record
Impacts			
Underwater sound	MMO megafauna visual observations	Continuous during acquisition and pre-starts	MMO daily reports End-of-survey report
Atmospheric emissions	Fuel consumption	Tallied at end of survey	Daily reports and/or bunker receipts
Bilge water	Volume of bilge water discharged during the survey	Each discharge (infrequent)	Oil record book
Risks			
Waste disposal	Weight/volume of wastes sent ashore (including oil sludge, solid/hazardous wastes)	Tallied at end of survey	Waste manifest
Displacement of or interaction with third-party vessels	Ongoing patrol for, and communications with, third-party vessels by the support vessels. Radar surveillance from source vessel.	Continuous during survey	Bridge communications book
Introduction of IMS to survey area	Volume and location of ballast water discharges noted	Each discharge	Ballast water log
Vessel strike or entanglement with cetaceans	MMO continuous megafauna observations	Continuous during survey	Incident report
MDO spill (in the event of)	Operational monitoring in line with oil spill response arrangements (Chapter 9)	As required	Incident report

8.14.3. Routine Reporting and Notifications

Regulations 11A and 14(9) of the OPGGS(E) specify that consultation with relevant authorities, persons and organisations must take place. This consultation includes an implicit obligation to report on the progress of the survey. Table 8.7 outlines the routine reporting obligations that ConocoPhillips Australia will undertake with external organisations.

Table 8.7: External routine reporting obligations

Requirement	Timing	Contact details	OPGGS(E) regulation
Pre-survey			
Notify AMSA in order to issue daily AusCoast warnings.	Within 24 hours of survey starting.	rccaus@amsa.gov.au	11A
Notify NOPSEMA with the survey commencement date.	At least 10 days prior to survey starting.	submissions@nopsema.gov.au	29
Notify the AHO of the survey commencement date and duration to enable Notices to Mariners to be issued.	Three weeks prior to survey starting.	datacentre@hydro.gov.au 02 4223 6500	11A
Notify all other stakeholders in the stakeholder register with the survey commencement date.	Two weeks prior to survey starting.	Via email addresses managed by the Government and External Affairs Manager	11A
Survey completion			
Notify AMSA in order to cease daily AusCoast warnings.	Within 24 hours of survey completion.	rccaus@amsa.gov.au	11A
Notify all stakeholders in the stakeholder register.	Within 2 days of survey completion.	Via email addresses managed by the External Affairs Advisor	11A
Notify the AHO in order to cease the issuing of Notices to Mariners.	Within 2 days of survey completion.	datacentre@hydro.gov.au 02 4223 6590	11A
Notify NOPSEMA of the survey end date.	Within 10 days of survey completion.	submissions@nopsema.gov.au	29
Notify NOPSEMA of the end of the operation of the EP.	After acceptance of the end-of-activity EP performance report.	submissions@nopsema.gov.au	25A
Performance reporting			
Submit an end-of-survey EP Performance Report.	Within 3 months of survey completion.	submissions@nopsema.gov.au	26C
Provide marine fauna observation data to the DAWE.	Within 3 months of survey completion.	Upload via the online Cetacean Sightings Application at: https://data.marinemammals.gov.au/nmmdb	N/A – EPBC Act

8.15. Element 14: Audits

This element establishes requirements for audit programs that assess the adequacy and effectiveness of environmental controls and drive continual improvement.

Various inspections and audits will be undertaken for the Sequoia 3DMSS, as outlined in Table 8.8.

Table 8.8: Summary of environmental inspections and audits

Type	When	Frequency	Vessel	Method	Details
HSE due diligence inspection	Post-award, pre-survey	Once	Survey vessel and support vessels	Desktop or in port/during mobilisation	Focused on ensuring EPS can be met through review of relevant records and databases
Ongoing inspections	During survey	Weekly	Survey vessel and support vessels	In person on board	Checklists provided by ConocoPhillips to be completed by: • Survey vessel – ConocoPhillips Australia Sequoia Offshore Representative • Support vessels – Vessel master

Any non-compliances or opportunities for improvement identified at the time of an inspection or audit will be communicated to the relevant ConocoPhillips Australia and contractor personnel at the time of the inspection or audit. These are tracked in the incident management system IntelexTM, which includes assigning responsibilities to personnel to manage the issue and verify that it is closed out.

A summary of the EP commitments for the survey will be distributed aboard the vessels (including role-specific checklists), and implementation of the EPS will be continuously monitored by the ConocoPhillips Australia Offshore Representative and verified by the ConocoPhillips Australia HSE General Manager (or delegate) through review of the completed weekly checklists and attendance at relevant meetings.

Non-compliances and/or opportunities for improvement will be communicated to survey personnel in writing and at appropriate meetings (as listed in Table 8.5).

8.15.1. EP Performance Report

An end-of-survey EP performance report will be prepared that details performance against the EPS in this EP. The information in the report will be based on the information collected during routine communications, inspections and audits, as outlined in this chapter.

The EP performance report will be issued to NOPSEMA within three months of survey completion.

8.15.2. Regulatory Inspections

Under Part 5 of the OPGGS Act, NOPSEMA inspectors have the authority to enter ConocoPhillips Australia premises, including the survey vessel, to undertake monitoring or investigation against this EP.

ConocoPhillips Australia will cooperate fully with the regulator if such investigations take place.

8.16. Element 15: Review

This element establishes requirements to review the content and functionality of the HSEMS to ensure there is a functioning and systematic process in place so that HSE risks are identified and managed to achieve the ConocoPhillips Australia HSE goals and objectives.

8.16.1. EP Review

ConocoPhillips Australia may determine that an internal review of the EP may be necessary based on any one or all of the following factors:

- Changes to hazards and/or controls identified in the review of the EP, which in itself is supported by:
  - Reviewing changes to Australian Marine Park (AMP) management arrangements (through subscription to the AMP email update service at https://parksaustralia.gov.au/marine/about/).
  - Environment and industry legislative updates (through subscriptions to NOPSEMA, APPEA and legal firms).
  - Running a new EPBC Act Protected Matters Search Tool (PMST) search for the EMBA immediately prior to the survey to determine whether there are newly-listed threatened species or ecological communities in the EMBA.
  - Remaining up to date with new scientific research that may impact on the EIA/ERA in the EP (for example, through professional networking and APPEA membership).
  - Remaining in regular contact with stakeholders.
- Implementation of corrective actions to address internal or external inspection or audit findings;
- An environmental incident and subsequent investigation identifies issues in the EP that require review and/or updating;
- A modification of the activity is proposed that is not significant but needs to be documented in the EP;
- Changes identified through the MoC process, such as hazards or controls, organisational changes affecting personnel in safety critical roles or HSE management systems; and
- Changes to any of the relevant legislation.

The HSE team provides advice to the ConocoPhillips Australia Exploration Manager on the material impact of the items listed previously and whether or not a review of the EP should be undertaken. The scope of a review is determined by the factors that trigger the review and an appropriate team will be assembled by the HSE General Manager to conduct the review. The team may consist of representatives from the Government and External Affairs, Engineering, HSE, Operations or Supply Chain teams as required by the scope.

If a review of the EP relates to a topic that had previously been raised by a stakeholder, an updated response to affected stakeholders will be prepared and provided to affected stakeholders in a process managed by the Government and External Affairs Manager. The MoC process (Section 8.13.1) will apply where relevant.

8.16.2. Revisions Triggering EP Re-submission

ConocoPhillips Australia will revise and re-submit the EP for assessment as required by the OPGGS(E) regulations listed in Table 8.9.

Table 8.9: EP revision requirements

Regulations	OPGGS(E) regulation
Submission of a revised EP before the commencement of a new activity.	17(1)
Submission of a revised EP when any significant modification or new stage of the activity that is not provided for in the EP is proposed.	17(5)
Submission of a revised EP before, or as soon as practicable after, the occurrence of any significant new or significant increase in environmental impact or risk not provided for in the EP.	17(6)
Submission of a revised EP if a change in titleholder will result in a change in the manner in which the environmental impacts and risks of an activity are managed.	17(7)

Revisions and re-submission of the EP generally centre around 'new' activities, impacts or risks and 'increased' or 'significant' impacts and risks. ConocoPhillips Australia defines these terms in the following manner:

- **New** impact or risk – one that has not been assessed in Chapter 7.
- **Increased** impact or risk – one with greater extent, severity, duration or uncertainty than is detailed in Chapter 7.
- **Significant change** –
- The change to the survey design deviates from the EP to the degree that it results in new activities that are not intrinsic to the existing Activity Description in Chapter 2.
- The change affects the ability to achieve ALARP or acceptability for the existing impacts and risks described in Chapter 7.
- The change affects the ability to achieve the EPO and EPS contained in Chapter 7.
- A change in the activities, knowledge, or requirements applicable to the activity are considered to result in a 'significant new' or 'significant increased' impact or risk if any of the following criteria apply:
- The change results in the identification of a new impact or risk and the assessed level of risk is not
- 'Low', acceptable and ALARP;
- The change results in an increase to the assessed impact consequence or risk rating for an existing impact or risk described in Chapter 7; and
- There is both scientific uncertainty and the potential for significant or irreversible environmental damage associated with the change.

While an EP revision is being assessed by NOPSEMA, any activities addressed under the existing accepted EP are authorised to continue. Additional guidance is provided in NOPSEMA's Guideline When to submit a proposed revision of an EP (N04750-GL1705, Rev 1, January 2017).

8.16.3. Minor EP Revisions

Minor revisions to this EP that do not require resubmission to NOPSEMA will be made where:

- Minor administrative changes are identified that do not impact on the environment (e.g., document references, contact details, etc.).
- A review of the activity and the environmental impacts and risks of the activity do not trigger a requirement for a revision, as outlined in Table 8.9.

Minor revisions to the EP will not be submitted to the regulators for formal assessment. Minor revisions will be tracked in the document control system.

8.17. Summary of Implementation Strategy Commitments

Table 8.10 summarises the commitments provided throughout this Implementation Strategy by assigning EPOs, EPS and measurement criteria to each commitment.

Table 8.10: Summary of Sequoia MSS implementation strategy commitments

Section	EPO	EPS	Measurement criteria
8.4 and 8.13.1	Changes to approved plans (including this EP), legal requirements, equipment, plant, standards or procedures are assessed through the MoC process.	Changes are documented in accordance with the MoC Procedure.	MoC records are available in a database.
8.6	All personnel working on the survey vessel and support vessels are familiar with their HSE responsibilities.	All personnel working on the survey vessel and support vessels are inducted into the survey HSE requirements.	Vessel crews and visitor lists, along with induction familiarisation checklists are readily available, verifying that all personnel working on and visiting the activity vessels are inducted.
8.7, 8.12 and 8.13	Vessel- and office-based personnel are familiar with operations HSE issues.	Regular HSE communications take place between vessel- and office-based personnel.	HSE meeting records are available and verify regularity of communications.
8.9	Operational and scientific monitoring arrangements are in place in the event of a hydrocarbon spill	ConocoPhillips Australia are in a state of readiness for operational and scientific monitoring.	Arrangements are in place with service providers.
8.9 and 8.10	Vessel- and office-based personnel are familiar with their emergency response responsibilities.	All relevant vessel- and office-based personnel participate in OPEP and emergency response training, drills and exercises.	Training records are readily accessible.
	The survey vessel and support vessel contractor personnel are familiar with their oil spill response responsibilities.	All vessel-based personnel participate in SMPEP training, drills and exercises.	Vessel training records are available and verify that relevant personnel are up to date with their training.
8.9 and 8.10	Vessel- and office-based personnel are familiar with their ERP and OPEP responsibilities.	All relevant vessel- and office-based personnel participate in annual ERP and OPEP training, drills and exercises.	Training records verify that ERP and OPEP exercises are undertaken annually.

Section	EPO	EPS	Measurement criteria
8.10	Training and competency records are maintained.	Core and critical HSE and technical compliance training is tracked and recorded.	Training records are readily accessible.
		Due diligence is undertaken on contractors to ensure they are competent to work on the survey.	Contractor due diligence reports are readily available and verify their suitability to work on the survey.
8.11	Incident reports are issued to the regulators as required.	Recordable incidents reports are issued monthly to NOPSEMA.	Recordable and reportable incident reports and associated email correspondence is available to verify their issue to NOPSEMA.
		Reportable incidents are reported to NOPSEMA in accordance with the timing requirements provided in Table 8.4	
8.11	Incidents are investigated.	Incident investigations are undertaken by suitably qualified and experienced personnel in a timely manner.	Incident investigation reports are available and align with incidents recorded in the incident management system.
8.14	Emissions and discharges from the survey vessel and support vessels are recorded.	Emissions and discharges from the survey vessel and support vessels, in line with Table 8.6, are recorded.	Monitoring records are available and align with the requirements in Table 8.6.
8.14	Waste is managed such that non-routine discharges overboard are avoided.	Survey vessel and support vessel Waste Management Plans are in place and implemented to ensure that waste is appropriately managed.	Waste disposal records are in place and verify that relevant wastes are received onshore for disposal.
8.15 and 8.16	The activity impact and risk register is maintained current.	ConocoPhillips Environment Team and vessel personnel contribute to the regular review and revision of the impact and risk register.	Sequoia MSS Impact and Risk Register is available and includes review and revision information.
8.15 and 8.16	There is continuous environmental management oversight of the MSS.	ConocoPhillips Australia employs environmental personnel to ensure there is continuous environmental management oversight of the MSS.	Environmental meeting notes, annual EP performance reports and environmental inspection and audit reports are available and verify continuous environmental management oversight.
8.15.1	An Annual EP Performance Report is submitted to the regulators.	The Annual EP Performance Report is issued each year to NOPSEMA.	Annual EP Performance Reports and associated email correspondence is available to verify their issue to NOPSEMA.
8.16		This EP is reviewed and updated based on the triggers presented	A record of EP reviews and updates is available in OpenText.

Section	EPO	EPS	Measurement criteria
	This EP is reviewed and updated on an as-required basis.	in Section 8.16 on an as-required basis.	The review and/or update details are recorded in the document control page of this EP.
		If the review identifies that significant changes to the EP are required, the EP (and OPEP, if required) is updated and re-issued to the regulators.	A record of EP revision is included in the document control page of this EP.
			Associated correspondence is available to verify the re-issue of the EP to NOPSEMA.

9. Oil Pollution Emergency Plan

The following Oil Pollution Emergency Plan (OPEP) details arrangements in place for the timely implementation of response measures required to reduce risks to ALARP and acceptable levels in the event of a vessel-based MDO spill during the Sequoia 3DMSS.

The OPEP is presented as a short EP chapter rather than a stand-alone document in recognition of the fact that the survey vessel is not a 'facility' as defined in Section 15 and Schedule 3 of the OPGGS Act 2006 because the vessel:

- Does not rest on the seabed;
- Is not fixed or connected to the seabed; and
- Is not attached or tethered to a facility, structure or installation.

Because the survey vessel is not a 'facility', for oil spill response purposes, it is treated as any other vessel under legislation such as the *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth), *Australian Maritime Safety Authority Act* 1990 (Cth) and the *Navigation Act* 2012 (Cth). It is therefore suitable to describe the spill response arrangements provided at the Commonwealth and state levels for responding to hydrocarbon spills (described in Section 9.1).

ConocoPhillips Australia will prepare a project-specific bridging ERP to the vessel ERP. The ERP contains key actions, responsibilities and contact details for responding to a vessel emergency, including an MDO spill.

In the event of an MDO spill, the Vessel Master will assume onsite command, will make the initial regulatory notifications to AMSA as defined in Section 9.3 and will act as onsite coordinator directed by AMSA. All persons aboard the vessel will be required to act under the direction of the Vessel Master.

The survey vessel and support vessels will have equipment on board for responding to emergencies, including but not limited to medical equipment, firefighting equipment and oil spill response equipment as defined in the vessel Shipboard Marine Pollution Emergency Plan (SMPEP).

The Vessel Master will notify the ConocoPhillips Australia IMT via the on-call Operations Section Chief, with the IMT Leader acting as onshore liaison.

9.1. Oil Spill Response Arrangements

A release of MDO may occur from the survey or support vessels as a result of:

- A vessel-to-vessel collision;
- Vessel refuelling; or
- Equipment failure.

In order to ensure capability to respond to the identified worst-case credible spill scenario, modelling of a loss of 373 m3 of MDO has been undertaken and the risks assessed (Section 7.13). This volume has been calculated by taking the average of the largest externally located MDO tanks of the candidate survey vessels. This spill scenario is considered highly conservative as survey vessel tanks are rarely at full capacity given fuel will have already been combusted to reach the survey location. In addition, the likelihood of vessel collision (resulting in a spill) is considered extremely unlikely.

The overall OPEP for the Sequoia 3DMSS comprises the following emergency plans:

- Vessel SMPEP – for spills contained on the vessel or spills overboard that can be managed by the vessel;
- Project-specific bridging ERP;
- ConocoPhillips Australia Crisis and Incident Management Plan (ABUE-450-HS-N05-C-00119).

- The National Plan for Maritime Environmental Emergencies (‘NatPlan’) (AMSA, 2020) – AMSA is the jurisdictional authority and control agency for spills from vessels originating in or affecting Commonwealth waters;
- The Victorian State Maritime Emergencies (Non-search and Rescue) Plan (‘VicPlan’) (EMV, 2016) – the DJPR is the Control Agency for spills that affect Victorian State Waters; and
- The Tasmanian Marine Oil and Chemical Spill Contingency Plan (‘TasPlan’) (EPA, 2019) – the Tasmanian EPA is the Control Agency for spills from vessels that affect Tasmanian State waters.

9.1.1. National Plan Summary

The NatPlan is an integrated government and industry framework that seeks to enable effective response to marine pollution incidents and maritime casualties. In accordance with the polluter pays principles of the OPRC 1990, the framework provides for industry as the Control Agency for all spills that originate from offshore petroleum facilities (e.g., platforms, drill rigs). NOPSEMA collaborates closely with AMSA, as the manager of NatPlan, to ensure that arrangements under NatPlan, the OPGGS Act and associated regulations are aligned and understood.

As stated in Section 4.4 of the NatPlan (AMSA, 2020, pg 42), for all marine pollution incidents that do not originate from a petroleum facility, AMSA is the Control Agency for spills that cannot be managed locally (i.e., Level 2 and 3 spills). Guidance for incident classification, as noted in Part 5 of the NatPlan (AMSA, 2020, pg 50) is provided in Table 9.1

Table 9.1: Guidance for spill incident classification

Characteristic	Level 1	Level 2	Level 3*
Jurisdiction	Single	Multiple	Multiple, including international
Agencies	First-response (e.g., vessel only)	Multiple agencies	Agencies across government and industry
Resources	From within one area	Intra-state	National or international resources
Type of response	First-strike	Escalated	Campaign
Duration	Single shift	Multiple shifts (days to weeks)	Extended (weeks to months)
Environment at risk	Isolated impacts. Natural recovery expected within weeks.	Significant impacts. Recovery may take months. Remediation required.	Significant area. Recovery may take months. Remediation required.

*Note: No maximum credible spill scenario that represents a tier 3 spill has been identified as part of the Sequoia 3D MSS risk assessment

The Australian Government established the Offshore Petroleum Incident Coordination (OPIC) framework for coordinating a whole-of-government response to a significant petroleum incident in Commonwealth waters. The framework interfaces with other emergency incident response/coordination arrangements, including the NatPlan, titleholder OPEPs and state/ Territory marine pollution contingency plans as appropriate.

Maritime environmental emergencies have the potential to impact upon the interests of two or more Australian jurisdictions where both jurisdictions have legitimate administrative and regulatory interests in the incident; for the Sequoia 3DMSS, this includes Victoria and/or Tasmania. In the case of a spill impacting multiple jurisdictions, the NatPlan addresses the administrative and regulatory complexities through the ‘Guidance on the Coordination of Cross Border Incidents’, which provides for the establishment of an incident coordination process and the determination of a ‘lead’ jurisdiction, if appropriate. In the case of the

Sequoia 3DMSS, AMSA would liaise with the Victorian DJPR and the Tasmanian EPA to determine which agency is best placed to take the lead.

9.1.2. Victorian Arrangements

In the event that the MDO spill crosses into Victorian state waters, DJPR will only assume Incident Control over the impacted area in State waters while AMSA will remain responsible for managing the spill outside Victorian coastal waters.

If an incident affecting wildlife occurs in Commonwealth waters close to Victorian State waters, AMSA will request support from DELWP to assess and lead a wildlife response if required. DELWP may also place a DELWP Liaison Officer in a state-based oil spill Incident Management Team (IMT) and/or the ConocoPhillips Australia IMT.

In the event DJPR is leading an oil spill response within Victorian state waters, a joint IMT will be established between DJPR and AMSA. The joint IMT aims to ensure a coordinated response between lead agencies. ConocoPhillips Australia will have representation embedded within the joint teams and provide feedback to ConocoPhillips Australia IMT.

As noted in the Victorian Animal Emergency Welfare Plan (DJPR/DELWP, 2019, Rev 2), DELWP will be the Control Agency for a wildlife response, using arrangements included in the Wildlife Response Plan for Marine Pollution Emergencies (DELWP, 2007).

9.1.3. Tasmanian Arrangements

Under the Pollution of Water by Oil and Other Noxious Substances Act 1987 (Tas), the Tasmanian EPA is responsible for responding to oil and chemical spills in Tasmanian state waters.

In the event that an MDO spill in Commonwealth waters crosses into Tasmanian state waters, the EPA will only assume Incident Control over the impacted area in State waters while AMSA will remain responsible for managing the spill outside Tasmanian coastal waters in consultation with the State.

The Tasmanian Oiled Wildlife Response Plan (‘WildPlan’) is administered by the Resource Management and Conservation Division of DPIPWE and outlines priorities and procedures for the rescue and rehabilitation of oiled wildlife.

9.1.4. Vessel SMPEP

MARPOL Annex I requires a SMPEP to be carried on all vessels >400 GRT. In general, a SMPEP describes the steps to be taken:

- In the event that a hydrocarbon spill has occurred;
- If a vessel is at risk of a hydrocarbon spill occurring, and
- For notification procedures in the event of a hydrocarbon spill occurring and provides all important contact details.

Each vessel conducting work for the Sequoia 3DMSS will hold a current SMPEP that will be the principal working document for the vessel and crew in the event of an MDO spill. The Vessel Master is responsible for activating and implementing the vessel SMPEP which includes information on about initial response, reporting requirements and arrangements for the involvement of third parties having the appropriate skills and facilities to effectively respond to oil spill issues.

The shipboard ERT is responsible for both prevention and response activities, with the SMPEP providing procedures for vessel-specific emergencies, including steps to control discharges associated with bunkering, hull damage, grounding and stranding, fire and explosion, collisions, vessel list, tank failure, sinking and vapour releases. The SMPEP also includes requirements for regular emergency response drills of the plan and revisions following drills or incidents.

Priority actions in the event of an MDO spill are to:

- Make the area safe;

- Stop the leak (source control); and
- Ensure that further spillage is avoided.

All deck spills will be cleaned-up immediately, using appropriate equipment from the onboard spill response kits to minimise any likelihood of discharge of hydrocarbons or chemicals to the sea.

The Vessel Master is responsible for activating and implementing the vessel SMPEP, the shipboard Emergency Response Team is responsible for both prevention and response activities with detailed instructions for the team being listed in the vessel SMPEP.

Specifically, the SMPEP provides the following:

- A description of all actions to be taken by onboard personnel to reduce or control the discharge following an MDO spill;
- A detailed description of all spill response equipment held onboard the vessel, including what equipment is available and where it is stored;
- Detailed diagrams of the vessel, including locations of drainage systems, location of spill response equipment and general layout of the vessel;
- An outline of the roles and responsibilities of all onboard personnel with regard to MDO spills;
- A description of the procedures and contacts required for the coordination of MDO spill response activities with the relevant Commonwealth and state agencies; and
- Requirements for testing of the SMPEP and associated drills.

ConocoPhillips Australia will conduct a multi-agency desktop drill exercise prior to the Sequoia 3DMSS commencing that incorporates a vessel-based MDO spill scenario (see Section 8.9.3). This is planned to take place in mid-2021 in ConocoPhillips Australia's Brisbane office.

9.2. Spill Response Options Assessed

Spill response mitigation measures will be implemented as appropriate to reduce the likelihood of impacts to key marine environmental receptors (see Section 9.2.1 for the spill response strategy). The objectives of spill response include the protection of human health, environmental values, and the protection of assets.

The selection of spill response techniques in any situation will include an operational NEBA to confirm the suitability of the implementation of EPS pre-identified in the strategic NEBA (presented in Section 7.13). The operational NEBA would be jointly undertaken between AMSA and ConocoPhillips Australia. The operational NEBA will take into consideration priorities for protection and sensitivity of the receptors at risk, as well as operational limitations including the amount and availability of equipment, access to competent personnel, logistical support (e.g., vessels, aircraft and land transport), access, maintaining equipment deployments, waste management, unfavourable weather conditions and seasonal variations.

9.2.1. Preferred Spill Response

A number of response options have been assessed specific to the Sequoia 3DMSS location, fuel type and spill modelling results. This assessment concluded that the following response strategies are the preferred options for an MDO release due to the location of the survey and likely behaviour of the MDO:

- Source control – locating the source of the leakage and isolating the tanks and transferring fuel to slack or empty tanks (where safe to do so) (suitable for spill levels 1, 2 and 3);
- Monitoring and evaluating the trajectory and extent of the spill (suitable for spill levels 2 and 3); and
- Assisted natural dispersion using propeller wash, if advised by the Control Agency that it is safe to do so (suitable for spill levels 2 and 3).

Initial actions for source control are outlined in the vessel SMPEP and would be undertaken in consultation with the relevant Control Agency (initially AMSA, given the survey's location in Commonwealth waters).

These spill response activities are not expected to introduce additional hazards to the marine environment or to result in significant additional potential impacts. The response options of source control, monitoring and evaluation and assisted natural dispersion will use existing survey and/or support vessels, and the potential impacts associated with the use vessels is evaluated throughout Chapter 7.

Spill response detail will reside with the vessel specific Emergency Response plan (First strike Response Plan) and the ConocoPhillips Crisis and Incident Management Plan.

9.3. Spill Notifications

The Vessel Master has the responsibility for reporting overboard spills to the AMSA Response Coordination Centre (RCC) (via POLREP Form contained in the vessel's SMPEP).

Once this initial report has been undertaken, further reports (SITREP forms) will be issued from the vessel at regular intervals to keep relevant parties (such as AMSA, NOPSEMA, etc.) informed. The ConocoPhillips Australia Offshore Representative is responsible for advising the ConocoPhillips Australia HSE General Manager of the spill incident via the agreed process. ConocoPhillips Australia is then responsible for notifying NOPSEMA.

Regulatory notification arrangements are provided in Table 9.2. In addition to this, ConocoPhillips Australia will advise potentially affected stakeholders of the spill.

Table 9.2: MDO spill regulatory notifications

Notification timing	Authority	Notification By	Contact Number	Details
Level 1 spill				
Immediately	Conoco-Phillips Australia General Manager HSE	Vessel Master	[redacted]	Vessel to notify ConocoPhillips Australia immediately or ASAP to ensure further notifications can be undertaken.
Within 2 hours	AMSA	Vessel Master	1800 641 792	Verbally notify AMSA RCC of spill. Follow up with written POLREP ASAP. http://www.amsa.gov.au/forms-and-publications/AMSA1522.pdf https://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/Contingency/Oil/documents/Appendix7.pdf
Within 2 hours	NOPSEMA	ConocoPhillips Australia General Manager HSE	08 6461 7090	ConocoPhillips Australia to verbally notify NOPSEMA of spill >80L. http://www.nopsema.gov.au/assets/Guidance-notes/N-03000-GN0926-Notification-and-Reporting-of-Environmental-Incidents-Rev-4-February-2014.pdf
Level 2 or 3 (in addition to Level 1 notifications)				
ASAP - if spill affects Vic Waters	DJPR	AMSA/ ConocoPhillips Australia General Manager HSE	03 8392 6934	Verbally notify DJPR and follow up with POLREP ASAP.
ASAP- if spill affects Tas Waters	EPA Tasmania	AMSA/ ConocoPhillips Australia General Manager HSE	03 6165 4599	Verbally notify EPA and follow up with POLREP ASAP.
Within 2 hours	Type II Monitoring Service Provider (RPS)	Environmental Unit Lead/ ConocoPhillips Australia General Manager HSE	08 9211 1111	Verbally notify service provider to initiate scientific monitoring if triggered (as outlined in Section 9.6.2).
Within 1 day	NOPTA	ConocoPhillips Australia General Manager HSE	08 6424 5317	Provide a verbal or written incident summary.

Within 3 days	NOPSEMA	ConocoPhillips Australia General Manager HSE	08 6461 7090	Provide a written incident report form.
If within the Zeehan AMP or adjacent to the Apollo AMP, regardless of spill size				
ASAP	Director of National Parks	ConocoPhillips Australia General Manager HSE	0419 293 465	Spill with potential to impact AMPs or other MNES, including potential for oiled wildlife. Provide: • Titleholder details; • Time and location of the incident (including name of AMP likely to be affected); • Proposed response arrangements as per the OPEP; • Confirmation of provision of monitoring and evaluation reports when available; and • Contact details for the response coordinator.

9.4. Spill Response Testing Arrangements

The vessel SMPEP includes provision for testing the SMPEP oil pollution emergency drills (in accordance with Regulation 14(8A)(8C) of the OPGGS(E)). Furthermore, a test of the oil spill emergency response arrangements referred to in this EP will be conducted:

- When they are introduced;
- When they are significantly amended;
- Not later than 12 months after the most recent test; and
- If and when a new vessel is engaged for the activity.

Prior to commencing the survey, spill response arrangements applicable to the survey vessel will be tested. The outcomes of the test will be documented to assess the effectiveness of the exercise against its objectives and to record any lessons and actions. Any actions will be recorded and tracked to completion.

The test will audit the onboard spill response capability against the SMPEP to verify spill preparedness and ensure vessel personnel are familiar with required actions.

9.4.1. OPEP Review

In accordance with OPGGS(E) Regulation 14(8), the OPEP must be kept up to date. A review of the OPEP occurs on an annual basis and is revised as required. Any of the following factors may trigger a revision of the OPEP:

- Changes to hazards and/or controls identified in the EP;
- Changes to response and/or monitoring capability;
- Outcomes from annual testing of the response arrangements;
- Revision of emergency management procedures;
- When major changes that may affect the oil spill response coordination or capabilities have occurred;
- After an actual emergency if gaps are identified within the plan;
- Change in state or Commonwealth oil spill response arrangements and resources; and

- Before installing and commissioning new plant and equipment (if risk profile changes).

9.5. Cost Recovery

In the event of a hydrocarbon spill, Part 6.1A of the OPGGS Act states that titleholders are required to eliminate or control the spill, clean up the spill and remediate any environmental damage and undertake environmental monitoring of the impact of the spill. The Act also states that any costs incurred by NOPSEMA and Commonwealth and state/Territory government agencies must be reimbursed by the titleholder.

Part 1B of the OPGGS(E) specifies that titleholders are required to maintain sufficient financial assurance to meet the costs, expenses and liabilities that may result from a worst-case event associated with its offshore activities. In the case of the Sequoia 3DMSS, this most credible such event would be a large scale MDO spill. Financial assurance must be demonstrated to NOPSEMA before the EP can be accepted. The joint title holders, ConocoPhillips Australia and 3D Oil, have processes in place to support cost recovery associated with spill response and operational and scientific monitoring (see the following section).

9.6. Hydrocarbon Spill Monitoring

The OSMP for the Sequoia 3DMSS can be rapidly activated in the event of a level 2 or 3 MDO spill.

Monitoring appropriate to the nature and scale of the spill will be determined based on the hydrocarbon characteristics, the size and nature of the release (e.g., slow continuous release or instantaneous short duration release), weathering characteristics (dispersion and dilution rates), the location of the spill and the modelled trajectory of the spill. There are two types of monitoring considered, discussed in detail below.

9.6.1. Type 1 Operational Monitoring

As the Control Agency, AMSA is responsible for initiating an appropriate level of Type I Operational Monitoring using NatPlan resources to monitor the spill and any response effort, if required.

Operational monitoring may include spill surveillance and tracking to validate oil spill trajectory modelling. ConocoPhillips Australia may, at the direction of the Control Agency, support Type I monitoring with on-the-water surveillance to:

- Determine the location, extent and character of a spill;
- Track the movement and trajectory of the spill;
- Identify receptors at risk; and
- Determine sea conditions and potential constraints to spill response activities.

This monitoring will also enable the Vessel Master to provide information to the relevant Control Agency (AMSA), via a POLREP/SITREP form, to allow for determination and planning of appropriate response actions under the NatPlan and relevant state plan(s), if required.

Operational monitoring and observation in the event of a spill will inform an adaptive spill response and, if required, will support the identification of appropriate scientific monitoring of relevant key sensitive receptors.

Specific monitoring/data requirements for Type 1 monitoring may include:

- Estimation of sea state;
- Estimation of wind direction and speed;
- Locating and characterising surface slicks (thickness and areal extent);
- GPS tracking using drifter buoys, if available;
- Manual or computer predictions of oil trajectory and weathering for Level 2 and 3 spills; and
- GIS mapping.

Determining the location, extent and characterisation of surface slicks will likely be restricted to daylight hours only, when surface slicks will be visible from the survey and support vessels. Evaluations of sea state and weather conditions from the vessel/s will continue until this function is taken over by the Control Agency. The information gathered from this initial monitoring will be passed on to the Control Agency, via the POLREP form, but also via ongoing SITREP reports following the initial spill notification to AMSA RCC.

ConocoPhillips Australia will implement, assist with, or contribute to (including funding if required) any other Type I monitoring (e.g., computer OSTM) as directed by the Control Agency.

9.6.2. Type II Scientific Monitoring

In consultation with the Control Agency, ConocoPhillips Australia will commit to scientific monitoring dependent on the circumstances of the spill, and the sensitivities at risk. The ConocoPhillips Australia OSMP describes the detailed arrangements and studies that could be activated upon request and agreement with AMSA (Table 9.3). The OSMP ensures ConocoPhillips Australia has a capability to undertake Type II scientific monitoring if required and also enable the chosen service provider to act (in a capacity as agreed with all parties) to either assist the Control Agency or to undertake key Type II monitoring activities on ConocoPhillips Australia's behalf (if initiation criteria are triggered).

ConocoPhillips Australia will work with AMSA and relevant stakeholders to implement appropriate Type II Scientific Monitoring. The aim of the Type II monitoring is to understand the environmental impacts of the spill and response activities on the marine environment, with a focus on relevant environmental, socio-economic and cultural values and sensitive receptors.

The scientific monitoring program outlined in the OSMP has been developed to ensure that it is sufficient to inform any remediation activities and is consistent with monitoring guidelines and methodologies such as CSIRO (2016).

The Type II monitoring may comprise some or all of the monitoring studies described in Table 9.3. As described previously, ConocoPhillips Australia will engage with AMSA to coordinate and review operational monitoring data, such as surveillance and modelling outputs to confirm the predicted extent and degree of MDO exposure and impacts. This data will then be used to determine if scientific monitoring of relevant key sensitive receptors may be of value in the longer term to assess environmental impacts and recovery of affected receptors. The requirement for, and design of scientific monitoring studies will be based on desktop/technical studies and/or field investigations, in order to ensure they are feasible and will obtain relevant information based on available monitoring data, the nature of the receiving environment and results of the consultation process.

If OSMP scientific monitoring studies are triggered, a detailed monitoring plan for each study will be developed in line with the OSMP. It is noted that where termination criteria for a study includes comparison to appropriate thresholds of concern, those thresholds will be confirmed and specified in the monitoring plan.

If deemed necessary, following consultation with the Control Agency and relevant stakeholders, ConocoPhillips Australia will activate its contract with its OSMP provider to design and implement the appropriate scientific monitoring studies as outlined in the ConocoPhillips Australia OSMP.

Initiation criteria for scientific monitoring studies are outlined throughout the ConocoPhillips Australia OSMP. Following ConocoPhillips Australia's notification to RPS that a spill has occurred, RPS will make the necessary preparations for the potentially required monitoring studies.

Table 9.3: Scientific monitoring program summary

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
Operational monitoring (OM)						
OM01 Hydrocarbon spill trajectory prediction	Used to predict the trajectory and concentration of spilled hydrocarbon, to guide the management and execution of spill response operations.	Level 2 or 3 hydrocarbon spills; **or** Level 1 hydrocarbon spill in the event that the spill extends beyond 500 m from the source and the source has not been contained.	Confirmation hydrocarbon release has ceased; **and** Trajectory assessment indicates that sensitive receptors are no longer at risk of hydrocarbon contact at or above moderate thresholds.	< 2 hours	Spill modelling software provided. Personnel with appropriate training and expertise in oil spill modelling. Accurate current, wind, temperature (air and sea), precipitation and tide data, detailed bathymetric data for the EMBA.	RPS OSRL
OM02 Hydrocarbon spill surveillance and reconnaissance	To provide regular and daily ongoing surveillance in the event of a spill; and to assess the colour, consistency, distribution and location of surface slicks and/or subsurface plumes (if visible).	Level 2 or 3 hydrocarbon spills; **or** Level 1 spill in the event that the spill extends beyond 500 m from the source and the source has not been contained.	Confirmation hydrocarbon release has ceased; **and** surface sheen (as per Bonn Agreement Oil Appearance Code) and subsurface plumes are no longer visible.	< 2 days	Output from OM01. Satellite tracker buoy(s). Crew for deployment of buoy. Personnel with aerial, satellite and vessel surveillance experience. Suitable aircraft/vessels.	Vessel/aerial contractor AMOSC/OSRL

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
OM03 Operational monitoring of hydrocarbon properties, behaviour and weathering at sea	To detect and monitor for the presence, quantity, properties, behaviour and weathering of surface, entrained and dissolved hydrocarbons, to inform decision making for spill response activities.	Level 2 or 3 hydrocarbon spills	When the hydrocarbon has weathered such that the weathering assessment no longer informs the operational response, and response activities have ceased, and concentrations of hydrocarbon in water are equal to or below relevant environmental guidelines (ANZECC/ARMCANZ 2000, ANZG 2018) species protection levels.	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the OM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification	Output from OM01-02. Personnel with appropriate training and expertise in field sampling Suitable vessels Sampling and sample storage equipment Accredited National Association of Testing Authorities (NATA) Laboratory.	Environmental Service Provider under contract for duration of activities Vessel contractor AMSA AMOSC
OM04 Pre-emptive assessment of sensitive receptors at risk	To assess the presence and extent of sensitive receptors based on a desktop review of existing data, where available; to undertake a desk-based review of fate and weathering predictions and spill trajectory predictions, combined with the location of key environmental and socio- economic sensitive receptors to determine those at risk of being affected by the spill and/or response activities; and to consult with stakeholders to validate existing data	Level 2 or 3 hydrocarbon spills	Spill response operations have been completed; or the assessment of sensitive receptors that were identified as being potentially impacted/contacted by the hydrocarbon spill is completed.	< 2 days	Output from OM01-03. Environmental Unit Leader to undertake a desktop review, identify key information gaps in baseline data, assist with determining study design.	Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
OM05 Operational monitoring of contaminated sensitive receptors	To confirm which sensitive receptors (habitats and organisms) are at risk from the hydrocarbon spill based on sensitivity and geographical location in relation to the spill trajectory and results of OM04; to inform suitable response activities to minimise the threat posed to sensitive receptors from the spill, dispersant application or other response activities; to assess and document actual/ anticipated impacts to wildlife during the spill and response activities; and to establish the need for scientific monitoring of sensitive receptors affected by the spill and response activities. Informs implementation of SMPs.	Level 2 or 3 hydrocarbon spills; **or** Level 1 spill in the event that the spill extends beyond 500 m from the source and the source has not been contained.	Confirmation hydrocarbon release has ceased; **and** spill response operations have been completed; **or** operational monitoring has been superseded by relevant scientific monitoring plans (SM02, SM03, SM04, SM05, SM06, SM07 and SM08).	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the OM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification	Output from OM01-02. Personnel with appropriate training and expertise in field sampling Suitable vessels Sampling and sample storage equipment Accredited National Association of Testing Authorities (NATA) Laboratory.	AMSA OSRL AMOSC Vessel/aerial contractor Environmental Service Provider

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
Scientific monitoring (SM)						
SM01 Monitoring of hydrocarbons in marine waters	To measure concentrations of hydrocarbon fractions and dispersed hydrocarbons in marine waters, via the implementation of vessel- based water quality surveys; to quantify the presence, concentrations and persistence of, as well as provide ground-truthing data on the longer term weathering fate of hydrocarbon compounds in marine waters (for comparison with modelling predictions); to input resulting data into identification of zones of exposure relative to key habitats and sensitive receptors for other SMs; to assess hydrocarbon/ dispersant content of water samples against accepted environmental guidelines and/or benchmarks, where available i.e. ANZECC/ ARMCANZ (2000), ANZG 2018.	Level 2 or 3 hydrocarbon spills	Monitoring has established the temporal and spatial distribution and nature of the spill and it is considered there is no further risk of receptors being contacted; **or** concentrations of hydrocarbons in water are equal to or below relevant environmental guidelines (ANZECC/ARMCANZ 2000, ANZG 2018 species protection levels) or United States Environmental Protection Authority (US EPA) Water Quality Benchmarks for Aquatic Life reference levels).	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the OM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification	Output from OM01-03. Personnel with aerial, satellite and vessel surveillance experience. Personnel with appropriate training and expertise in field sampling and in the use of specialised imagery software, image enhancement, feature extraction, geo-referencing, and interpretation of satellite imagery	Vessel/aerial contractor Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
SM02 Monitoring of hydrocarbons in benthic sediments	To understand composition, persistence and fate of hydrocarbons in sediments to provide data to assist in quantifying impacts on environmental values, sensitivities or receptors; to assess hydrocarbon concentrations and type in sediments at sites that were exposed to the spill against concentrations at reference sites and sediment quality guidelines; to conduct fingerprinting to characterise hydrocarbons and other chemicals in marine sediments to determine whether all hydrocarbons recorded are from the spill and not from other sources.	Level 2 or 3 hydrocarbon spills where: Spill trajectory modelling, surveillance **or** monitoring (OM01-05) predicts hydrocarbon contact with a sensitive receptor that is closely linked to marine sediments; **or** other SMs are triggered that require information on the presence, extent and toxicity/persistence of hydrocarbons in the water column (SM04, SM05 and SM08).	Monitoring has established temporal and spatial distributions and nature of hydrocarbons and show no further natural receptors or open ocean waters will be contacted; **or** monitoring results indicate that the concentrations of petrogenic hydrocarbons are equal to or below ANZECC/ARMCANZ 2000, ANZG 2018 guidelines where parameter values exist. The US EPA Water Quality Benchmarks for Aquatic Life reference levels will be used in any instance where a particular parameter guideline value does not exist.	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the SM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Output from OM01-04. Personnel with appropriate training and expertise in field sampling (water collection and processing). Suitable vessels. Sample collection and sample storage equipment (including multiparameter logger with fluorometer). Accredited NATA Laboratory.	Vessel contractor Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
SM03 Survey of shoreline and intertidal sediments and biological communities to determine impacts of hydrocarbon spill and recovery	To monitor and determine the impact of a hydrocarbon spill and/or response activities and the recovery for intertidal and shoreline sediments and biological communities	Spill trajectory modelling, surveillance **or** monitoring (OM01-05) predicts hydrocarbon contact with a sensitive resource (shoreline, intertidal benthic habitat/ community; **or** other scientific monitoring programs are triggered that require information on the presence, extent, toxicity and persistence of hydrocarbons in key habitats or to sensitive receptors (SM04 and SM05).	Impacts to shoreline and intertidal sediments and biological communities have been determined and monitoring results indicate no further habitats are at risk from, or have been exposed to, hydrocarbons; **or** affected shoreline and intertidal biological communities have returned to baseline conditions and show no detectable sublethal and lethal impacts in comparison to controls sites; **or** sediment samples indicate that levels of hydrocarbons are equal to or below reference/pre-impact levels.	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the SM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Output from OM01-04 and SM01-02. Personnel with appropriate training and expertise in field sampling (coral reef, seagrass, macroalgae, intertidal habitat / communities and shoreline assessment) Suitable vessels (i.e., low draft) and vehicles Sample collection and sample storage equipment Accredited NATA Laboratory Underwater video / photographic equipment (i.e., towed video, drop camera, BRUVs)	Vessel contractor Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
SM04 Monitoring of subtidal benthos to determine impacts of hydrocarbon spill and recovery	To determine the extent, severity, and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities; to collect information to determine short-term and long-term (including direct and indirect) impacts of hydrocarbon spill (and response activities) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time after termination of the response.	Spill trajectory modelling, surveillance or monitoring (OM01-05) predicts hydrocarbon contact with a sensitive subtidal benthic habitat/ community; **or** Results from OM04 indicate that hydrocarbon has or is likely to have reached a shoreline.	Impacts to subtidal habitats have been determined and monitoring results indicate no further habitats are at risk from, or have been exposed to hydrocarbons; **or** affected subtidal benthic habitats have returned to baseline conditions and show no detectable sublethal and/or lethal impacts in comparison to controls sites; **or** monitoring shows restoration or resumption of key biological processes (e.g., reproduction and recruitment) necessary for post impact recovery is demonstrated by affected marine benthos; **or** sediment samples indicate that levels of hydrocarbons are equal to or below reference / pre-impact levels.	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the SM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Output from OM01-05 and SM01-03). Personnel with appropriate training and expertise in field sampling (coral reef, seagrass, macroalgae, fish communities) Suitable vessels Sample collection and sample storage equipment Accredited NATA Laboratory Underwater video / photographic equipment (i.e. towed video, drop camera, BRUVs)	Vessel contractor Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
SM05 Wildlife surveys to determine impact of hydrocarbon spill on shorebirds and seabirds	To assess any short term or longer-term environmental effects on seabird and migratory shorebird populations within the study area that may have resulted from a hydrocarbon spill.	Spill trajectory modelling, surveillance or monitoring (OM01-05) predicts contact is possible to seabirds or shorebird populations or any of their habitats of importance for breeding, nesting or foraging; **or** Monitoring (OM05) has identified contact or an impact to seabirds or shorebird populations as a result of the hydrocarbon spill; **or** Reports or scientific evidence of oiled seabirds or shorebird populations.	There has been no demonstrable evidence of an impact on seabirds and/or shorebirds from the hydrocarbon/chemical spill; **or** key seabird and shorebird behaviour and breeding activities have been quantified in the zone of exposure and are comparable to reference sites; **or** measured parameters have returned to baseline conditions (taking into account natural variability) in terms of breeding population (for seabirds) or counts (for shorebirds) and impacts on species and taxa are no longer detectable, with regard to reference sites.	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the SM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Output from OM01-05. Personnel with appropriate training and expertise in field sampling (avian ecologists). Photographic equipment. Binoculars. Tissue sample collection and sample storage equipment. Accredited NATA laboratory.	Vessel/aerial contractor Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
SM06 Wildlife surveys to determine impact of hydrocarbon spill on marine megafauna	To assess any short term or longer-term environmental effects on marine megafauna which may have resulted from the hydrocarbon spill.	Spill trajectory modelling, surveillance or monitoring (OM01-05) predicts contact is possible to marine megafauna populations or any of their habitats of importance for breeding or foraging; or Monitoring (OM05) has identified contact or an impact to marine megafauna populations as a result of the hydrocarbon spill; **or** Reports or scientific evidence of oiled marine megafauna	There has been no demonstrable evidence of an impact on marine megafauna from the hydrocarbon/chemical spill; **or** key biological processes (e.g. abundance, distribution, breeding) are similar to pre-spill or reference sites.	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the SM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Output from OM01-05 and SM04. Personnel with appropriate training and expertise in field sampling (marine megafauna ecologists). Photographic equipment Binoculars. Tissue sample collection and sample storage equipment Accredited NATA laboratory	Vessel/aerial contractor Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
SM07 Determination of impact of hydrocarbon spill on commercial, traditional and recreational fisheries and aquaculture	To identify, report, and monitor potential impacts on fish resulting from the hydrocarbon spill and/or associated spill response activities; and to determine the spatial and temporal extent of sublethal impacts on indicator species, which may impact commercial, traditional and recreational fish species, including health effects attributable to the spill and/or response activities and tainting of the flesh and/or bioaccumulation of toxins in fish.).	Spill trajectory modelling, surveillance or monitoring (OM01-05) predicts contact is possible to commercial, traditional or recreational species or aquaculture species; or advice has been provided to government to restrict, ban or close a fishery (SM07 will commence to provide data for government to enable decisions to be made on when a fishery can be reopened); **or** declarations of intent by commercial fisheries or government agencies to seek compensation for alleged or possible damage.	Contamination in the edible portion or in the stomach / intestinal contents attributable to the spill is no longer detected; **or** The physiological and biochemical parameters of commercial, traditional, recreational or aquaculture species are comparable between reference and impact sites; **or** Evidence that catch rates, species composition, community abundance, distribution and age structure of commercial fisheries and by-catches have returned to baseline levels (taking into account natural variability).	Preparation to deploy field personnel and equipment will commence on notification from ConocoPhillips IMT that the SM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Output from OM01-05. Personnel with appropriate training and expertise in field sampling (i.e. ecotoxicology, fisheries sampling). Photographic equipment. Binoculars. Fish traps. Tissue sample collection and sample storage equipment. NATA accredited laboratory.	Vessel contractor Environmental Service Provider under contract for duration of activities

Monitoring plan	Aim and objectives	Initiation criteria	Termination criteria	Approximate mobilisation time	Resources required	Suppliers/ support party
SM08 Determination of impact of hydrocarbon spill on recreational, commercial and/or industrial users	To determine the extent, severity and likely persistence of direct and indirect impacts on commercial, recreational and/or industrial users from a hydrocarbon spill and associated response activities; to identify areas where monitoring may need to continue for an extended period of time following termination of the response.	Spill trajectory modelling, surveillance or monitoring (OM01-05) predicts hydrocarbon spill contact, or impacts from associated response activities with commercial, recreational and/or industrial users.	Monitoring results have quantified the extent and level of impact to selected recreational, commercial and/or industrial users; and monitoring indicates there are no new or additional impacts likely to affect recreational, commercial and/or industrial users; and areas requiring long term monitoring have been identified and an ongoing monitoring plan developed in consultation with key stakeholders.	Preparation to deploy personnel will commence on notification from ConocoPhillips IMT that the SM has been triggered. Deployment of personnel within 7 days of receipt of notification.	Output from OM01-05. Baseline data on relevant users. Personnel with appropriate training and expertise in socio-economic receptors and economic impact analysis and/or ecosystem-based valuation methods.	Environmental Service Provider under contract for duration of activities

10. References

ABC. 2017. Dolphins migrate across Bass Strait to double dip in the gene pool. A WWW article accessed at http://www.abc.net.au/news/2017-07-27/dolphins-migrating-to-mate-in-tasmania-and-victoria/8742292. Australian Broadcasting Corporation.

ABC News. 2014. 'Clean-up underway after tar balls wash up on Ninety Mile Beach.' ABC News Online. Article posted 18 March 2014. Australian Broadcasting Corporation.

ABS. 2020. Quick Stats. A WWW database accessed at https://www.abs.gov.au/websitedbs/D3310114.nsf/Home/2016%20QuickStats. Australian Bureau of Statistics. Canberra.

Adam P. 1990. Saltmarsh Ecology. Cambridge University Press, Cambridge.

Addison, R.F. and Brodie,P.F. 1984. Characterization of ethoxyresorufin O-de-ethylase in gray seal Halichoerus grypus. Comp. Biochem. Physiol. 79C:261-263.

Addison, R.F., Brodie,P.F., Edwards, A. and Sadler, M.C. 1986. Mixed function oxidase activity in the harbour seal (*Phoca vitulina*) from Sable Is., N.S. Comp. Biochem. Physiol. 85C (1):121-124.

AFMA. 2021. Blue warehou. A WWW database accessed in January 2021 at http://www.afma.gov.au. Australian Fisheries Management Authority. Canberra.

Agreement on the Conservation of Albatross and Petrels. 2020. Species Assessments. A WWW database accessed on 21st September 2020 at http://www.acap.aq/acap-species.

Aguilar de Soto, N., N. Delorme, J. Atkins, S. Howard, J. William, and M. Johnson. 2013. Anthropogenic noise causes body malformations and delays development in marine larvae. Scientific Reports 3:2831.

AMMC. 2012. Report of the workshop on the satellite tracking of southern right whales in Australian waters, Melbourne, Australia 22-23 November 2012. Department of Sustainability, Environment, water, People and Communities, Australian Antarctic Division.

AMMC. 2009. Report of the Australian Southern Right Whale Workshop, 19-20 March 2009, Australian Antarctic Division, Kingston, Tasmania.

AMOSC. 2017. Australian Industry Cooperative Oil Spill Response Arrangements. Australian Marine Oil Spill Centre. Geelong.

AMSA. 2020. National Plan for Maritime Environmental Emergencies. Australian Maritime Safety Authority.

Andrew, N. 1999. Under Southern Seas: The Ecology of Australia's Rocky Reefs. University of New South Wales Press: Sydney.

André, M., K. Kaifu, M. Solé, M. van der Schaar, T. Akamatsu, A. Balastegui, A.M. Sánchez, and J.V. Castell. 2016. Contribution to the understanding of particle motion perception in marine invertebrates. (Chapter 6) In Popper, A. and A. Hawkins (eds.). The Effects of Noise on Aquatic Life II. Springer. 47-55.

APPEA. 2008. Code of Environmental Practice. Australian Petroleum Production and Exploration Association.

AMSA. 2015. Technical guidelines for preparing contingency plans or marine and coastal facilities. Australian Maritime Safety Authority. Canberra.

AMSA. 1998. The Effects of Maritime Oil Spills on Wildlife Including Non-Avian Marine Life. Australian Maritime Safety Authority. Canberra.

AODN. 2020. Australian Ocean Data Network. A WWW database accessed at https://portal.aodn.org.au. University of Tasmania and National Research Infrastructure for Australia.

APASA. 2012. Marine diesel fuel oil spills and weathering. Memorandum from Trevor Gilbert, Director Maritime, Environment and Chemical Services at APASA, to Phil Harrick, HSEQ Manager, AGR Petroleum Services. 24th June 2012.

AQIS. 2011. Australian Ballast Water Management Requirements. Version 5. Australian Quarantine Inspection Service, Department of Agriculture, Fisheries and Forestry. Canberra.

Arnould, J. and Berlincourt, M. 2013. At-sea movements of little penguins (*Eudyptula minor*) in the Otway Basin. Report prepared for Origin Energy.

Atlas of Living Australia. A WWW database accessed at https://spatial.ala.org.au/#.

Au, W.L., Popper, A.N. and Ray, A. 2000. Hearing by Whales and Dolphins. Springer New York.

Backhouse, G., Jackson J., & O'Connor, J. 2008. National Recovery Plan for Australian Grayling *Prototroctes* maraena. Department of Sustainability and Environment, Melbourne.

Baines, P. and Fandry, C. 1983. Annual cycle of the density field in Bass Strait. Marine and Freshwater Research 34, 143-153.

Bannister, J., Kemper, C. and Warnecke R. 1996. The Action Plan for Australian Cetaceans. The Director of National Parks and Wildlife Biodiversity Group. Environment Australia. Canberra.

Barkaszi, M.J., M. Butler, R. Compton, A. Unietis, and B. Bennet. 2012. Seismic survey mitigation measures and marine mammal observer reports. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-015.

Barry, S. B., Cucknell, A. C. and Clark, N. 2012. 'A direct comparison of bottlenose dolphin and common dolphin behaviour during seismic surveys when air guns are and air not being utilised.' In: The effects of noise on aquatic life. Edited by A. N. Popper and A. Hawkins.

Barton, J., Pope, A. and Howe, S. 2012. Marine Natural Values Study Vol 2: Marine Protected Areas of the Flinders and Twofold Shelf Bioregions. Parks Victoria Technical Series. Number 79. Parks Victoria. Melbourne.

Barrett, N., Buxton, C. and Edgar, G. 2009. Changes in invertebrate and macroalgal populations in Tasmanian marine reserves in the decade following protection. Journal of Experimental Marine Biology and Ecology. 370. 104-119. 10.1016/j.jembe.2008.12.005.

Bartol, S.M., Musick, J.A. and Lenhardt, M.L. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). Copeia: 836-840.

Bartol, S.M. and Ketten, D.R. 2006. Turtle and tuna hearing. In: Swimmer, Y. and Brill, R (eds). December 2006. NOAA Technical Memorandum NMFS-PIFSC-7. 98-103.

Bell, B., Spotila, J.R. and Congdon, J. 2006. High Incidence of Deformity in Aquatic Turtles in the John Heinz National Wildlife Refuge. Env Poll. 142(3): 457– 465.

Birdlife Australia. 2020. Species fact sheets. A WWW database accessed at http://birdlife.org.au/.

Birdlife Australia. 2016. Species fact sheets. A WWW database accessed in August 2016 at http://birdlife.org.au/.

Birdlife International. 2020. Important Bird Areas factsheet: Hunter Island Group. A WWW database accessed at http://www.birdlife.org.

Bik, H.M, Halanych, K.H., Sharma, J. and Thomas, W.K. 2012. Dramatic shifts in benthic microbial eukaryote communities following the Deepwater Horizon oil spill. PLOS One 7(6): e38550.

Black, K.P., Brand, G.W., Grynberg, H., Gwyther, D., Hammond, L.S., Mourtikas, S., Richardson, B.J., and Wardrop, J.A. 1994. Production facilities. In: Environmental implications of offshore oil and gas development in Australia – the findings of an independent scientific review. Swan, J.M., Neff, J.M. and Young, P.C. (eds) Australian Petroleum Exploration Association. Sydney. Pp 209-407.

Blackwell, S.B., Nations, C., McDonald, T., Thode, A., Mathias, D., Kim, K., Greene, C. Jr. and Macrander, A. 2015. Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioural thresholds. PLoS ONE 10(6): e0125720.

Blumer, M. 1971. Scientific aspects of the oil spill problem. Environmental Affairs 1:54–73.

Boeger, W. A., Pie, M.R., Ostrensky, A. and Cardoso, M.F. 2006. The effect of exposure to seismic prospecting on coral reef fishes. Brazilian Journal of Oceanography 54:235-239.

BOEM. 2014. Proposed Geological and Geophysical Activities, Mid-Atlantic and South Planning Areas, Final Programmatic Environmental Impact Statement. US Department of the Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region. New Orleans.

Bolle, L.J., de Jong, C.A.F., Bierman, S.M., van Beek, P.J.G., van Keeken, O.A., 2012. Common sole larvae survive high levels of pile-driving sound in controlled exposure experiments. PLoS One 7, e33052.

Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren, T. and Toklum, K. 1996. Effects of airgun shooting on eggs, larvae and personnel. Havet (3): 1-83.

Bolstad, K. & O'Shea, S. 2004. Gut contents of a giant squid *Architeuthis dux* (Cephalopoda: Oegopsida) from New Zealand waters, New Zealand Journal of Zoology, 31:1, 15-21, DOI: 10.1080/03014223.2004.9518354).

BoM. 2020. Climate Statistics for Australian Locations: King Island. A WWW database accessed at http://www.bom.gov.au/climate/averages/tables/cw_098017.shtml. Bureau of Meteorology. Canberra.

Bond. C, Harris A.K. 1988. Locomotion of sponges and its physical mechanism, Developmental and Cellular Biology, Vol. 246, Issue 3, June 1988 pp271-284

Boreen, T., James, N., Wilson, C. and Heggie, D. 1993. Surficial cool-water carbonate sediments on the Otway continental margin, southeastern Australia. Marine Geology 112: 35-56

Boyle, P., Rodhurst, P. 2005. Cephalopods, Ecology and Fisheries, Blackwell Publishing. Carlton, Victoria

BP. 2015. Gulf of Mexico Environmental Recovery and Restoration. Five-year Report. March 2015. BP Exploration and Production Inc. London.

BP. 2014. Abundance and Safety of Gulf Seafood. Seafood Background White Paper. A WWW publication accessed at https://www.thestateofthegulf.com/media/1428/seafood-background-white-paper.pdf. BP Exploration and Production Inc. London.

Brown, P.B. and Wilson, R.I. 1980. A Survey of the Orange-bellied Parrot *Neophema chrysogaster* in Tasmania, Victoria and South Australia. Tasmanian National Parks & Wildlife Service. Hobart.

Bruce, G.D., J.D. Stevens & H. Malcolm. 2006. Movements and swimming behaviour of white sharks (*Carcharodon carcharias*) in Australian waters. Marine Biology. 150:161-172. Available from: http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=5&hid=15&sid=e92b4861-0c33-4972-81be-796819288dd2%40sessionmgr4.

Bruce, B.D, Bradford, R., Daley, R., Green, M. & Phillips, K. 2002. Targeted Review of Biological and Ecological Information from Fisheries Research in the South East Marine Region, Final Report, CSIRO Marine Research, National Oceans Office.

Bruce, B.D., Neira, F.J., Bradford, R.W. 2001. Laval Distribution and abundance of blue and spotted warehous (*Seriolella brama* and *S. punctata*: Centrolophidae) in south-eastern Australia, Mar. Freshwater Res., 2001, 52, 631-6

Brusati, E.D. and Grosholz, E.D. 2007. Effect of native and invasive cordgrass on *Macoma petalum* density, growth and isotopic signatures. Estuarine Coastal and Shelf Science 71: 517–522.

Brown, D. & Root, F. 2010. Western Port Ramsar Wetland Ecological Character Description. Report for Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Burger, A.E. 1993. Estimating the mortality of seabirds following oil spills: effects of spill volume. Mar. Poll. Bull 26:140–143.

Butler, A., Althaus, F., Furlani, D. and Ridgway, K. 2002. Assessment of the Conservation Values of the Bass Strait Sponge Beds Area: A component of the Commonwealth Marine Conservation Assessment Program 2002-2004. Report to Environment Australia, CSIRO Marine Research. Hobart

Butler, C., Lucieer, V., Walsh, P., Flukes., E and Johnson, C .2017. Seamap Australia [Version 1.0] the development of a national benthic marine classification scheme for the Australian continental shelf. A WWW database accessed at: https://seamapaustralia.org. Institute for Marine and Antarctic Studies, University of Tasmania.

Caputi, N., Feng M., Pearce A.. 2015. Management implications of climate change effect on fisheries in Western Australia: Part 1 Environmental change and risk assessment. FRDC Project 2010/535. Fisheries Research Report 260, Department of Fisheries, Western Australia, 180 pp.

CarbonNet. 2018. Geotechnical and Geophysical Investigations Environment Plan Summary. A WWW publication accessed at https://info.nopsema.gov.au/home/underway_offshore. Department of Jobs, Precincts and Regions. Melbourne.

CarbonNet. 2020. Pelican 3D Marine Seismic Survey Offshore Habitat Assessments Executive Summary. A WWW publication accessed at: https://www.earthresources.vic.gov.au/projects/carbonnet-project/marine-seismic-survey-habitat-impact-assessment-outcomes). Department of Jobs, Precincts and Regions. Melbourne.

Carls, M.G., Holland. L., Larsen, M., Collier, T.K., Scholz, N.L. and Incardona, J.P. 2008. Fish embryos are damaged by dissolved PAHs, not oil particles. Aquatic Toxicology 88:121– 127.

Carlyon, K., Pemberton, D. and Rudman, T. 2011. Islands of the Hogan Group, Bass Strait: Biodiversity and Oil Spill Response Survey. Resource Management and Conservation Division, DPIPWE, Hobart, Nature Conservation Report Series 11/03.

Carlyon, K., Visoiu, M., Hawkins, C., Richards, K. and Alderman, R. 2015. Rodondo Island, Bass Strait: Biodiversity & Oil Spill Response Survey. Natural and Cultural Heritage Division, DPIPWE, Hobart. Nature Conservation Report Series 15/04.

Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M. and Bruce, B. 2017. A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Mar. Poll. Bull. 114 (2017) 9-24.

Castellote, M., Clark, C.W. and Lammers, M.O. 2012. Acoustic and behavioural changes by fin whales (*Balaenaptera physalus*) in response to shipping and airgun noise. Bio. Cons. 147: 115-122.

Casper, B.M., Halvorsen, M.B., Matthews, F., Carlson, T.J. and Popper, A.N. 2012. Recovery of barotrauma injuries resulting from exposure to pile driving sound in two sizes of hybrid striped bass. PLoS ONE 8(9): e73844.

Cato, D., Noad, M., Dunlop, R., McCauley, R., Gales, N., Salgado K.,, Chandra K., Eric P., and David J. 2013. A study of the behavioural response of whales to the noise of seismic air guns: Design , methods and progress. Acoustics Australia. 41. 88-97.

Centre of Integrative Ecology. 2020. Southern Australian Sea Turtles Database. A WWW database accessed at https://cie-deakin.com/database/. Deakin University.

Challenger, G. and Mauseth, G. 2011. Chapter 32 – Seafood safety and oil spills. In: Oil Spill Science and Technology. M. Fingas (ed) 1083-1100.

Christian, J.R., Mathieu, A., Buchanan, R.A., 2004. Chronic Effects of Seismic Energy on Snow Crab (*Chionoecetes opilio*). Environmental Funds Project No. 158. Fisheries and Oceans Canada. Calgary (25pp).

Christian, J.R., Mathieu, A., Thomson, D.H., White, D., Buchanan, R.A. 2003. Effect of seismic energy on snow crab (*Chionoecetes opilio*). Environmental Research Funds Report No 144, Calgary, 106p.

Christensen-Dalsgaard, J., Christian, B., Willis, K., Christensen, C., Ketten, D., Edds-Walton, P., Fay, R., Madsen, P., and Carr, C. 2012. Specialization for underwater hearing by the tympanic middle ear of the turtle, Trachemys scripta elegans Proc. R. Soc. B.2792816–2824 http://doi.org/10.1098/rspb.2012.0290

Cintron, G., Lugo, A.E., Marinez, R., Cintron, B.B., Encarnacion, L. 1981. Impact of oil in the tropical marine environment. Prepared by Division of Marine Research, Department of Natural Resources. Puerto Rico.

Clark, R.B. 1984. Impact of oil pollution on seabirds. Environmental Pollution (Series A) 33:1–22.

CoA. 2009. National Biofouling Management Guidance for the Petroleum Production and Exploration Industry. Commonwealth of Australia. Canberra.

Committee on Oil in the Sea. 2003. Oil in the Sea III: Inputs, Fates and Effects. Washington, D.C. The National Academies Press.

Connell, D. W., Miller, G.J. and Farrington, J.W. 1981. Petroleum hydrocarbons in aquatic ecosystems—behaviour and effects of sublethal concentrations: Part 2. Critical Reviews in Environmental Science and Technology. 11(2): 105-162.

Cooper Energy. 2020. Offshore Victoria Operations. A WWW document accessed at: https://www.cooperenergy.com.au/our-operations/australia/otway-basin/offshore-vic. Cooper Energy, Adelaide.

Courtney, A., Spillman, C., Lemos, R., Thomas, J., Leigh, G. & Campbell, A. 2015. Physical oceanographic influences on Queensland reef fish and scallops. Fisheries Research and Development Corporation. Department of Agriculture and Fisheries.

Cox, B., Dux, A., Quist, M. and Guy, C. 2012. Use of a Seismic Air Gun to Reduce Survival of Nonnative Lake Trout Embryos: A Tool for Conservation?, North American Journal of Fisheries Management, 32:2, 292-298, DOI: 10.1080/02755947.2012.675960.

Cranford, T. and Krysl, P. 2015. Fin Whale Sound Reception Mechanisms: Skull Vibration Enables Low-Frequency Hearing. PLOS ONE 10(3): e0122298. https://doi.org/10.1371/journal.pone.0122298

CSIRO. 2015. Plankton 2015. State of Australia's Oceans. Linking science and policy: an assessment of our oceans using plankton indicators of ecological change. CSIRO Oceans and Atmosphere.

Curtin University. 2009. Report on Biopsy Collections from Specimens Collected from the Surrounds of the West Atlas Oil Leak – Sea Snake Specimen. Curtin University, Perth.

Curtin University. 2010. Report on Necropsies from a Timor Sea Horned Sea Snake. Curtin University, Perth.

DAFF. 2020. Marine Pests Interactive Map. A WWW database accessed at http://www.marinepests.gov.au/Pages/ marinepest-map.aspx. Department of Agriculture, Fisheries and Forestry. Canberra.

DAFF. 2009. The National Biofouling Management Guidance for the Petroleum Production and Exploration Industry. A WWW document accessed at http://www.marinepests.gov.au/marine_pests/publications/Pages/petroleum-exportation.aspx. Department of Agriculture, Fisheries and Forestry. Canberra.

Dalen, J. and Knutsen, G.M. 1987. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations. In Merklinger, H.M. (ed.) Progress in underwater acoustics. Plenum Press. New York.

Dalen, J., Ona, E., Soldal, A.V. and Saetre, R. 1996. Seismic investigations at sea: an evaluation of consequences for fish and fisheries. Institute of Marine Research Fisken og Havet. 9.

Dalley, DD, McClatchie, S, .1989. Functional feeding morphology of the euphausiid Nyctiphases Australia, Marine Biology 1010 1950293.

Danion, M. Le Floch, S. Kanan, R., Lamour, F. and Quentel, C. 2011. Effects of in vivo chronic hydrocarbons pollution on sanitary status and immune system in sea bass (*Dicentrarchus labrax* L.). Aquatic toxicology. 105. 300-11. 10.1016/j.aquatox.2011.06.022.

Davis, H.K., Moffat, C.F. and Shepherd, N.J. 2002. Experimental Tainting of Marine Fish by Three Chemically Dispersed Petroleum Products, with Comparisons to the Braer Oil Spill. Spill Science & Technology Bulletin. 7(5–6): 257– 278.

Davies, J.L. 1949. Observations on the gray seal (*Halichoerus grypus*) at Ramsey Island, Pembrokeshire. Proc. Zool. Soc. London. 119: 673-692.

Davis, J.E. and Anderson, S.S. 1976. Effects of oil pollution on breeding gray seals. Mar. Pollut. Bull. 7:115-118.

DAWE. 2020. The Australian Ballast Water Management Requirements (v8). A WWW document downloaded from https://www.agriculture.gov.au/sites/default/files/documents/australian-ballast-water-management-requirements.pdf. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2020a. EPBC Act Protected Matters Search Tool. A WWW database accessed at http://www.environment.gov.au/epbc/pmst/. Department of the Environment and Energy. Canberra.

DAWE. 2020b. Species Profile and Threats (SPRAT) Database. Department of the Environment and Energy. Canberra.

DAWE. 2020c. National Conservation Values Atlas. A WWW database accessed at https://www.environment.gov.au/topics/marine/marine-bioregional-plans/conservation-values-atlas. Department of the Environment and Energy. Canberra.

DAWE. 2020d. Australia's World Heritage List. A WWW database accessed at http://www.environment.gov.au/heritage/places/world-heritage-list. Department of the Environment and Energy. Canberra.

DAWE. 2020e. Australia's National Heritage List. A WWW database accessed at http://www.environment.gov.au/heritage/places/national-heritage-list. Department of the Environment and Energy. Canberra.

DAWE. 2020f. Australia's Commonwealth Heritage List. A WWW database accessed at http://www.environment.gov.au/topics/heritage/heritage-places/ commonwealth-heritage-list. Department of the Environment. Canberra.

DAWE. 2020g. Directory of Important Wetlands in Australia. A WWW database accessed at https://www.environment.gov.au/water/wetlands/australian-wetlandsdatabase/directory-important-wetlands. Department of Agriculture, Water and the Environment. Canberra.

DAWE. 2020h. Australian National Shipwreck Database. A WWW database accessed at http://environment.gov.au/heritage/historic-shipwrecks/australian-national-shipwreck-database. Department of the Environment and Energy. Canberra.

DAWR. 2018. Marine Pest Plan 2018-2023. National Strategic Plan for Marine Pest Biosecurity. Department of Agriculture and Water Resources. Canberra.

DAWR. 2017. Australian Ballast Water Management Requirements. Version 7. Department of Agriculture and Water Resources. Canberra.

DAWR. 2016. The Australian Ballast Water Management Requirements (v6). A WWW document downloaded from http://www.agriculture.gov.au/biosecurity/avm/vessels/ballast/australian-ballast-water-management- requirements-version6. Department of Agriculture and Water Resources. Canberra.

DAWR. 2015. Ballast Water. A WWW database accessed at http://www.agriculture.gov.au/biosecurity/avm/vessels/quarantine-concerns/ballast. Department of Agriculture and Water Resources. Canberra.

Day, R., Fitzgibbon, Q., McCauley, R., Hartmann, K. and Semmens, J. 2020. Lobsters with pre-existing damage to their mechanosensory statocyst organs do not incur further damage from exposure to seismic air gun signals. Environmental Pollution. 267. 115478. 10.1016/j.envpol.2020.115478.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, and J.M. Semmens. 2019. Seismic air guns damage rock lobster mechanosensory organs and impair righting reflex. Proc. R. Soc. B 286(1907): 10.

Day, R., McCauley, R., Fitzgibbon, Q., Hartmann, K. and Semmens, J. 2017. Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop Pecten fumatus. Proceedings of the National Academy of Sciences Oct 2017, 114 (40) E8537-E8546; DOI: 10.1073/pnas.1700564114.

Day, R. D., McCauley, R., Fitzgibbon, Q.P. and Semmens, J.M. 2016a. Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries. FRDC Report 2012/008. University of Tasmania. Hobart.

Day, R.D., McCauley, R.D. Fitzgibbon, Q.P. and Semmens, J.M. 2016b. Seismic air gun exposure during early stage embryonic development does not negatively affect spiny lobster *Jasus edwardii* larvae (Decapoda:Palinuridae), Scientific Reports 6, Article Number: 22733.

De Soto, N.A. 2016. Peer-reviewed studies on the effects of anthropogenic noise on marine invertebrates: From scallop larvae to giant squid. Advances in Experimental Medicine and Biology 875: 17-26.

DEH. 2006. A Guide to the Integrated Marine and Coastal Regionalisation of Australia. Department of the Environment and Heritage. Canberra.

DEH. 2005a. Humpback Whale Recovery Plan 2005-2010. Department of Environment and Heritage. Canberra.

DEH. 2005b. Southern Right Whale Recovery Plan 2005-2010. Department of Environment and Heritage. Canberra.

DELWP. 2020. Victorian Biodiversity Atlas. Accessed at: https://www.environment.vic.gov.au/biodiversity/victorian-biodiversity-atlas

DELWP. 2018. Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site Management Plan. Department of Environment, Land, Water and Planning, East Melbourne.

DELWP. 2017. Western Port Ramsar Site Management Plan. Department of Environment, Land, Water and Planning, East Melbourne.

DELWP. 2016. National Recovery Plan for the Orange-bellied Parrot, *Neophema chrysogaster*. A WWW document accessed at http://www.environment.gov.au/biodiversity/threatened/recovery-plans/orange-bellied-parrot2016. Department of Environment, Land, Water and Planning. Melbourne.

DELWP. 2015. Australian Grayling Action Statement. A WWW document accessed at https://www.environment.vic.gov.au/_data/assets/pdf_file/0012/33024/Australian-Grayling_actionstatement.pdf. Department of Environment, Land, Water and Planning. Melbourne.

DEDJTR. 2017. Oil Spill Response Atlas. Maintained by Transport for Victoria. Department of Economic Development, Jobs, Transport and Resources. Melbourne.

DEDJTR, 2016. Victorian Giant Crab Fishery, Stock Assessment report, 2014/2015 Season, Department of Economic Development, Jobs, Transport and Resources available at https://vfa.vic.gov.au/commercial-fishing/giant-crab/stock-assessmentreports.

DEWHA. 2008. EPBC Act Policy Statement 2.1-Interaction between offshore seismic exploration and whales, Department of Environment, Water, Heritage & the Arts, Canberra.

DFO. 2004. Potential impacts of seismic energy on snow crab. DFO Can. Sci. Advis. Sec. Habitat Status Report 2004/003.

Di Iorio, L. and C.W. Clark. 2010. Exposure to seismic survey alters blue whale acoustic communication. Biology Letters 6(1): 51-54.

DNP. 2013. South-east Commonwealth Marine Reserves Network Management Plan 2013-23. Director of National Parks. Canberra.

DoE. 2015a. South-east Marine Regional Profile. A WWW document accessed at http://www.environment.gov.au/system/files/resources/7a110303-f9c7-44e4-b33700cb2e4b9fbf/files/south-east-marine-region-profile.pdf. Department of the Environment. Canberra.

DoE. 2015b. Conservation Management Plan for the Blue Whale. A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999. Department of the Environment. Canberra.

DoE. 2015b. Conservation Advice *Calidris ferruginea* curlew sandpiper. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservationadvice.pdf

DoE. 2015c Conservation Advice *Numenius madagascariensis* eastern curlew. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847conservation-advice.pdf.

DoE. 2014a. Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*). Available from: https://www.environment.gov.au/system/files/resources/91e141d0-47aa-48c5-8a0f-992b9df960fe/files/recovery-plan-grey-nurse-shark-carcharias-taurus.pdf. Department of the Environment. Canberra.

DoE. 2014b. Conservation Advice – *Thinornis rubricollis rubricollis* (hooded plover, eastern). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/66726-conservation-advice.pdf

DoE. 2013. EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance. Department of the Environment. Canberra.

DoE. 2014. Assessment of the Tasmanian Giant Crab Fishery. A WWW document accessed at https://www.environment.gov.au/system/files/pages/605d8e41-3d23-4901-a5db-060e58a0d73b/files/tas-giant-crab-assessment-report-2014.pdf. Department of the Environment. Canberra.

DoEE, 2020. National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds. Department of Energy and the Environment. Canberra.

DoEE. 2018a. Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans 2018. Department of the Environment and Energy. Canberra.

DoEE. 2017a. Recovery Plan for Marine Turtles in Australia. Australian Government, Canberra. Available from: http://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia- 2017.DoEE. 2017b. Australian National Guidelines for Whale and Dolphin Watching.

Australian Government, Canberra. Available from: https://www.environment.gov.au/system/files/resources/7f15bfc1-ed3d- 40b6-a177-c81349028ef6/files/aust-national-guidelines-whale-dolphin-watching-2017.pdf.

DoEE. 2017c. National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna. Australian Government, Canberra. Available from: https://www.environment.gov.au/system/files/resources/ce6d7bec-0548-423d-b47f-d896afda9e65/files/vessel-strike-strategy.pdf.

Doodie, H. 2003. Personal communication. Dedicated marine mammal observation team member – 2002 Bass Strait seismic surveys. Heath Doodie, Environmental Consultant, NSR Environmental Consultants Pty Ltd.

DPI. 2009. Victorian Rock Lobster Fishery Management Plan, Fisheries Victoria Management Report Series No. 70, Department of Primary Industries, Victoria

DPI. 2005. Statement of Management Arrangements for the Victorian Commercial Scallop (*Pecten fumatus*) Fishery. Victorian Department of Primary Industries. Melbourne.

DPIPWE. 2020a. Marine Life and Their Habitats. A WWW document accessed at: https://dpipwe.tas.gov.au/conservation/the-marine-environment/fisheries-habitats. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020b. Rock Lobster Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/rock-lobster-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020c. Shellfish Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/shellfish-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020d. Seaweed Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishingaquaculture/commercial-fishing/seaweed-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020e. Abalone Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/abalone-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020f. Scallop Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scallop-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020g. Scalefish Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scalefish-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020h. Commercial Dive Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/commercial-dive-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2020i. Octopus Fishery. A WWW database accessed at https://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/octopus-fishery. Department of Primary Industries, Parks, Water and Environment. Hobart.

DPIPWE. 2013. King Island Biodiversity Management Plan. Department of Primary Industries, Parks, Water and Environment. Hobart.

DRI. 2016. Burrunan Dolphins. A WWW database accessed at http://www.dolphinresearch.org.au/burrunandolphins/. Dolphin Research Institute. Hastings, Victoria.

DSE. 2013. Draft Marlo Foreshore Management Plan. A WWW document accessed at: http://www.eastgippsland.vic.gov.au/files/809dcb27-3e14-4ad1-a716-a212009b233e/draft_marlo_fmp.pdf. Department of Sustainability and Environment, Melbourne.

DSEWPC. 2013a Approved Conservation Advice for *Rostratula australis* (Australian painted snipe). Canberra: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf.

DSEWPC. 2013b. Recovery Plan for the White Shark (*Carcharodon carcharias*). Department of Sustainability, Environment, Water, Population and Communities. Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/recovery-plan-white-sharkcarcharodon-carcharias

DSEWPC. 2012a. Approved Conservation Advice for *Epinephelus daemelii* (black cod). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68449conservation-advice.pdf.

DSEWPC. 2012b. Approved Conservation Advice for *Brachionichthys hirsutus* (spotted handfish). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64418.

DSEWPC. 2012c. Conservation Management Plan for the Southern Right Whale 2011-21. Department of Sustainability, Environment, Water, Population and Communities. Canberra.

DSEWPC. 2012d Approved Conservation Advice for Giant Kelp Marine Forests of South East Australia. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/107-conservation-advice.pdf.

DSEWPC. 2011a. National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016. Department of Sustainability, Environment, Water, Population and Communities. Australian Antarctic Division. Canberra.

DSEWPC. 2011b. Approved Conservation Advice for *Sternula nereis nereis* (Fairy Tern). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82950-conservation-advice.pdf

DTPLI. 2013. Advisory Note Offshore Petroleum Industry Oil Spill Contingency Planning Consultation. Victorian Government. Melbourne.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Slade, R. Paton, D., and Cato, D.H. 2018. A behavioural dose-response model for migrating humpback whales and seismic air gun noise. Marine Pollution Bulletin, 133, 506-516.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Kniest, E., Slade, R. Paton, D., and Cato, D.H. 2017. The behavioural response of migrating humpback whales to a full seismic air gun array. Proceedings of the Royal Society B. Proc. R. Soc. B 284: 20171901. http://dx.doi.org/10.1098/rspb.2017.1901.

Dunlop, R.A. 2016a. The effect of vessel noise on humpback whale, Megaptera novaeangliae, communication behaviour. Animal Behaviour 111: 13-21.

Dunlop, R.A., M.J. Noad, R.D. McCauley, E. Kniest, R. Slade, D. Paton, and D.H. Cato. 2016b. Response of humpback whales (Megaptera novaeangliae) to ramp-up of a small experimental air gun array. Mar. Poll. Bull. 103(1–2): 72-83.

Dunlop, R.A., M.J. Noad, R.D. McCauley, E. Kniest, D. Paton, and D.H. Cato. 2015. The behavioural response of humpback whales (Megaptera novaeangliae) to a 20 cubic inch air gun. Aquatic Mammals 41(4): 412.

EA (Environment Australia). 2002. White Shark (Carcharodon carcharias) Recovery Plan. A WWW document accessed at: www.environment.gov.au/coasts/publications/gwshark-plan/index.html. Commonwealth of Australia.

Earthlife. 2014. The Phylum Ectoprocta (Bryzoa) available at http://www.earthlife.net/inverts/bryozoa.html

Easton, A.K. 1970. The tides of the continent of Australia. Flinders University of Australia.

Edmonds, N.J., C.J. Firmin, D. Goldsmith, R.C. Faulkner, and D.T. Wood. 2016. A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. Marine Pollution Bulletin 108(1–2): 5-11.

Elliott, M. 2014. Environmental Impact Assessment in Australia: Theory and Practice, 6th Edn. Leichhardt, NSW: Federation Press.

Engelhardt, F.R. 1983. Petroleum Effects on Marine Mammals. Aquatic Toxicology 4:199– 217.

EMV. 2016. State Maritime Emergencies (non-search and rescue) Plan. Edition 1. Emergency Management Victoria. Melbourne.

EPA Tasmanian. 2019. Tasmanian Marine Oil and Chemical Spill Contingency Plan (TasPlan). Department of Primary Industries, Parks, Water, and the Environment. Hobart.

Emery, T., Hartmann, K. and Gardner, C. 2015. Tasmanian Giant Crab Fishery – 13/14. Institute for Marine Science. A WWW document accessed at http://www.imas.utas.edu.au/_data/assets/pdf_file/0003/743106/GiantCrab_2013-14.pdf.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R. 2015. Communication masking in marine mammals: A review and research strategy. Mar. Poll. Bull. 103(1-2): 15–38.

Eriksen, R.S., Davies, C.H., Bonham, P., Coman, F.E., Edgar, S., McEnnulty, F.R., McLeod, D., Miller, M.J., Rochester, W., Slotwinski, A., Tonks, M.L., Uribe-Palomino, J. and Richardson, A.J. 2019. Australia's Long-Term Plankton Observations: The Integrated Marine Observing System National Reference Station Network. Front. Mar. Sci. 6:161. doi:10.3389/ fmars.2019.00161

ESDSC. 1992. National Strategy for Ecologically Sustainable Development. Ecologically Sustainable Development Steering Committee.Canberra.

European Commission. 2019. Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production. Luxembourg: Publications Office of the European Union.

Falconer, R. and Linforth, D. 1972. Winds and waves in Bass Strait. Bureau of Meteorology. Department of the Interior. Canberra.

Felder, D.L., Thoma, B.P., Schmidt, W.E., Sauvage, T., Self-Krayesky, S.L., Christoserdov, A., Bracken-Grissom, H.D. and Fredericq, S. 2014. Seaweeds and Decapod Crustaceans on Gulf Deep Banks after the Macondo Oil Spill. Bioscience 64: 808– 819.

Fewtrell, J.L. and R.D. McCauley. 2012. Impact of air gun noise on the behaviour of marine fish and squid. Mar. Poll. Bull. 64(5): 984–993.

Fields, D., Handegard, N. O., Dalen, J., Eichner, C., Malde, K., Karlsen, Ø., Browman, H. I. 2019. Airgun blasts used in marine seismic surveys have a minor effect on survival at distances less than 10 m and no sublethal effects on behaviour or gene expression in the copepod Calanus finmarchicus. ICES Journal of Marine Science.

Finneran, J.J. 2016. Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise. Technical Report.

Flegg, J. 2002. Photographic Field Guide Birds of Australia. Second Edition. Reed New Holland. Sydney. Fogden, S.C.L. 1971. Mother-young behaviour at gray seal breeding beaches. J. Zoo. 164:61-92.

FRDC. 2021a. Southern rock lobster. A WWW database accessed in January 2021 at http://fish.gov.au/report/174-Southern-Rock-Lobster-2018. Fisheries Research and Development Corporation.

FRDC. 2021b. Giant crab. A WWW database accessed in January 2021 at http://fish.gov.au/report/180-Giant-Crab-2018. Fisheries Research and Development Corporation.

FRDC. 2021c. Blue warehou. A WWW database accessed in January 2021 at http://fish.gov.au/report/146-Blue-Warehou-2018. Fisheries Research and Development Corporation.

FRDC. 2017 – Giant Crab. A www database accessed on 14th September 2020 at http://fish.gov.au/report/29-Giant-Crab-2016.

Fromont, J. 1993. Reproductive development and timing of tropical sponges (Order Haploscleria) from the Great Barrier Reef, Australia, James Cook University.

French, D. Schuttenberg, H. and Isaji, T. 1999. Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light In: Proceedings of the 22nd Artic and Marine Oil Spill Program (AMOP), Technical Seminar, June 1999. Alberta, Canada.

French-McCay, D.P. 2009. State-of-the-art and research needs for oil spill impact assessment modelling. Proceedings of the 32nd Arctic and Marine Oil Spill Program Technical Seminar. Environment Canada, Ottawa.

French-McCay, D.P. 2003. Development and application of damage assessment modelling: example assessment for the North Cape oil spill. Mar. Poll. Bull. 47 (9):9-12.

French-McCay, D.P., 2002. Development and application of an oil toxicity and exposure model, OilToxEx. Environmental Toxicology and Chemistry 21:2080-2094.

Gagnon, M.M. and Rawson, C. 2011. Montara Well Release, Monitoring Study S4A – Assessment of Effects on Timor Sea Fish. Curtin University, Perth, Australia.

Gala, W.R. 2001. Predicting the Aquatic Toxicity of Crude Oils. International Oil Spill Conference Proceedings (2):935–940.

Gausland, I. 2000. Impact of seismic surveys on marine life. SPE International Conference on Health, Safety and the Environment in Oil and Gas Exploration and Production. 26-28 June, 2000.

Geraci, J.R. and St. Aubin, D.J. 1988. Synthesis of Effects of Oil on Marine Mammals. Report to US Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study. Ventura, California.

Gibbs, C., Tomczak, Jr. And Longmore, A. 1986. The Nutrient Regime of Bass Strait. Australian Journal of Marine and Freshwater Resources: 36.

Gibbs, C. 1992. Oceanography of Bass Strait: Implications for the food supply of little penguins Eudyptula minor. EMU vol 91, 395-401.

Gill, P. 2020. Blue Whale Literature Review – Offshore Victoria (Otway Basin / Bass Strait). Report to Beach Energy Limited. Blue Whale Study Inc.

Gill, P.C., Pirzl, R., Morrice, M.G., Lawton, K. 2015. Cetacean Diversity of the Continental Shelf and Slope off Southern Australian, The Journal of Wildlife Management 79(4): 672-681; 2015; DOI: 10.1002/jwmg.867

Gill, P,C, Morrice, M.G., Page, B., Pirzl, R., Levings, A.H. and Coyne, M. 2011. Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. Marine Ecology Progress Series 421: 243–263).

Gill, P. and Morrice, M. 2003. Cetacean Observations. Blue Whale Compliance Aerial Surveys. Santos Ltd Seismic Survey Program Vic/P51 and P52. November-December 2002. Report to Santos Ltd.

Gill, P., Ross, G., Dawbin, W. and Wapstra, H. 2000. Confirmed sightings of dusky dolphins (*Lagenorhynchus obscurus*) in southern Australian waters. Marine Mammal Science, 16(2): 452-45.

Gippsland Times. 2014. Beach oil spill. Report by Julianne Langshaw, March 17, 2014. Gippsland Times and Maffra Spectator. Victoria.

GLaWAC, 2020. Gunaikurnai Land and Waters Aboriginal Corporation. A WWW document accessed on 15 May 2020 at https://gunaikurnai.org/.

Godwin, E. M., Noad, M. J., Kniest, E. and Dunlop, R. A. 2016. Comparing multiple sampling platforms for measuring the behavior of humpback whales (Megaptera novaeangliae). Mar. Mamm. Sci. 32, 268-286. doi:10.1111/mms.12262

Gohlke, J.M. 2011. A Review of Seafood Safety after the Deepwater Horizon Blowout. Environmental Health Perspectives. 119(8):1062– 1069.

Gomez, C., Lawson, J.W., Wright, A.J., Buren, A.D., Tollit, D. and Lesage, V. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. Canadian Journal of Zoology 94(12): 801–819.

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M. P., Swift, R., and Tompson, D. 2004. A review of the effects of seismic surveys on marine mammals. Mar. Technol. Soc. J. 37(4): 16–34.

Gormley, A. and Dann, P. 2009. Examination of Little Penguin Winter Movements from Satellite Tracking Data. Report for the Department of Sustainability and Environment Victoria available at http://www.oem.vic.gov.au/Assets/668/1/AnalysisofLittlePenguinWinterMovements.pdf

Gotz, T., Hastie, G., Hatch, L., Raustein, O, Southall, B., Tasker, M, Thomsen, F. 2009. Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR Commission. London.

Green, B. and Gardner, C. 2009. Surviving a sea-change: survival of southern rock lobster (Jasus edwardsii) translocated to a site of fast growth. ICES Journal of Marine Science 66, 656-664.

Guerra, A., Gonzalez, A.F., Pascual, S., Dawe, E.G. 2011. The Giant squid Architeuthis: An emblematic invertebrate that can represent concern for the conservation of marine biodiversity, Biological Conservation 144 (2011) 1989-1997.

Gwyther, D. and McShane, P.E. 1988. Growth rate and natural mortality of the scallop Pecten alba tate in Port Phillip Bay, Australia, and evidence for changes in growth rate after a 20-year period. Fisheries Research 6(4): 347-361.

Haddon, M., Harrington, J. and Semmens, J. 2006. Juvenile scallop discard rates and bed dynamics: testing the management rules for scallops in Bass Strait. FRDC Project 2003/017.

Halvorsen, M.B., Casper, B.M., Matthews, F., Carlson, T.J. and Popper, A.N. 2012. Effects of exposure to pile-driving sounds on the lake sturgeon, Nile tilapia and hogchoker. Proc. Biol. Sci. 279(1748): 4705–4714.

Halvorsen, M.B., Casper, B.M., Woodley, C.M., Carlson, T.J. and Popper, A.N. 2011. Predicting and mitigating hydroacoustic impacts on fish from pile installations. National Cooperative Highway Research Program Research Results Digest 363.

Harrington, J.J., MacAllistar, J. and Semmens, J.M. 2010. Assessing the immediate impact of seismic surveys on adult commercial scallops (Pecten fumatus) in Bass Strait. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. Hobart.

Harrington, J.J., MacAllistar, J. and Semmens, J.M. 2010. Assessing the immediate impact of seismic surveys on adult commercial scallops (Pecten fumatus) in Bass Strait. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania. Hobart.

Harris, P.T. and Heap, A. 2009. Geomorphology and Holocene sedimentology of the Tasmanian continental margin. J. Geo. Soc. Aus.

Hartmann, K., Gardner, C. and Hobday, D. 2013. Fishery Assessment Report. Tasmanian Rock Lobster Fishery 2011/12. May 2013. Institute for Marine and Antarctic Studies, University of Tasmania.

Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Løkkeborg, S., Misund, O.A., Østensen, Ø., Fonn, M. and Haugland,
E.K. 2004. Influence of seismic shooting on the lesser sandeel (Ammodytes marinus). ICES Journal of Marine Science: Journal du Conseil 61:1165-1173.

Hassel A., Knutsen T., Dalen J., Løkkeborg S., Skaar K., Østensen Ø., Haugland E. K., Fonn M., Høines Å., Misund O. A. 2003. Reaction of sandeel to seismic shooting: a field experiment and fishery statistics study. Institute of Marine Research, Fisken og Havet, vol. 4, 63 pp.

Hawkins, A.D. and Popper, A.N. 2016. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science: 17.

Hawkins, E. R. and Gartside, D. F. 2009. Interactive Behaviours of Bottlenose Dolphins (Tursiops aduncus) During Encounters with Vessels. Aquatic Mammals 2009 35(2): 259-268.

Heisler, S. and Parry, G.D. 2007. Parks Victoria Technical Series – Number 53. Species diversity and composition of benthic infaunal communities found in Marine National Parks along the outer Victorian coast. A WWW publication. Available from: http://parkweb.vic.gov.au/_data/assets/pdf_file/0015/314520/19_2096.pdf. Parks Victoria, Melbourne

Hermannsen, L., Tougaard, J., Beedholm, K., Nabe-Nielsen, J. and Madsen, P.T. 2015. Characteristics and propagation of airgun pulses in shallow water with implications for effects on small marine mammals. PLoS ONE 10(7): e0133436.

Heyward A., Colquhoun J., Cripps E., McCorry D., Stowar M., Radford B., Miller K., Miller I, and Battershill C. 2018. No evidence of damage to the soft tissue or skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. Marine Pollution Bulletin 129 (2018) 8-13 pp.

Heyward, A., Moore, C., Radford, B. and Colquhoun, J. 2010. Monitoring Program for the Montara Well Release Timor Sea: Final Report on the Nature of Barracouta and Vulcan Shoals. Report prepared by the Australian Institute of Marine Science for PTTEP Australasia (Ashmore Cartier) Pty Ltd.

Higgins, P.J. (ed.). 1999. Handbook of Australian, New Zealand and Antarctic Birds. Volume Four - Parrots to Dollarbird. Oxford University Press, Melbourne.

Higgins, L.V. and Gass, L. 1993. Birth to weaning: parturition, duration of lactation, and attendance cycles of Australian sea lions (*Neophoca cinerea*). Canadian Journal of Zoology 71:2047-2055.

Hill, N., Krueck, N. and Hartmann, K. 2020. Tasmanian Octopus Fishery Assessment 2018/19. Institute for Marine and Antarctic Studies. UTAS. A WWW publication accessed at: https://www.imas.utas.edu.au/_data/assets/pdf_file/0005/1296050/octopus_assessment2019.pdf.

Hook, S., Batley, G., Holloway, M., Irving, P. and Ross, A. 2016. Oil Spill Monitoring Handbook. CSIRO Publishing. Melbourne.

Holdway, D.A. 2002. The acute and chronic effects of wastes associated with offshore oil and gas production on temperate and tropical marine ecological processes. Mar. Poll. Bull. 44:185– 203.

Hosack, G. & Dambacher, J. 2012. Ecological indicators for the Exclusive Economic Zone of Australia's South-east Marine Region., A report prepared for the Australian Government Department of Sustainability, Environment, Water, Population and Communities, CSIRO Wealth from Oceans Flagship, Hobart.

Hotchkin, C. and Parks, S. 2013. The Lombard effect and other noise-induced vocal modifications: insight from mammalian communication systems. Biological Reviews 88(4): 809-824.

Houde, E. and Zastrow C. 1993. Ecosystem and taxon-specific dynamic and energetics properties of larval fish assemblages. Bulletin of Marine Science 53 (2): 290-335.

Huang, Z. and Wang, X. 2019. Mapping the spatial and temporal variability of the upwelling systems of the Australian south-eastern coast. Remote Sensing of Environment. 227, pp. 90-109.

Hume, F., Hindell M.A., Pemberton, D. and Gales, R. 2004. Spatial and temporal variation in the diet of a high trophic level predator, the Australian fur seal (*Arctocephalus pusillus doriferus*). Mar. Biol. 144(3): 407-415.

Huys, S. 2012. Aboriginal Heritage Assessment of a Proposed Golf Course Development at Currie, King Island, Tasmania (Draft Report)

IAGC. 2017. IAGC Zooplankton Paper talking Point. A WWW document accessed at https://globenewswire.com/news-release/2017/06/22/1027751/0/en/IAGC-Plankton-Study-Speculative-and-Needs-Better-Data.html. International Association of Geophysical Contractors.

IAGC. 2013. Environmental manual for worldwide geophysical operations. International Association of Geophysical Contractors. Available from: https://www.iagc.org/uploads/4/5/0/7/45074397/environmental_compliance_manual.pdf.

IMCRA. 1998. Interim Marine and Coastal Regionalisation for Australia: An ecosystem-based classification for marine and coastal environments. IMCRA Technical Group. Version 3.3.

International Maritime Organisation. 2012. Guidelines for the Development of Garbage Management Plans. Resolution MEPC.220(63).

IMO. 2014. International Dangerous Goods Maritime Code. International Maritime Organisation. London.

International Cable Protection Committee. 2014. Recommendation #8: Procedure to be followed whilst offshore seismic work is undertaken in the vicinity of active submarine cable systems (Issue9, 2014).

IMO. 2011. Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species. London.

IOGP. 2017. Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations. International Association of Oil and Gas Producers.

IOGP-IPIECA. 2020. Environmental management in the upstream oil and gas industry. Report 254. August 2020. International Association of Oil & Gas Producers and IPIECA. London.

IPIECA/OGP. 2015. Aerial observation of oil spills at sea. Good practice guidelines for incident management and emergency response personnel. International Petroleum Industry Conservation Association and International Association of Oil & Gas Producers. London.

IPIECA/OGP. 2014a. A guide to oiled shoreline assessment (SCAT) surveys. Good practice guidelines for incident management and emergency response personnel. International Petroleum Industry Conservation Association and International Association of Oil & Gas Producers. London.

IPIECA/OGP. 2014b. Oil spill waste minimisation and management. Good practice guidelines for incident management and emergency response personnel. International Petroleum Industry Conservation Association and International Association of Oil & Gas Producers. London.

IPIECA/IOGP, 2016. In-water surveillance of oil spills at sea – Good practice guidelines for incident management and emergency response personnel

ITOPF. 2011a. Effects of Oil Pollution on the Marine Environment. Technical Information Paper 13. The International Tanker Owners Pollution Federation Ltd. London.

ITOPF. 2011b. Aerial Observation of Marine Oil Spills. Technical Information Paper 2. The International

Tanker Owners Pollution Federation Ltd. London.

IUCN. 2016. The Effective Planning Strategies for Managing Environmental Risk associated with Geophysical and other Imaging Surveys: A Resource Guide for Managers. International Union for the Conservation of Nature. Gland, Switzerland.

Jackson, GD. & McGrath-Steer, B. 2003. FRDC Final Report: Arrow Squid in Southern Australian Waters – Supplying Management Needs through Biological Investigations, FRDC Project 1991/112, Institute of Antarctic and Southern Ocean Studies, University of Tasmania at http://www.afma.gov.au/wpcontent/uploads/2010/06/frdc_report_200504.pdf

Jenssen, B.M. 1994. Effects of Oil Pollution, Chemically Treated Oil, and Cleaning on the Thermal Balance of Birds. Env. Poll. 86:207– 215.

JNCC. 2017. Guide to Population Models Used in Marine Mammal Impact Assessment. JNCC Report No. 607. Joint Nature Conservation Committee, Peterborough.

Jones, G. and McCormick, M. 2002. Numerical and energetic processes in the ecology of coral reef fishes. In: Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem (ed. Sale PF), pp. 221–238. Academic Press, San Diego, CA.

Jones, I.T., J.A. Stanley, and T.A. Mooney. 2020. Impulsive pile driving noise elicits alarm responses in squid (Doryteuthis pealeii). Marine Pollution Bulletin 150: 110792. http://www.sciencedirect.com/science/article/pii/S0025326X19309488.

Jones, I.S.F. and Padman. L. 1983. Semi-diurnal internal tides in eastern Bass Strait, Aust. J. Mar. Freshw. Res., 34, 159-171

Jones, I.S.F. 1980. Tidal and Wind-drive Currents in Bass Strait. Aus. J. Mar. Freshwater Res. 31. 109-17.

Jung, J. 2011. Biomarker Responses in Pelagic and Benthic Fish Over One Year Following the Hebei Spirit Oil Spill (Taean, Korea). Mar. Poll. Bull. 62(8):1859– 1866.

Kaifu, K., T. Akamatsu, and S. Segawa. 2008. Underwater sound detection by cephalopod statocyst. Fisheries Science 74(4): 781-786.

Kailola, P.J., Williams, M.J., Stewart, P.C., Reighelt, R.E., McNee, A., and Grieve, C. 1993. Australian Fisheries Resources, Published by the Bureau of Resource Sciences, Department of Primary Industries and Fisheries and the Fisheries Research and Development Corporation, Canberra, Australia

Kampf, 2015. Phytoplankton blooms on the western shelf of Tasmania: evidence of a highly productive ecosystem, Ocean Sci. 11, 1-11, 2015. Doi: 10.5194/os-11-1-2015.

Kasamatsu F, Joyce G. 1995. Current status of odontocetes in the Antarctic waters. Antarct Sci 7:365-379.

Kasamatsu F., Matsuoka K., Hakamada T. 2000. Interspecific relationships in density among the whale community in the Antarctic. Polar Biol23:466-473

Kauss, P., Hutchinson, T.C., Soto, C., Hellebust, J. and Griffiths, M. 1973. The Toxicity of Crude Oil and its Components to Freshwater Algae. International Oil Spill Conference Proceedings: March 1973, Vol. 1973, No. 1, pp. 703-714.

Kennish, M.J. 1996. Practical Handbook of Estuarine and Marine Pollution. CRC Press. Florida.

Kent, C.S., McCauley, R.D., Duncan, A., Erbe, C., Gavrilov, A., Lucke, K. And Parnum, I. 2006. Underwater sound and vibration from offshore petroleum activities and their potential effects on marine fauna: an Australian perspective. Centre for Marine Science and Technology (CMST), Curtin University.

Ketten, D.R. and Bartol, S.M. 2005. Functional measures of sea turtle hearing. ONR project final report. Document Number ONR Award Number N00014-02-1-0510. Office of Naval Research (US).

Ketten, D.R., C. Merigo, E. Chiddick, and H. Krum. 1999. Acoustic fatheads: parallel evolution of underwater sound reception mechanisms in dolphins, seals, turtles, and sea birds. J. Acoust. Soc. Am. 105:1110.

Ketten, D.R. 1992. The cetacean ear: form, frequency, and evolution. In Thomas, J.A., R.A. Kastelein, and A.Y. Supin (eds.). Marine Mammal Sensory Systems. Plenum Press, New York. 53-75.

Kimmerer, W.J. & McKinnon, A.D. 1984 Zooplankton Abundances in Bass Strait and WesteEnsco 102 Tasmanian Shelf Waters, March1983.

King Island Tourism, 2018 – King Island Maritime Trails: Shipwrecks and Safe Havens In Bass Strait. A www publication accessed in November 2018 at https://www.kingisland.org.au/maritime-trails/

King Island Council. 2016. King Island Visitor Survey (April 2015-March 2016). Prepared by the King Island Council. Supported by the Tasmanian Government and assisted by Ling Island Regional Development Organisation.

KIRDO, 2020. King Island – A Place of Opportunity. King Island Regional Development Organisation. A www publication accessed in September 2020 at http://www.kingisland.net.au/chamber-of-commerce/kirdo

Kirkwood, R., Gales, R., Terauds, A., Arnould, J. P. Y., Pemberton, D., Shaughnessy, P. D., Mitchell, A. T., and Gibbens, J. 2005. Pup production and population trends of the Australian fur seal Arctocephalus pusillus doriferus. Marine Mammal Science 21, 260–282. doi:10.1111/J.1748-7692.2005.TB01227.

Kirkwood, R., Warneke, R.M., Arnould. J.P. 2009. Recolonization of Bass Strait, Australia, by the New Zealand fur seal, Arctocephalus forsteri. Marine Mammal Science 25(2): 441–449.

Klimley, A.P. and Myrberg, Jr A.A. 1979. Acoustic stimuli underlying withdrawal from a sound source by adult lemon sharks, Negaprion brevirostris (Poey). Bull. Mar. Sci. 29: 447–458.

Koessler, M.W., C.R. McPherson and S.J. Welch.2020. Sequoia 3D Marine Seismic Survey: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Document 02225, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Aventus Consulting Pty Ltd.

Kooyman, G.L., Gentry, R.L. and McAllister, W.B. 1976. Physiological impact of oil on pinnipeds. Report N.W. Fisheries Center. Natl. Mar. Fish. Serv. Seattle, WA.

Kooyman, G.L., Davis, R.W. and Castellini, M.A. 1977. Thermal conductance of immersed pinniped and sea otter pelts before and after oiling with Prudhoe Bay crude. pp. 151-157. In: Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms. D.A. Wolfe (ed.). Pergammon Press, New York, New York.

Kordjazi Z., Frusher S., Buxton C., Gardner C. and Bird T. 2015. The Influence of Mark-Recapture Sampling Effort on Estimates of Rock Lobster Survival. PLoS ONE 11(3): e0151683. https://doi.org/10.1371/journal.pone.0151683.

Kostyuchenko, L.P. 1973. Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. Hydrobiological Journal 9: 45-48.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., & Podesta, M. 2001. Collisions between Ships and Whales. Marine Mammal Science 17(1): 35-75.

Lamendella, R., Strutt, S., Borglin, S., Chakraborty, R., Tas., N., Mason, O., Hultman, J., Prestat, Hazen, T. and Jansson, J. 2014. Assessment of the Deepwater Horizon oil spill impact on Gulf coast microbial communities. Front. Microbiol. 5: 130.

Landman, N.H., Cochran, J.K., Cerrato, R., Mak, J., Roper C.F.E., Lu, C.C. 2004. Habitat and age of the giant squid (*Architeuthis sanctipauli*) inferred from isotopic analyse, Marine Biology (2004) 144: 685-691, DOI 10.1007/s00227-003-1245-y

Last, P.R & Stevens, J.D. 2009. Sharks and Rays of Australia, 2nd Edition, CSIRO Publishing, Melbourne, 2009.

Lavender, A.L., Bartol, S.M. and Bartol, I.K. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach. Journal of Experimental Biology 217(14): 2580-2589.

Lavender, A., Bartol, S. and Bartol, I. 2012. Hearing capabilities of loggerhead sea turtles (Caretta caretta) throughout ontogeny Popper, A.N. and Hawkins, A.D. (Eds.), The Effects of Noise on Aquatic Life (2012).

Law, R.J. 1997. Hydrocarbons and PAH in Fish and Shellfish from Southwest Wales following the Sea Empress Oil Spill in 1996. International Oil Spill Conference Proceedings 1997 (1): 205–211.

LCC. 1993. Marine and Coastal Descriptive Report (special investigation). Land Conservation Council. June 1993.

Lee, H.J., Shim, W.J., Lee, J. and Kim, G.B. 2011. Temporal and geographical trends in the genotoxic effects of marine sediments after accidental oil spill on the blood cells of striped beakperch (Oplegnathus fasciatus). Mar. Poll. Bull. 62:2264– 2268.

Lenhardt, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta). In: Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (eds.). 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum, NMFS-SEFSC-351, National Technical Information Service, Springfield, Virginia.

Lenhardt, M.L., Klinger, R. and Musick, J. 1985. Marine turtle middle-ear anatomy. Journal of Auditory Research 25(1): 66-72.

Levings, A.H. and Gill, P.C. 2010. 'Seasonal winds drive water temperature cycle and migration patterns of southern Australian giant crab Pseudocarcinus gigas.' In: Biology and Management of Exploited Crab Populations under Climate Change. Edited by G.H. Kruse, G.L. Eckert, R.J. Foy, R.N. Lipcius, B. Sainte-Marie, D.L. Stram and D. Woodby. Alaska Sea Grant, University of Alaska Fairbanks

Lewis, M. and Pryor, R. 2013. Toxicities of oils, dispersants and dispersed oils to algae and aquatic plants: Review and database value to resource sustainability. Env. Poll. 180:345–367.

Limpus, C.J. 2008a. A biological review of Australian Marine Turtles. 1. Loggerhead Turtle *Caretta caretta* (Linneaus). Queensland Environment Protection Agency.

Limpus, C.J. 2008b. A Biological Review of Australian Marine Turtles. Green Turtle, *Chelonia mydas* (Linnaeus). Prepared for the Queensland Environment Protection Agency.

Limpus, C.J. 2009. A Biological Review of Australian Marine Turtles. Leatherback Turtle, D*ermochelys coriacea* (Vandelli). Prepared for the Queensland Environment Protection Agency.

Lindquist, D., Shaw, R. and Hernandez, F Jr. 2005. Distribution patterns of larval and juvenile fishes at offshore petroleum platforms in the north-central Gulf of Mexico. Estuar Coast Shelf Sci 62(4):655–665.

Ling, S. & Johnson, C. 2012. Marine reserves reduce risk of climate-driven phase shift by restoring size and habitat specific trophic interactions. Ecological applications : a publication of the Ecological Society of America. 22. 1232-45. 10.2307/23213957.

Ling, S., Johnson, C., Frusher, D. and Ridgway, K. 2009. Overfishing reduces resilience of kelp beds to climate-driven catastrophic phase shift. Proceedings of the National Academy of Sciences Dec 2009, 106 (52) 22341-22345; DOI: 10.1073/pnas.0907529106.

Loyn, R.H., Lane, B.A., Chandler, C and Carr, G.W. 1986. Ecology of Orange-bellied Parrots Neophema chrysogaster at their main remnant wintering site. Emu. 86:195-206.

Madsen, P.T., Johnson, M., Miller, P.J.O, Aguilar Soto, N., Lynch, J. and Tyack, P. 2016. Quantitative measures of air-gun pulses recorded on sperm whales (Physeter macrocephalus) using acoustic tags during controlled exposure experiments. Journal of the Acoustical Society of America 120(4): 2366-2379.

Maldonado, M., Aguilar, R., Bannister, R., Bell, J., Conwa, K., Dayton, P., Diaz, M., Gutt, J., Kelly, M., Kenchington, E., Leys, S., Pomponi, S., Rapp, H., Rutzler, K., Tendal, O., Vacelet, J. and Young, C. 2016. Sponge Grounds as Key Marine Habitats: A Synthetic Review of Types, Structure, Functional Roles, and Conservation Concerns. 10.1007/978-3-319-17001-5_24-1.

Malme, C. I., & Miles, P. R. 1985. Behavioral responses of marine mammals (gray whales) to seismic discharge. In G. D. Greene, F. R. Engelhardt, & R. J. Paterson (Eds.), Proc. Workshop on effects of explosives use in the marine environment, Jan 1985 (pp. 253’80). Tech. Rep. 5. Can. Oil and Gas Lands Adm., Inviron. Prot. Br.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Manage. Serv., Anchorage, AK. NTIS PB86-218377.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. BBN Rep. 5366. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for U .S. Minerals Manage. Serv., Anchorage, AK. Var. pag. NTIS PB86-174174.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the loggerhead turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms. Journal of Experimental Biology 215(17): 3001-3009.

Matishov, G.G. 1992. The reaction of bottom-fish larvae to airgun pulses in the context of the vulnerable Barents Sea ecosystem. Contr. Petro Piscis II ‘92 F-5, Bergen, Norway, 6-8 April, 1992.

McCauley, R.D., Day, R.D., Swadling, K.M., Fitzgibbon, Q.P., Watson, R.A. and Semmens, J.M. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nat. Ecol. Evol. 1, 0195.

McCauley, R. D. and Kent, C.S. 2012. A lack of correlation between air gun signal pressure waveforms and fish hearing damage. Advances in Experimental Medicine and biology 730:245–250.

McCauley, R.D., Fewtrell, J., Popper, A.N. 2003.High intensity anthropogenic sound damages fish ears. J. Acoust. Soc. Am. 113, 638–642

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K. 2000a. ‘Marine Seismic Surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid.’ In: Environmental implications of offshore oil and gas development in Australia: Further research. Australian Petroleum Production and Exploration Association. Canberra.

McCauley, R. D., Fewtrell, J., Duncan, A. J., Jenner, C., Jenner, M. N., Penrose, J. D., et al. 2000b. Marine seismic surveys ’A study of environmental implications. APPEA Journal, 40, 692’08.

McCauley, R. D. 1994. ‘Seismic Survey.’ In: Environmental Implications of Offshore Oil and Gas Developments in Australia – the Findings of an Independent Scientific Review. Swan J.M., Neff J.M. and Young P.C. (eds) Australian Petroleum Exploration Association. Sydney.

McClatchie, S., Middleton, J., Pattiaratchi, C., Currie, D., & Kendrick, G. 2006. The South-west Marine Region: Ecosystems and Key Species Groups, Department of Environment & Water Resources downloaded on 21st July at http://www.environment.gov.au/coasts/mbp/publications/south-west/sw-ecosystems.html

McDonald, M.A., Hildebrand, J.A. and Webb, S.C. 1995. Blue and fin whales observed on a seafloor array in the Northeast Pacific. Journal of the Acoustical Society of America 98(2): 712–721.

McInnes, K. L. and Hubbert, G. D. 2003. A numerical modelling study of storm surges in Bass Strait. Australian Meteorological Magazine 52(3)

McLeay, L., Sorokin, S., Rogers, P. and Ward, T. 2003. Benthic Protection Zone of the Great Australian Bight Marine Park: 1. Literature review. South Australian Research and Development Institute (Aquatic Sciences). Final report to: National Parks and Wildlife South Australia and the Commonwealth Department of the Environment and heritage.

McPherson, C. R., et al. (2019). Underwater sound propagation modelling to illustrate potential noise exposure to Maui dolphins from seismic surveys and vessel traffic on West Coast North Island, New Zealand, Report by JASCO Applied Sciences for Fisheries New Zealand. New Zealand Aquatic Environment and Biodiversity Report No. 217. © Crown Copyright**:** 62.

MESA, 2018. Marine Worms – Annelids (Segmented worms). Marine Education Society of Australasia. A www publication accessed in September 2020 at http://www.mesa.edu.au/marine_worms/marine_worms02.asp

Middleton, J., Arthur, C., Van Ruth, P, Ward, T., McClean, J., Maltrud, M., Gill, P., Levings, A. and Middleton, S. 2007. El Nino Effects and Upwelling off South Australia. Journal of Physical Oceanography 37: 2,458–2,477.

Middleton, J. and Black, K. 1994. The low frequency circulation in and around Bass Strait: a numerical study Cont. Shelf Res, I 4, 1495-1521.

Milicich, M. J., Meekan, M. G. and Doherty, P. J. 1992. Larval supply: a good predictor of recruitment in three species of reef fish (Pomacentridae). Mar. Ecol. Prog. Ser. 86: 153-166.

Miller, I. and Cripps, E. 2013. Three dimensional marine seismic survey has no measurable effect on species richness or abundance of a coral reef associated fish community. Mar. Poll. Bull. 77:63-70.

Meekan, M. G., Wilson, S. G., Halford, A. and Retzel, A. 2001. A comparison of catches of fishes and invertebrates by two light trap designs, in tropical NW Australia. Mar. Biol. 139: 373 – 381.

Moein, S.E., Musick, J.A., Keinath, J.A., Barnard, D.E., Lenhardt, M.L. and George, R. 1995. Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges, in Sea Turtle Research Program: Summary Report. In: Hales, L.Z. (ed.). Report from U.S. Army Engineer Division, South Atlantic, Atlanta GA, and U.S. Naval Submarine Base, Kings Bay GA. Technical Report CERC-95. 90 pp.

Montgomery, J.C., A. Jeffs, S.D. Simpson, M. Meekan, and C. Tindle. 2006. Sound as an orientation cue for the pelagic larvae of reef fishes and decapod crustaceans. Advances in Marine Biology 51: 143-196.

Mooney, T.A., Yamato, M. and Branstetter, B.K. 2012. Hearing in cetaceans: From natural history to experimental biology. Advances in Marine Biology 63: 197–246.

Moore, B., Lyle, J. & Hartmann, K. 2019. Tasmanian Scalefish Fishery Assessment 2017/18. Institute for Marine and Antarctic Studies. A WWW publication accessed at: http://www.imas.utas.edu.au/_data/assets/pdf_file/0004/1227541/ Tasmanian-Scalefish-Fishery-Assessment-2017_18.pdf.

Morrice, M.G., Gill, P.C., Hughes, J. and Levings, A.H. 2004. Summary of mitigation aerial surveys for the Santos Ltd EPP32 seismic survey, 2-13 December 2003. Report # WEG-SO 02/2004, Whale Ecology Group-Southern Ocean, Deakin University.

Morris, C.J., Cote, D., Martin, B. and Kehler, D. 2017. Effects of 2D seismic on the snow crab fishery. Fisheries Research.

Museums Victoria. 2020. Fishes of Australia database. A WWW database accessed at http://fishesofaustralia.net.au. Museums Victoria. Melbourne.

Mustoe, S. and Ross, G. 2004. Search Australian Whales & Dolphins, Interactive CD ROM Identification Guide Version 1.0, Australian Petroleum Production and Exploration Association.

Mustoe, S.H. 2008. Killer Whale (*Orchinus orca*) sightings in Victoria. Victorian Naturalist 125(3): 76-81.

Myrberg, A.A. 2001. The acoustical biology of elasmobranchs. Environmental Biology of Fishes 60(3): 31- 45.

Nelms, S.E., Piniak, W.E., Weir, C.R. and Godley, B.J. 2016. Seismic surveys and marine turtles: An underestimated global threat? Biological Conservation 193: 49–65.

NERA. 2017. Environment Plan Reference Case: Planned discharge of sewage, putrescible waste and grey water. National Energy Resources Australia. Perth

Newall, P.R. and Lloyd, L.N. 2012. Lavinia Ramsar Site Ecological Character Description. Lloyd Environmental report to NRM North. Lloyd Environmental, Syndal, Victoria. 2 March 2012.

Nichol, S., & Endo, Y. (1999) – Krill Fisheries: Development, management and ecosystem implications. Aquat. Living Resources. 12 (2) (1999) 105-120.

Nicol, M. Shi, H., Campi, S., (2013) – Economic Impact Analysis – Tourism of Tasmania's King Island, Report prepared for Tourism Tasmania and the Cradle Coast Authority, June 2013. REMPLAN and Department of Economic Development, Tourism and the Arts.

Nieblas, A-E., Sloyan, B.M., Hobday, A.J., Coleman, R. and Richardson, A.J. 2009. Variability of biological production in low wind-forced regional upwelling systems: a case study off southeastern Australia. Limnol. Oceanogra. 54(5): 1548-1558

NERA. 2017. Environment Plan Reference Case: Planned Discharge of Sewage, Putrescible Waste and Grey Water. Department of Industry, Innovation and Science. Canberra.

NMFS. 2018. Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Thresh old Shifts. National Marine Fisheries Service. U.S. Department of Commerce, NOAA. NOAA Technic al Memorandum NMFS-OPR-
59. 167 pp. https://www.fisheries.noaa.gov/webdam/download/75962998.

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. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. National Marine Fisheries Service.

NMFS. 2014. Marine Mammals: Interim Sound Threshold Guidance. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS. 2013. Marine Mammals: Interim Sound Threshold Guidance. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. National Marine Fisheries Service

NOO. 2002. Ecosystems - Nature's Diversity. The South-East Regional Marine Plan Assessment Reports. National Oceans Office. Hobart.

NOAA. 2013. Deepwater Horizon Oil Spill: Assessment of Potential Impacts on the Deep Softbottom Benthos. Interim data summary report. NOAA Technical Memorandum NOS NCCOS 166. National Oceanic and Atmospheric Administration. Washington.

NOAA. 2002. Environmental Sensitivity Index Guidelines. Version 3. March 2002. National Oceanic and Atmospheric Administration. Washington.

NOPSEMA. 2020a. Environment Plan Assessment Policy (NOPSEMA Policy N-04750-PL1347, Rev 8, March 2020). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Policies/A662608.18.19.pdf.

NOPSEMA. 2020b. Reducing marine pest biosecurity risks through good practice biofouling management (NOPSEMA Information Paper N-04750-IP1899, Rev 1, March 2020). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Environment-resources/A715054.pdf.

NOPSEMA. 2019a. Environment plan decision making guideline (NOPSEMA Guideline GL1721, Rev 6, November 2019). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidelines/A524696.pdf.

NOPSEMA. 2019b. Environment plan content requirements (NOPSEMA Guidance Note, N-04750-GN1344, Rev 4, April 2019). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidance-notes/A339814.pdf.

NOPSEMA. 2019c. Oil spill modelling (NOPSEMA Environment Bulletin, April 2019). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf.

NOPSEMA. 2018a. Acoustic impact evaluation and management (NOPSEMA Information Paper, N-04750-IP1765, Rev 2, December 2018). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Information-papers/A625748.pdf.

NOPSEMA. 2018b. Petroleum activities and Australian Marine Parks (NOPSEMA Guidance Note, N-04750-GN1785, Rev 0, July 2018). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidance-notes/A620236.pdf.

NOPSEMA, 2018c. Oil pollution risk management (NOPSEMA Guidance Note GN1488, Rev 2, February 2018). National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidance-notes/A382148.pdf.

Nowacek, D & Southall, P. 2016. Effective Planning Strategies for Managing Environmental Risk associated with Geophysical and other Imaging Surveys: A Resource Guide for Managers. Gland, Switzerland: IUCN. 42pp.

Nowacek, D., Johnson, M. and Tyack, P.L. 2004. North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alarm stimuli. Proceedings of the Royal Society of London B 271: 227–231.

NMSC. 2010. Marine Incidents during 2009. Preliminary Data Analysis. A WWW database accessed at http://www.nmsc.gov.au. Australian National Marine Safety Committee.

NRC. 2003. Ocean Noise and Marine Mammals. National Research Council (U.S.), Ocean Studies Board, Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. National Research Council. The National Academies Press, Washington, DC.

NRDA. 2012. April 2012 Status Update for the Deepwater Horizon Oil Spill. A WWW publication accessed at: http://www.gulfspillrestoration.noaa.gov. Natural Resource Damage Assessment.

NSF. 2011. National Science Foundation (U.S.), U.S. Geological Survey, and [NOAA] National Oceanic and Atmospheric Administration (U.S.). 2011 Final Programmatic Environmental Impact Statement/Overseas. environmental Impact Statement for Marine Seismic Research Funded by the

National Science Foundation or Conducted by the U.S. Geological Survey. National Science Foundation, Arlington, VA.

O'Brian, P. and Dixon, P. 1976. The effects of oils and oil components on algae: A review. British Phycological Journal 11:115– 141.

O'Hara, J. and Wilcox, J.R. 1990. Avoidance responses of loggerhead turtles, Caretta caretta, to low frequency sound. Copeia 2: 564-567.

O'Sullivan, D. and Cullen, J. 1983. Food of the squid *Nototodarus gouldi* in Bass Strait. Australian Journal of Marine and Freshwater Research 34(2) 261 – 285.

Oritsland, N.A. 1975. Insulation in marine mammals: the effect of crude oil on ringed seal pelts. pp. 48-67. In: The Effect of Contact and Ingestion of Crude Oil on Ringed Seals of the Beaufort Sea. T.G. Smith and J.R. Geraci (eds.). Beaufort Sea Project. Inst. of Ocean Sci. Sidney, British Columbia. Technical Report No. 5.

Parks, S.E., Clark, C.W. and Tyack, P.L. 2007. Short-and long-term changes in right whale calling behaviour: The potential effects of noise on acoustic communication. Journal of the Acoustical Society of America 122(6): 3725-3731.

Parks Australia. 2020. Boags Australian Marine Park. A WWW publication accessed at: https://parksaustralia.gov.au/marine/parks/south-east/boags/. Australian Government. Canberra.

Parks and Wildlife Services Tasmania (PWST). 2017. Visitor Guide: Tasmania's national parks and reserves including 60 Great Short Walks. A WWW publication accessed at https://www.parks.tas.gov.au/file.aspx?id=47191. Parks and Wildlife Services Tasmania. Hobart.

Parks Victoria and DSE 2009, Caring for Country — The Otways and You. Great Otway National Park and Otway Forest Park Management Plan, Parks Victoria and DSE, Melbourne

Parks Victoria. 2020. Marine pests. A WWW database accessed at http://parkweb.vic.gov.au/parkmanagement/environment/weeds-and-pests/marine-pests. Parks Victoria. Melbourne.

Parks Victoria, 2007a. Marengo Reef Management Plan. Parks Victoria. Melbourne.

Parks Victoria. 2007b. Barwon Bluff Marine Sanctuary Management Plan. Parks Victoria. Melbourne.

Parks Victoria. 2007c. Yaringa Marine National Park, French Island Marine National Park and Churchill Island Marine National Park Management Plan. Parks Victoria. Melbourne.

Parks Victoria. 2006a. Bunurong Marine National Park, Bunurong Marine Park, Bunurong Coastal Reserve and Kilcunda-Harmers Haven Coastal Reserve management plan. Parks Victoria. Melbourne.

Parks Victoria, 2006b. Twelve Apostles Marine National Park and The Arches Marine Sanctuary Management Plan. Parks Victoria, Melbourne.

Parks Victoria, 2006c. Port Phillip Heads Marine National Park management plan. Parks Victoria, Melbourne.

Parks Victoria. 2006d. Wilsons Promontory Marine National Park and Wilsons Promontory Marine Park Management Plan, Parks Victoria. Melbourne

Parks Victoria 2006e. Point Hicks Marine National Park Management Plan, Parks Victoria, Melbourne.

Parks Victoria 2006f. Cape Howe Marine National Park Management Plan, Parks Victoria, Melbourne.

Parks Victoria. 2005a. Corner Inlet Marine National Park Management Plan. Parks Victoria, Melbourne.

Parks Victoria. 2005b. Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary Management Plan, Parks Victoria, Melbourne.

Parks Victoria. 2005c. Cape Conran Coastal Park Management Plan, Parks Victoria, Melbourne.

Parks Victoria, 2005d. Mushroom Reef Marine Sanctuary Management Plan. Parks Victoria, Melbourne.

Parks Victoria. 2003. Cape Liptrap Coastal Park Management Plan. Parks Victoria. Melbourne.

Parks Victoria. 2002. Wilsons Promontory National Park Management Plan. Parks Victoria. Melbourne.

Parks Victoria, 1998a. Mornington Peninsula National Park and Arthurs Seat State Park Management Plan. Parks Victoria. Melbourne.

Parks Victoria, 1998b. French Island National Park Management Plan. Parks Victoria. Melbourne.

Parks Victoria. 1996. Croajingolong National Park Management Plan, Parks Victoria. Melbourne.

Parsons, K. 2011. Nowhere Else on Earth: Tasmania's Marine Natural Values. Report for Environment Tasmania. Aquenal, Tasmania.

Parry, G.D., S. Heislers, G.F. Werner, M.D. Asplin, and A. Gason. 2002. Assessment of Environmental Effects of Seismic Testing on Scallop Fisheries in Bass Strait. Marine and Freshwater Resources Institute Report No. 50. Marine and Freshwater Institute, Queenscliff, Victoria.

Parry, G.D. and Gason, A. 2006. The Effect of Seismic Surveys on Catch Rates of Rock Lobsters in Western Victoria, Australia. Fisheries Research 79(2006): 272-284.

Parvin S.J., Nedwell, J.R. and Harland, E. 2007. Lethal and physical injury of marine mammals, and requirements for Passive Acoustic Monitoring. Subacoustech Report Reference: 565R0212, February 2007, Submitted to the UK DTI, 1 Victoria Street, London, SW1H 0ET. Published by the UK Department of Business, Enterprise and Regulatory Reform.

Parvulescu, A. 1967. The acoustics of small tanks. In: Tavolga WN (ed) Marine bio-acoustics, vol 2. Pergamon, Oxford, pp 7–13.

Passlow, V., Rogis, J., Hancock, A., Hemer, M., Glenn, K and Habib, A. Final Report, National Marine Sediments Database and Seafloor Characteristics Project. Geoscience Australia, Record 2005/08.

Passlow, V., O'Hara, T., Daniell, J., Beaman, R. J., and Twyford, L.M, 2006. Sediments and Biota of Bass Strait: an Approach to Benthic Habitat Mapping. Geoscience Australia, Record 2004/23.

Patterson, H., Noriega, R., Georgeson, L., Larcombe, J. and Curtotti, R. 2020. Fishery status reports 2019. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Larcombe, J. and Curtotti, R. 2019. Fishery status reports 2019. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Larcombe, J. and Curtotti, R. 2018. Fishery status reports 2018. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Larcombe, J. and Curtotti, R. 2017. Fishery status reports 2017. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Patterson, H., Noriega, R., Georgeson, L., Stobutski, I. and Curtotti, R. 2016. Fishery status reports 2016. Australian Bureau of Agricultural and Resource Economics and Sciences. Canberra.

Parry, G.D., Campbell, S.J., and Hobday, D.K. 1990. Marine resources off East Gippsland, Southeastern Australia. Technical Report No. 72, Marine Science Laboratories. Queenscliff, Victoria.

Payne, J., Andrews, C., Fancey, L., White, D. and Christian, J. 2008. Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003. Report Number 2008/060. Canadian Science Advisory Secretariat.

Payne, J., Andrews, C., Fancey, L., Cook, A., Christian, J. 2007. Pilot study on the effects of seismic air gun noi se on lobster (Homarus americanus). Fisheries and Oceans Canada.

Peakall, D.B., Wells, P.G. and Mackay, D. 1987. A hazard assessment of chemically dispersed oil spills and seabirds. Mar. Env. Res. 22(2):91-106.

Pearson, W., Skalski, J., Sulkin, S. and C. Malme. 1994. Effects of seismic energy releases on the survival and development of zoeal larvae of dungeness crab (Cancer magister). Mar. Environ. Res. 38: 93-113

Peel, D., Kelly, N., Smith, J., Childerhouse, S. 2016. National Environmental Science Program Project C5 – Scoping of Potential Species for Ship Strike Risk Analysis, Pressures and impacts. CSIRO. Australia.

Perrin, W. 1998. *Stenella longirostris*. Mammalian Species. 599. 1. 10.2307/3504456.

Phillip Island Nature Parks (PINP). 2018. Phillip Island Nature Parks Strategic Plan 2018-2023. A WWW document accessed at https://penguins.org.au/assets/About/PDF-Publications/PINP-Strategic-Plan-2018-23-web.pdf.

Pichegru, L., Nyengera, R., McInnes, A.M. 2017. Avoidance of seismic survey activities by penguins. Sci Rep 7, 16305. DOI: https://doi.org/10.1038/s41598-017-16569.

Piniak, W.E.D., Mann, D.A., Harms, C.A., Jones, T.T. and Eckert, S.A. 2016. Hearing in the Juvenile Green Sea Turtle (Chelonia mydas): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. PLOS ONE 11(10): e0159711.

Piniak, W.E., Mann, D.A., Eckert, S.A. and Harms, C.A. 2011. Amphibious hearing in sea turtles. In: Hawkins, T. and Popper, A.N. (eds.). Proceedings of the 2nd International Conference on the Effects of Noise on Aquatic Life. August 15-20, 2010. Springer-Verlag. (In Press).

August 15-20, 2010. Springer-Verlag. (In Press).

Pinzone, G. 2003. Personal observations. Dedicated marine mammal observation team member – 2002 Bass Strait seismic surveys. Giulio Pinzone, Environmental Consultant, NSR Environmental Consultants Pty Ltd.

PIRSA, 2002 – A Report Prepared for Environment Australia on the Management of the South Australian Giant Crab (*Pseudocarcinus gigas*) Fishery for the purposes of Section 303FN (Approved Wildlife Trade Operation) of the Environment Protection and Biodiversity Conservation Act 1999, October 2002 at http://www.pir.sa.gov.au/_data/assets/pdf_file/0006/12777/giant_crab2002.pdf

Poore, G.C.B., Wilson, R.S., Gomon, M., and Lu, C.C. 1985. Museum of Victoria Bass Strait Survey, 1979-1984. Museum of Victoria: Melbourne.

Popper, A. 2018. Potential for Impact of Cumulative Sound Exposure on Fishes During a Seismic Survey. Prod uced for Santos Ltd. Bethany 3D Seismic Survey Environment Plan Summary.

Popper, A.N., Carlson, T.J., Gross, J.A., Hawkins, A.D., Zeddies, D., Powell, L. and Young, J. 2016. Effects of seismic air guns on pallid sturgeon and paddlefish. Advances in Experimental Medicine and Biology 875: 871-878. NLM.

Popper, A.N., Carlson, T., Gross, J.A., Hawkins, A.D., Zeddies, D.G. and Powell, L. 2015. Effects of Seismic Air Guns on Pallid Sturgeon and Paddlefish. Advances in Experimental Medicine and Biology 875:871-878.

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. SpringerBriefs in Oceanography, Volume ASA S3/SC1.4 TR-2014. ASA Press.

Popper, A.N. and M.C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. J. Fish Biol. 75(3):455-489

Popper, A.N. and Løkkeborg, S. 2008. Effects of anthropogenic sound on fish. Bioacoustics 17: 214-217.

Popper A.N., Halvorsen, M.B., Kane, E., Miller, D.D., Smith, M.E., Stein, P. and Wysocki, L.E. 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. J. Acoust. Soc. Am. 122: 623–635.

Popper, A. N., M. E. Smith, P. A. Cott, B. W. Hanna, A. O. MacGillivray, M. E. Austin, and D. A. Mann. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. The Journal of the Acoustical Society of America 117:3958-3971.

Popper, A. Salmon, M. & Horch, K. 2001. Acoustic detection and communication by decapod crustaceans. Journal of comparative physiology. A, Sensory, neural, and behavioral physiology. 187. 83-9.10.1007/s003590100184.

Prideaux., 2017. Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities

Przeslawski, R., Hurt, L., Forrest, A. and Carroll, A. 2016a. Potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin, FRDC Project No 2014/041. Geoscience Australia. Canberra.

Przeslawski, R., Bruce, B., Carroll, A., Anderson, R., Bradford, A., Durrant, A., Edmunds, M., Foster, S., Huang, Z., Hurt, L., Lansdell, M., Lee, K., Lees, C., Nichols, P. and Williams, S. 2016b. Marine Seismic Survey Impacts on Fish and Invertebrates. Final Report for the Gippsland Marine Environmental Monitoring Project. Record 2016/35. Geoscience Australia. Canberra.

PTTEP. 2013. Montara Environmental Monitoring Program. Report of Research. A WWW document accessed at: www.au.pttep.com/sustainable-development/environmentalmonitoring. PTTEP Australasia. Perth.

Purser, J. and Radford, A.N. 2011. Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (*Gasterosteus aculeatus*). PLoS ONE 6(2): e17478.

PWS. 2002. Arthur–Pieman Conservation Area Management Plan. Department of Primary Industries, Water and Environment, Hobart.

PWS. 2000. Lavinia Nature Reserve (Ramsar Site) Management Plan 2000 (Draft). A WWW document accessed at: https://www.parks.tas.gov.au/file.aspx?id=6601. Parks and Wildlife Service Department of Primary Industries, Water and Environment, Hobart.

Plummer A., Morris L., Blake S. and Ball, D. 2003. Marine Natural Values Study, Victorian Marine National Parks and Sanctuaries, Parks Victoria Technical Series No. 1, Parks Victoria, Melbourne.

Radford, A. N., Lèbre, L., Lecaillon, G., Nedelec, S.L. and Simpson, S.D. 2016. Repeated exposure reduces the response to impulsive noise in European seabass. Global Change Biology.

Ramachandran, S.D., Hodson, P.V., Khan, C.W. and Lee, K. 2004. Oil dispersant increases PAH uptake by fish exposed to crude oil. Ecotoxicology and Environmental Safety 59:300– 308.

Richardson, W. J., Greene, C. R., Maime, C. I. and Thomson, D. H. 1995. Marine Mammals and Noise. Academic Press. California.

Rawson, C., Gagnon, M.M. and Williams, H. 2011. Montara Well Release Olfactory Analysis of Timor Sea Fish Fillets. Curtin University, Perth, Western Australia, November 2011.

Richardson, A.J., Matear, R.J. and Lenton, A. 2017. Potential impacts on zooplankton of seismic surveys. CSIRO. Australia.

Richardson, W. J., Greene, C. R., Maime, C. I. and Thomson, D. H. 1995. Marine Mammals and Noise. Academic Press. California.

Ridgway, S.H., Wever, E.G., McCormick, J.G., Palin, J. and Anderson, J.H. 1969. Hearing in the giant sea turtle, Chelonia mydas. Proceedings of the National Academy of Sciences 64(3): 884-890.

Roberts, L. and Breithaupt, T. 2016. Sensitivity of crustaceans to substrate-borne vibration. Advances in Experimental Medicine and Biology 875: 925-931.

Robinson S., Gales R., Terauds A. & Greenwood M. 2008. Movements of fur seals following relocation from fish farms. Aquatic Conservation: Marine and Freshwater Ecosystems. Vol. 18, no. 7, pp. 1189-1199

Rogers P. H., Hawkins A. D., Popper A. N., Fay R. R., Gray M. D. 2016. Parvulescu revisited: small tank acoustics for bioacousticians. In: The Effects of Noise on Aquatic Life, II, pp. 933–941. Ed. by Popper A. N., Hawkins A. D.. Springer Science+Business Media, New York.

Ross P., Minchinton T. and Ponder W. 2009. The ecology of molluscs in Australian saltmarshes. In: Australian Saltmarsh Ecology. (ed. N Saintilan). CSIRO Publishing, Victoria.

Ross, G. 2006. Review of the Conservation Status of Australia's Smaller Whales and Dolphins. Report to the Australian Department of the Environment and Heritage. Canberra.

Ross, R. 2000. Mangroves and Salt Marshes in Westernport Bay, Victoria, Arthur Rylah Institute for Environmental Research, Department of Natural Resources and the Environment, Victoria.

Rowe, C.L., Mitchelmore, C.L. and Baker, J.E. 2009. Lack of Biological Effects of Water Accommodated Fractions of Chemically and Physically Dispersed Oil on Molecular, Physiological, and Behavioural Traits of Juvenile Snapping Turtles Following Embryonic Exposure. Science of The Total Environment. 407(20): 5344– 5355.

RPS. 2020. Sequoia 3D Marine Seismic Survey. Oil Spill Modelling. Rev 1. date 2020. Prepared by RPS for ConocoPhillips.

Saddlier, S., Jackson, J. & Hammer, M. 2010. National Recovery Plan for the Dwarf Galaxias (*Galaxiella pusilla*). Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-dwarfgalaxias-galaxiella-pusilla.

Saetre, R. and Ona, E. 1996. The effects of seismic surveys on fish eggs and larvae. Fiskens Og Havet 8: 24.

Samson, J.E., Mooney, T.A., Gussekloo, S.W. and Hanlon, R.T. 2016. A Brief Review of Cephalopod Behavioral Responses to Sound. Adv. Exp. Med. Biol. 875: 969-75.

Sandegren, F.E. 1970. Breeding and maternal behaviour of the Steller sea lion (*Eumetoias jubata*) in Alaska. M.Sc. Thesis, Univ. Alaska, Anchorage, AK. Sergeant.

Sandery P.A. and Kampf J. 2005. Winter Spring flushing of Bass Strait, South Eastern Australia; Numerical modelling study. Estuarine and coastal shelf science 63.

Santos. 2004. Casino Gas Field Development Environment Report. Prepared by Enesar Consulting Pty Ltd. Hawthorn East, Victoria, for Santos Ltd, Adelaide

Santulli, A., Modica, A., Messina, C., Ceffa, L., Curatolo, A., Rivas, G., Fabi, G. and D'Amelio, V. 1999. Biochemical Responses of European Sea Bass (Dicentrarchus labrax L.) to the Stress Induced by Off Shore Experimental Seismic Prospecting. Mar. Poll. Bull. 38:1105-1114.

SARDI. 2011. Conservation management priorities for little penguin populations in Gulf St Vincent. Report to Adelaide and Mount Lofty Ranges Natural Resources Management Board. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000188-1. SARDI Research Report Series No.588. 97pp.

Schahinger, R.B. 1987. Structure of coastal upwelling events observed off the south-east coast of South Australia during February 1983-April 1984. Australian Journal of Marine and Freshwater Research 38: 439-459.

Schlacher, T., Schlacher-Hoenlinger, M., Williams, A., Althaus, F., Hooper, J. and Kloser, R. 2007. Richness and distribution of sponge megabenthos in continental margin canyons off southeastern Australia. Marine Ecology Progress Series. 340: 73-88.

Shaughnessy, P.D. 1999. The action plan for Australian seals. CSIRO Wildlife and Ecology.

Shaw, R. F., Lindquist, D. C., Benfield, M. C., Farooqi, T., Plunket, J. T. 2002. Offshore petroleum platforms: functional significance for larval fish across longitudinal and latitudinal gradients. Prepared by the Coastal Fisheries Institute, Louisiana State University. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2002-077.

Shigenaka, G. 2011. Chapter 27 – Effects of Oil in the Environment. In: Oil Spill Science and Technology. Gulf Professional. Pp 985-1024.

Shigenaka, G. 2003. Oil and Sea Turtles: Biology, Planning, and Response. National Oceanographic and Atmospheric Administration, United States of America.

Simmonds, M., Dolman, S. and Weilgart, L. 2004. Oceans of Noise. Whale and Dolphin Conservation Society. Wiltshire.

Slabbekoorn, H. 2016. Aiming for Progress in Understanding Underwater Noise Impact on Fish: Complementary Need for Indoor and Outdoor Studies. In: Popper, N.A. and Hawkins, A. (eds.). The Effects of Noise on Aquatic Life II. Springer New York, New York, NY. 1057–1065.

Slotte, A., Hansen, K., Dalen, J., Ona, E., 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research 67, 143–150.

Smithsonian Institute. 2014. - Marine Station at Fort Pierce – What is a Bryozoan? A www publication available at http://www.sms.si.edu/irlspec/IntroBryozoa.html

Solan, M., Hauton, C., Godbold, J.A., Wood, C.L., Leighton, T.J. and White, P. 2016. Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. Scientific Reports 6: 20540.

Southall, B.L., Nowaceck, D.P., Miller, P.J.O. and Tyack, P.L. 2016. Experimental field studies to measure behavioural responses of cetaceans to sonar. Endangered Species Research 31: 293-315.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A and Tyack, P.L. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals. 33(4): 411–521.

SRL. 2021. The Life of a Southern Rock Lobster. A WWW resource accessed at https://www.southernrocklobster.com. Southern Rocklobster Limited.

Williams, A., Gardner, C., Althaus, F. and Barker, B. 2009. Understanding shelf-break habitat for sustainable management of fisheries with spatial overlap. Final Report to the Fisheries Research and Development Corporation; Project No. 2004/066. June 2009.

Stadler, J. and Woodbury, D. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. 38th International Congress and Exposition on Noise Control Engineering 2009, INTER-NOISE 2009. 5.

Stephenson, L.H. 1991. Orange-bellied Parrot Recovery Plan: Management Phase. Tasmanian Department of Parks, Wildlife & Heritage. Hobart.

Stone, C.J. and Tasker, M.L. 2006. The effects of seismic airguns on cetaceans in UK waters. Journal of Cetacean Research and Management 8(3): 255.

Streever, B., Raborn, S.W., Kim, K.H., Hawkins, A.D. and Popper, A.N. 2016. Changes in fish catch rates in the presence of air gun sounds in Prudhoe Bay, Alaska. Arctic 69(4): 346-358.

SWIFFT, 2018 – Southern Right Whale research and monitoring project. A www publication accessed on 15th November, 2018 at https://www.swifft.net.au/cb_pages/team_southern_right_whale_south_eastern_australia_monitoring.php

Shapiro M.A. 1975. Westernport Bay Environmental Study, 1973 -1974. Ministry for Conservation, Victoria.

Sim, R. 1991. Prehistoric Archeological Investigations on King and Flinders Islands, Bass Strait, Tasmania. A Thesis submitted for the Degree of Master of Arts in Prehistory. Department of Prehistory and Anthropology, Faculty of Arts, Australian National University.

Shaughnessy, P.D. and P. Chapman. 1984. Commensal Cape fur seals in Cape Town docks. S. African J. Mar. Sci. 2: 81-91.

Shorebirds 2020. A WWW database accessed at (https://birdata.birdlife.org.au/).

Tasmanian SMPC. 1999. Iron Baron oil spill, July 1995: long term environmental impact and recovery. Tasmania State Marine Pollution Committee. Long Term Impact Assessment Group.

Threatened Species Scientific Committee. TSSC. 2010. Commonwealth Listing Advice on *Neophoca cinerea* (Australian Sea-lion). Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/22-listing-advice.pdf

Threatened Species Section. 2012. King Island Biodiversity Management Plan. Department of Pimary Industries, Parks, Water and Environment, Hobart available at https://www.environment.gov.au/system/files/resources/f15149a7-f50d-42a9-b6df-7b275c235ccc/files/king-island-bmp.pdf

Thomson, R.B., Sporcic, M., Foster, S.D., Haddon, M., Potter, A., Carroll, A., Przeslawski, R., Knuckey, I., Koopman, M. and Hartog J. 2014. Examining Fisheries Catches and Catch Rates for Potential Effects of Bass Strait Seismic Surveys. CSIRO and Geoscience Australia. Hobart and Canberra.

Thomsen, B. 2002. An Experiment on How Seismic Shotting Affects Caged Fish. University of Aberdeen.

Tidau, S. and Briffa, M. 2016. Review on behavioral impacts of aquatic noise on crustaceans. Proc. Mtgs. Acoust. 27(1): 010028.

TSSC. 2016a. Conservation Advice *Mirounga leonina* southern elephant seal. Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26-conservation-advice-07122016.pdf.

Threatened Species Scientific Committee. 2016b. Conservation Advice Arctocephalus tropicalis subantarctic fur-seal. Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/25909-conservation-advice-07122016.pdf.

Thursby, G.B. and Steele, R. L. 2004. Toxicity of arsenite and arsenate to the marine macroalga *Champia parvula* (rhodophyta). Environmental Toxicology and Chemistry 3 (3):391-397.

TSSC. 2016c. Conservation Advice *Lathamus discolor* swift parrot. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/744-conservationadvice-05052016.pdf.

TSSC. 2015a. Conservation Advice – Rhincodon typus (whale shark). A WWW document accessed at http://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservation-advice01102015.pdf. Threatened Species Scientific Committee. Canberra.

TSSC. 2015b. Conservation Advice – Balaenoptera borealis (sei whale). A WWW document accessed at http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice01102015.pdf. Threatened Species Scientific Committee. Canberra.

TSSC. 2015c. Conservation Advice – Balaenoptera physalus (fin whale). A WWW document accessed at http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice01102015.pdf. Threatened Species Scientific Committee. Canberra.

TSSC. 2015d. Conservation Advice – Megaptera novaeangliae (humpback whale). A WWW document accessed at http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice10102015.pdf. Threatened Species Scientific Committee. Canberra.

TSSC. 2013. Commonwealth Conservation Advice for Subtropical and Temperate Coastal Saltmarsh. A WWW document accessed at: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/118conservationadvice.pdf. Threatened Species Scientific Committee. Canberra.

Tsvetnenko, Y. 1998. Derivation of Australian Tropical Marine Water Quality Criteria for Protection of Aquatic Life from Adverse Effects of Petroleum Hydrocarbons. Environmental Toxicology and Water Quality 13(4):273284.

TSSC. 2001. Commonwealth Listing Advice on Carcharias taurus, Grey Nurse Shark (East Coast population). A WWW document accessed at http://www.environment.gov.au/biodiversity/threatened/species/c-taurus.html. Threatened Species Scientific Committee. Canberra.

Tyack, P. L. 2008. Convergence of calls as animals form social bonds, active compensation for noisy communication channels, and the evolution of vocal learning in mammals. Journal of Comparative Psychology, 122(3), 319–331. https://doi.org/10.1037/a0013087

UNEP-WCMC. 2020. Protected Planet; The World Database on Protected Areas. A WWW database accessed at www.protectedplanet.net. Cambridge, UK: UNEP-WCMC and IUCN.

University of Michigan (2018). Animal Diversity Web. – Hydrozoa. A www publication accessed on 29th September 2020 at http://animaldiversity.org/accounts/Hydrozoa/

Van Meter, R.J., Spotila, J.R. and Avery, H.W. 2006. Polycyclic Aromatic Hydrocarbons Affect Survival and Development of Common Snapping Turtle (Chelydra serpentina) Embryos and Hatchlings. Env. Poll. 142(3): 466–475.

Van Overbeek, J., & Blondeau, R. 1954. Mode of Action of Phytotoxic Oils. Weeds, 3(1), 55-65.

Victorian Fisheries Authority. 2020. Commercial fisheries. A WWW database accessed at: https://vfa.vic.gov.au/commercial-fishing. Victorian Fisheries Authority, Melbourne.

VFA. 2017. Scallop Report. A WWW database accessed at https://vfa.vic.gov.au/__data/assets/pdf_file/0007/423736/Copy-of-DOC-18-385073-FINAL_Vic-Ocean-Scallop-2017-18-Survey-Final-Report-1.PDF. Victorian Fisheries Authority. Melbourne.

VFA. 2017. Victorian Rock Lobster Fishery Management Plan. Victorian Fisheries Authority. Melbourne.

VFA. 2010. Victorian Giant Crab Fishery Management Plan. Victorian Fisheries Authority. Melbourne.

Volkman, J.K., Miller, G.J., Revill, A.T. and Connell, D.W. 1994. 'Oil spills.' In: Environmental Implications of offshore oil and gas development in Australia - the findings of an independent scientific review. Edited by Swan, J.M., Neff, J.M. and Young, P.C. Australian Petroleum Exploration Association. Sydney.

Wale, M. A., Simpson, S. D and Radford, A. N. 2013. Noise negatively affects foraging and antipredator behaviour in shore crabs. Animal Behaviour. 86(1) 111–118.

Ward, W. D. 1997. Effects of high-intensity sound in Encyclopedia of Acoustics, edited by M. J. Crocker (Wiley, New York, NY), pp. 1497–1507.

Wardle, C.S., Carter, T.J., Urquhart, G.C., Johnstone, A.D.F., Ziolkowski, A.M., Hampson, G. and Mackie, D. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research. 21: 1005–1027.

Wartzok, D. and Ketten, D.E. 1999. Marine Mammal Sensory Systems. In: Reynolds, J. and Rommel, S. (eds.). Biology of Marine Mammals. Smithsonian Institution Press, Washington DC. 117–175.

Walker, D.I. and McComb, A.J. 1990. Salinity response of the seagrass Amphibolis antarctica (Labill.) Sonder et Aschers: an experimental validation of field results. Aquat Bot. 36:359–366.

Watson, C.F. and Chaloupka, M.Y. 1982. Zooplankton of Bass Strait: Species Composition, Systematics and Artificial key to Species. Tasmanian Institute of Marine Science Technical Report No. 1.

WDCS. 2006. Vessel collisions and cetaceans: What happens when they don't miss the boat. Whale and Dolphin Conservation Society. United Kingdom.

WDCS. 2004. Oceans of Noise.: A WDCS Science Report. Whale and Dolphin Conservation Society. United Kingdom.

Webster, F.J., Wise, B.S., Fletcher, W.J. and Kemps, H. 2018. Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia. Fisheries Research Report No. 288 Department of Primary Industries and Regional Development, Western Australia. 42 pp.

Weilgart, L.S. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85: 1091–1116.

Weir, C. 2007. Observations of marine turtles in relation to seismic airgun sound off Angola. Mar. Turt. Newsl. 116(2007):17–20.

Wever, E.G. 1978. The Reptile Ear: Its Structure and Function. Princeton University Press, Princeton, N.J.

Wiese, F. K., W. A. Montevecci, G. K. Davoren, F. Huettmann, A. W. Diamond, and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the northwest Atlantic. Marine Pollution Bulletin 42:1285–1290.

Willis, K.L. 2016. Underwater Hearing in Turtles. In Popper, N.A. and A. Hawkins (eds.). The Effects of Noise on Aquatic Life II. Springer New York, New York, NY. 1229-1235.

Wilson, R. and Poore, G. 1987. The Bass Strait survey: biological sampling stations, 1979-1984. Occasional papers from the Museum of Victoria 3, 1–14.

Wilson, S. and Swan, G. 2005. A Complete Guide to the Reptiles of Australia. Reed New Holland. Sydney.

Winkelmann I, Campos PF, Strugnell J, Cherel Y, Smith PJ, Kubodera T, Allcock L, Kampmann M-L, Schroeder H, Guerra A, Norman M, Finn J, Ingrao D, Clarke M, Gilbert MTP. 2013 Mitochondrial genome diversity and population structure of the giant squid Architeuthis: genetics sheds new light on one of the most enigmatic marine species. Proc R Soc B 280: 20130273. http://dx.doi.org/10.1098/rspb.2013.0273).

Wood, J., Southall, B.L. and Tollit, D.J., 2012. PG&E offshore 3D Seismic Survey Project EIR-Marine Mammal Technical Draft Report. SMRU Ltd.

Woodside. 2012a. Browse LNG Development, Maxima 3D MSS Monitoring Program Information Sheet 2 – Impacts of Seismic Airgun Noise on Fish Diversity and Abundance: A Coral Reef Case Study. Woodside Energy Ltd. Perth.

Woodside. 2012b. Browse LNG Development, Maxima 3D MSS Monitoring Program Information Sheet 1 – Impacts of Seismic Airgun Noise on Fish Behaviour: A Coral Reef Case Study. Woodside Energy Ltd. Perth.

Woodside. 2012c. Browse LNG Development, Maxima 3D MSS Monitoring Program Information Sheet 2 – Impacts of Seismic Airgun Noise on Fish Pathology, Physiology and Hearing Sensitivity: A Coral Reef Case Study. Woodside Energy Ltd. Perth.

Woodside. 2011. Browse LNG Development. Draft Upstream Environmental Impact Assessment, EPBC Referral 2008/4111, November 2011. Woodside Energy Ltd. Perth.

Woodside. 2008. Browse LNG Development. Torosa South-1 Pilot Appraisal Well Environment Plan. Woodside Energy Ltd. Perth.

Woodside. 2003. Environmental Impact Statement/Environment Effects Statement: Otway Gas Project. Woodside Energy Ltd. Perth.

World Bank Group. 2015. Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development. World Bank Group. Washington.

Young, M.A., Lerodiaconou, D., Edmunds, M., Hulands, L. and Schimel, A.C. G. 2016. Accounting for habitat and seafloor structure characteristics on southern rock lobster (Jasus edwardsii) assessment in a small marine reserve. Mar. Bio. 163: 1–13.

Yudhana, A., Sunardi, J.D., Abdullah, S. and Hassan, R.B.R. 2010. Turtle hearing capability based on ABR signal assessment. Telkomnika 8: 187-194.