Environment Plan

Prion 3D Marine Seismic Survey (T/RL2, T/RL4, T/RL5)

Revision	Date	Reason for issue	Originator	Reviewers	Approver
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Review frequency	Revision frequency
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THE THREE WHATS
What can go wrong?
What could cause it to go wrong?
What can I do to prevent it?

Document Information and History

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Document history

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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
AHR	Aboriginal Heritage Register
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
AS	Action Statement
ASBTIA	Australian Southern Bluefin Tuna Industry Alliance
AUV	Autonomous Underwater Vehicle
Bar(g)	Gauge pressure
BAT	Best Available Technique/s
BIA	Biologically Important Area
BPEM	Best Practice Environmental Management
BSCZSF	Bass Strait Central Zone Scallop Fishery
BSSIA	Bass Strait Scallop Industry Association
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes

Acronym	Definition
CA	Conservation Advice
CAMBA	China-Australia Migratory Bird Agreement
CASA	Civil Aviation Safety Authority
CBS	Central Bass Strait
CCTV	Closed Circuit Television
CD	Conservation Dependent
CE	Critically Endangered
CER	Commission for Energy Regulation
CFA	Commonwealth Fisheries Authority
CIE	Centre for Integrative Ecology
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973
CMP	Conservation Management Plan
CM&ER	Crisis Management and Emergency response
CMT	Crisis Management Team
CO2	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)
DNP	Director of National Parks
DoEE	Department of the Environment and Energy (Cth) (former)
DPI	Department of Primary Industries
DPIPWE	Department of Primary Industries, Parks, Water and Environment
E	Endangered
EAC	East Australian Current
EARPL	Esso Australia Resources Pty Ltd
EIA	Environment Impact Assessment
EMAC	Eastern Maar Aboriginal Corporation
EMBA	Environment that May Be Affected
EMP	Emergency Management Plan
EMT	Emergency Management Team
ENVID	Environmental Identification
EP	Environment Plan

Acronym	Definition
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
ERR	Earth Resources Regulation
ESD	Ecologically Sustainable Development
ESD	Emergency Shutdown
FFG Act	Flora and Fauna Guarantee Act 1988 (Vic)
GAB	Great Australian Bight
GHaT	Gillnet Hook and Trap
GHG	Greenhouse Gas
GPS	Global positioning system
HAZID	Hazard Identification
HSE	Health Safety and Environment
IAGC	International Association of Geophysical Contractors
IAP	Incident Action Plan
IAPP	International Air Pollution Prevention Certificate
IBA	Important Bird Area
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IMO	International Maritime Organization
IMS	Invasive Marine Species
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
KI-BDSE	King Island Blue Dot South East
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

Acronym	Definition
MNES	Matters of National Environmental Significance
MNP	Marine National Park
MO	Marine Orders
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MP	Marine Park
MPa	Megapascal(s)
MRT	Mineral Resources Tasmania
MSS	Marine Seismic Survey
NatPlan	Australian National Plan for Maritime Environmental Emergencies
NC	No Contact
NCEP	National Centre for Environmental Prediction
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
OEMS	Operational Excellence Management System
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
OWS	Oily Water Separator
PBW	Pygmy Blue Whale
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
POWBONS	Pollution of Waters by Oil and Noxious Substances Act 1986

Acronym	Definition
PPE	Personal Protective Equipment
PTS	Permanent Threshold Shift
PTW	Permit To Work
QLD	Queensland
RGPS	Relative Global Positioning System
RO	Reverse Osmosis
ROKAMBA	Republic of Korea–Australia Migratory Birds Agreement
RP	Recovery Plan
SA	South Australia
SIV	Seafood Industry Victoria
SEL	Sound Exposure Level
SEP	Stakeholder Engagement Plan
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
SRW	Southern Right Whale
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
STP	Sewage Treatment Plant
TACC	Total Allowable Commercial Catch
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
V	Vulnerable
VBA	Victorian Biodiversity Atlas
VFA	Victorian Fishing Authority

Acronym	Definition
VHF	Very High Frequency
Vic	Victoria
VicPlan	Victorian State Maritime Emergencies (Non-search and Rescue) Plan
VoO	Vessels of Opportunity
VRLA	Victorian Rock Lobster Fishing Association
WA	Western Australia

Units of Measurement

Abbreviation	Definition
cui	Cubic inches
km	Kilometre
m	Metre
M	Million
nm	Nautical miles
Psi	Pounds per square inch
m^2	Metres squared
km^2	Kilometres squared
ppm	Parts per million
pb	Parts per billion

1. Introduction

1.1 Background

Beach Energy (Operations) Ltd (Beach) is the Operator of the Retention Leases T/RL2, T/RL4 and T/RL5, located in Commonwealth waters in central Bass Strait. These retention leases contain the following gas fields:

- T/RL2 – Trefoil;
- T/RL4 – White Ibis and Bass; and
- T/RL5 – Bass.

Beach is investigating the potential for developing these gas reserves and tying them into the existing Yolla-A platform (operated by Beach) that processes gas from the Yolla gas field in T/L1. To facilitate this investigation, Beach is proposing to acquire the Prion three-dimensional (3D) marine seismic survey (MSS) (3DMSS) over the three permits (Figure 1.1), which will fill in knowledge gaps from MSS previously undertaken in and around the survey area (see Section 3.3).

At its closest points, the survey area is located 84 km southwest of Cape Liptrap (Victoria), 14 km west of Beach's Yolla-A platform, 57 km north of Stanley (Tasmania) and 74 km east of King Island (Tasmania).

1.2 Environment Plan Summary

Table 1.1 provides a summary of this Environment Plan (EP) as required by Regulation 11(4) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (herein referred to as the OPGGS(E)).

Table 1.1. EP Summary of material requirements

EP Summary requirement	Relevant EP section
The location of the activity	Section 3.1
A description of the receiving environment	Chapter 5
A description of the activity	Chapter 3
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 1.3

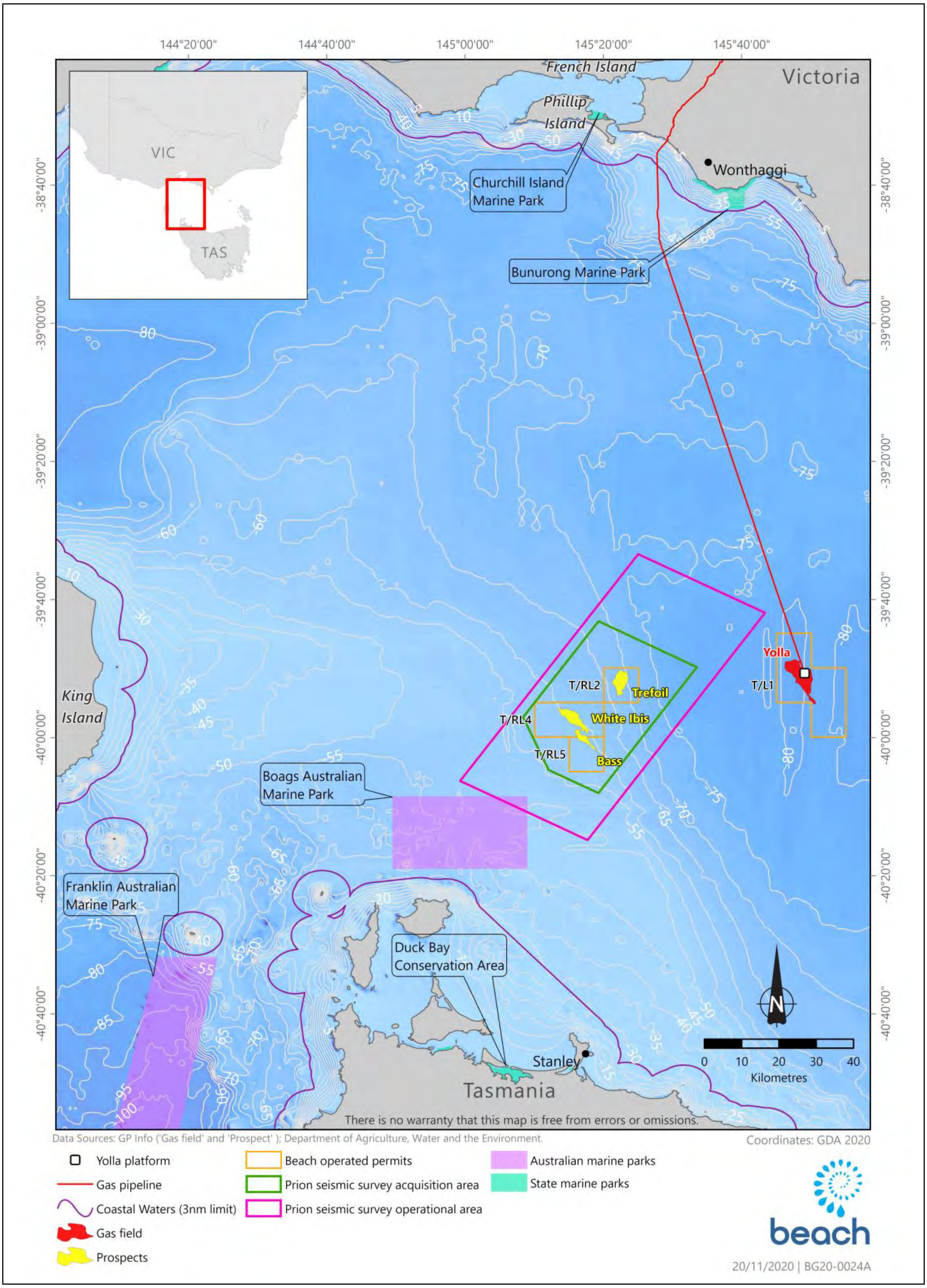


Figure 1.1. Prion 3DMSS location map

1.3 The Titleholder

Beach is the Titleholder and Operator of the three retention leases on behalf of several joint venture partners. The composition of each retention lease and holding is the same across all leases, as outlined in Table 1.2.

Table 1.2. Titleholder details for T/RL2, T/RL4 and T/RL5

Titleholder	ABN	Holding
Beach Energy (Operations) Limited	66 007 845 338	39% (Operator)
Beach Energy Limited	20 007 617 969	11.25%
AWE Petroleum Pty Ltd	52 009 440 975	40%
Prize Petroleum International Pte Ltd	16 601 684 048	9.75%

Beach acquired Lattice Energy Ltd (previously Origin Energy Resources Limited (Origin)) on 31 January 2018. This ownership change follows on from the announcement made by Origin in December 2016 to divest its conventional upstream oil and gas assets in Australia and New Zealand and the subsequent formation of the Lattice group of companies as owner of the conventional upstream assets. Subsequently in January 2020, Beach completed a name change of Lattice Energy to Beach Energy.

Beach was formed in 1961 and is an Australian Stock Exchange-listed oil and gas, exploration and production company headquartered in Adelaide, South Australia. It has operated and non-operated onshore and offshore oil and gas production from five petroleum basins across Australia and New Zealand and is a key supplier to the Australian east coast gas market. Beach's asset portfolio includes ownership interests in strategic oil and gas infrastructure, as well as a suite of high potential exploration prospects. Beach's gas exploration and production portfolio includes acreage in the Otway, Bass, Cooper/Eromanga, Perth, Browse and Bonaparte basins in Australia, as well as the Taranaki and Canterbury basins in New Zealand (Figure 1.2).

Beach is Australia's largest onshore oil producer and a key supplier to the Australian east coast gas market, supplying approximately 15% of the east coast's domestic gas demand, with two offshore production platforms and two gas plants in Victoria.

The Titleholder for this activity is:

Beach Energy (Operations) Ltd
Level 8, 80 Flinders Street, Adelaide, South Australia, 5000
Phone: 08-8338 2833
Email: info@beachenergy.com.au

The nominated liaison person for this EP is:

Wayne Mothershaw
Seismic Acquisition and Survey Lead
Level 8, 80 Flinders Street, Adelaide, South Australia, 5000
Phone: 08-8338 2833
Email: info@beachenergy.com.au

Beach 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.

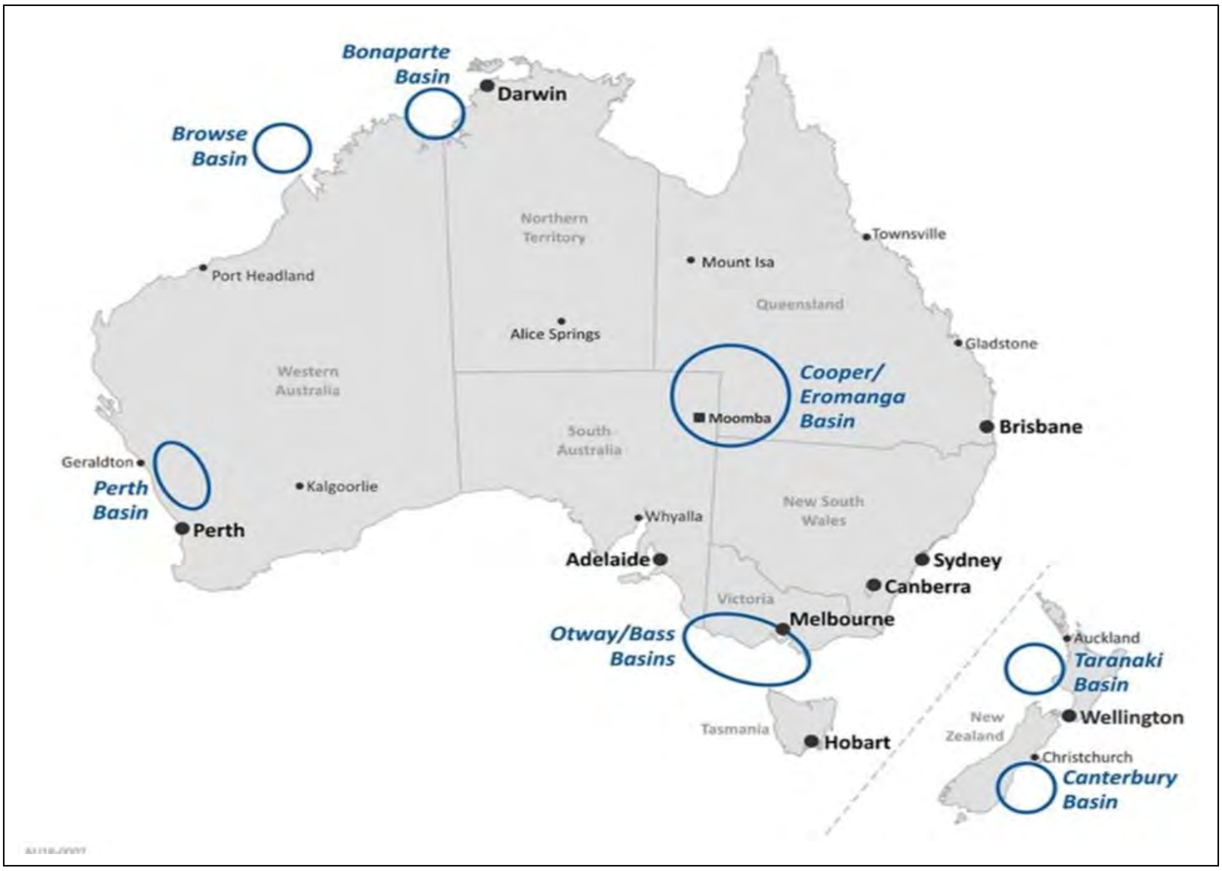


Figure 1.2. Locations of Beach assets

1.4 Objectives of this EP

As required by Regulation 6 of the OPGGS(E), an accepted EP must be in place prior to any offshore petroleum activity commencing, and operations must comply with the accepted EP.

This EP aims to secure acceptance of the Prion 3DMSS by demonstrating that Beach will manage the environmental impacts and risks of the activity to As Low As Reasonably Practicable (ALARP) and to an acceptable level.

1.5 Scope of this EP

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.

1.5.1 Definition of the Activity

In accordance with Regulation 4(1) of the OPGGS(E), this EP applies to a defined 'petroleum activity.' Beach defines this petroleum activity as the:

> *Acquisition of seismic data by the survey vessel within the Prion survey 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.*

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

1.5.2 Jurisdiction

The activity occurs entirely within Commonwealth waters and has been prepared to satisfy the requirements of Part 2 of the OPGGS(E), administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

2. Environmental Regulatory 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.

2.1 Beach Environment Policy

In accordance with Regulation 16(a) of the OPGGS(E), Beach's Environment Policy is provided in Figure 2.1. The policy provides a public statement of the company's commitment to minimise adverse effects on the environment and to improve environmental performance.

2.2 Commonwealth Legislation

Table 2.1 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.

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 and provides for the grant of exploration permits, retention leases, production licences, infrastructure and pipeline licences, among other things.

Under this Act, 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.

Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

The OPGGS(E) addresses all licensing and environmental issues for offshore petroleum and greenhouse (GHG) activities in Commonwealth waters. This EP has been prepared in accordance with Part 2 of the OPGGS(E) for NOPSEMA's assessment.

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.

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 Regulator of the EPBC Act. Activities that may have impacts to MNES are required to prepare and submit a Referral to the DAWE for determination on the level of environmental impact assessment (EIA) required.

In February 2014, NOPSEMA became the sole designated assessor of petroleum and GHG 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 activities are assessed solely through NOPSEMA. As such, an EPBC Act Referral has not been prepared and submitted to the DAWE for the Prion 3DMSS.

Beach proposes to undertake a trial of new seismic survey acquisition technology immediately adjacent to the survey area (beyond the scope of this EP). This is briefly described in Section 3.7. An EPBC Referral will be submitted to the DAWE for the technology trial.

beach

Environment Policy

Objective

Beach is committed to conducting operations in an environmentally responsible and sustainable manner.

Strategy

To achieve this, Beach will:

- Comply with relevant environmental laws, regulations, and the Beach Health, Safety and Environment Management System which is the method by which Beach identifies and manages environmental risk.
- Establish environmental objectives and targets, and implement programs to achieve them that will support continuous improvement;
- Identify, assess and control environmental impacts of our operations by proactive management of activities and mitigation of impacts;
- Ensure that incidents, near misses, concerns and complaints are reported, investigated and lessons learnt are implemented;
- Inform all employees and contractors of their environmental responsibilities including consultation and distribution of appropriate environmental management guidelines, regulations and publications for all relevant activities;
- Efficiently use natural resources and energy, and engage with stakeholders on environmental issues; and
- Publicly report on our environmental performance.

Application

This policy applies to all personnel associated with Beach activities.

Matt Kay
Managing Director and CEO
December 2019

Figure 2.1. Beach Environmental Policy

Table 2.1. Summary of key Commonwealth environmental legislation relevant to the activity

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (& 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. **Relevance to this activity:** This EP includes a description and assessment of 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 this activity)
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

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
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 may take over from Beach as the Combat Agency and implement the NatPlan.	• International Convention on Oil Pollution Preparedness, Response and Cooperation 1990. • 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
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
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.	• 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).	AMSA

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
	• MO 70 – Seafarer certification. **Relevance to this activity**: The vessels will adhere to the relevant MOs while operating within Commonwealth waters.	• International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) as amended, 1995.	
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 ; and • 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. See also Table 2.2 for further information.	Various parts of MARPOL.	AMSA
Protection of the Sea (Shipping Levy) Act 1981	Provides that where, at any time during a quarter when a ship with tonnage length of no less than 24 m was in an Australia port, there was on board the ship a quantity of oil in bulk weighing more than 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.	• International Convention on Civil Liability for Bunker Oil Pollution Damage 2001.	AMSA

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
	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.		
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
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:** Beach is a registered reporter under this Act (ABN 200 076 179 69). 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 Beach's operational control, it will be required to collect and submit its own emissions data under the NGER Act.	• UNFCCC 1994.	Clean Energy Regulator
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. 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, aircraft and	• International Convention for the Control and Management of Ships Ballast Water & 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

<table>
<tr><th>Legislation/Regulation</th><th>Scope</th><th>Related International Conventions</th><th>Administering Authority</th></tr>
<tr><td></td><td>vessels (not subject to biosecurity control) that leave Australian territory and are exposed to the installations are subject to biosecurity control when returning to Australian territory.

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.</td><td></td><td></td></tr>
<tr><td>Marine Safety (Domestic Commercial Vessel) National Law Act 2012

(& Regulations 2013)</td><td>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:
• MO 501 (Administration – National Law) 2013;
• MO 502 (Vessel Identifiers – National Law) 2013;
• MO 503 (Certificates of Survey – National Law) 2013;
• MO 504 (Certificates of Operation and Operational Requirements – National Law) 2013;
• MO 505 (Certificates of Competency – National Law) 2013; and
• 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.</td><td>Not applicable.</td><td>AMSA</td></tr>
</table>

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 Ecologically Sustainable Development (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

2.3 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 would be relevant in the case of a large hydrocarbon release, as the environment that may be affected (EMBA) intersects Victorian waters (see Chapter 5). 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 Commonwealth *Biosecurity Act* 2015 (see Table 2.1).
- *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 5.4.9 and Section 5.4.10).
- *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)).

2.4 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 case of a large hydrocarbon release, as the EMBA intersects areas of Tasmanian waters (around some Bass Strait islands and islands off the northwest coast). 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.

2.5 Government Guidelines

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:

<u>EPs</u>

- 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).
- 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).

<u>Oil Pollution Emergency Plans (OPEPs)</u>

- 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).

Operational and Scientific Monitoring Programs (OSMPs)

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

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).

2.6 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:

- 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.

2.7 International Industry 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 in chronological order. The Commonwealth legislation described in Table 2.2 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 in the demonstrations of acceptability throughout Chapter 7.

2.7.1 MARPOL

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 174 countries (as of December 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 2.2 lists the annexes of the Convention and identifies how they are given effect under Commonwealth legislation (with Victorian and Tasmanian legislation also included in the event of ingress into State waters being required in an emergency situation).

2.7.2 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 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.

2.7.3 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.

2.7.4 IUCN: Effective Planning Strategies for Managing Environmental 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. 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 2.2. Commonwealth, Victorian and Tasmanian legislation enacting the MARPOL Convention

MARPOL 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 International Oil Pollution Prevention (IOPP) certificate is required; • A Shipboard Marine Pollution Emergency Plan (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 International Pollution Prevention (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.
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

MARPOL 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**
				• Incidents involving discharges of dangerous goods are reported to AMSA.
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.
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 Protection Act* 1970: • Clause 33 (Management	*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 International Air Pollution Prevention (IAPP) certificate is in place; • An Engine International Air Pollution Prevention (EIAPP) certificate is in place for each marine diesel engine installed; • An International Energy Efficiency (IEE) certificate is in place; • 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

MARPOL 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**
		of Greenhouse Gases). • Clause 35 (Management of ODS). • Clause 36 (Management of other Mobile Sources).		(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.

2.7.5 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.

2.7.6 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.

2.7.7 IOGP Best Practice Guidelines

The International Association of Oil & Gas Producers (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 Program (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.

At December 2020, IOGP's members comprise 82 members, comprising oil and gas exploration and production companies, associations and contractors. Beach is an IOGP 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.

2.7.8 IPIECA: Best Practice Guidelines

IPIECA is the International Petroleum Industry Environmental Conservation Association, established in 1974 (since 2002, IPIECA stopped using the full title). At December 2020, IPIECA's members comprise 69 members, comprising oil and gas exploration and production companies, associations and contractors.

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.

Beach has applied IPIECA's *Mapping the Oil and Gas Industry to the Sustainable Development Goals: An Atlas* (July 2017) to the 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 Beach takes prevention, preparedness and response seriously and is well prepared to act in the event of an environmental emergency.

2.7.9 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 to support the oil spill response strategies.

2.8 Australian Industry Codes of Practice and Guidelines

There are few Australian industry codes of practice or guidelines regarding environmental management for offshore petroleum exploration. Those that do apply to the survey are briefly discussed in this section in chronological order.

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.

2.8.1 Australian Ballast Water Management Requirements (2020)

The *Australian Ballast Water Management Requirements* (DAWR, 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.

2.8.2 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, 2017a) 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.

2.8.3 Australian National Guidelines for Whale and Dolphin Watching (2017)

The *Australian National Guidelines for Whale and Dolphin Watching* (DoEE, 2017b) 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, Beach applies these guidelines to the support vessels so that approach distances to cetaceans are adhered to.

2.8.4 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.

2.8.5 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).

2.8.6 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.

2.8.7 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:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
- 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 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;
- The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and
- 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 6.5.4).

3. Activity Description

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

3.1 Location

The proposed Prion 3DMSS will take place over the following Beach operated permits located in Commonwealth waters:

- T/RL2 – covering the Trefoil gas field;
- T/RL4 – covering the White Ibis gas field; and
- T/RL5 – covering the Bass gas field;

The proposed Prion 3DMSS is divided into two areas (Figure 3.1), these being the:

- 'Acquisition area' - the physical area in which the seismic source will operate (i.e., acquire data), occurring over the three leases (covering an area of 880 km^2) and some open acreage around the permits. The acquisition area measures 39 km long (northeast-southwest orientation) at its longest and 24 km wide (northwest-southeast orientation) at its widest. The acquisition area occurs in water depths ranging from 55 m to 75 m Lowest Astronomical Tide (LAT).
- 'Operational area' - the physical area in which operations ancillary to achieving survey coverage will take place. This includes vessel approach, vessel line turns (up to 8 km, with allowance for 15 km), 'soft starts' of the seismic source, run-ins and run-outs of the seismic source and miscellaneous maintenance operations. The operational area measures 71 km long (northeast-southwest orientation) and 32 km wide (northwest-southeast orientation), covering an area of 2,272 km^2. The operational area occurs in water depths ranging from 50 m to 80 m LAT.

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

At its nearest points, the survey area is located 75 km east of King Island (Tasmania), 57 km north of the town of Stanley (Tasmania) and 84 km from Cape Liptrap (Victoria). The coordinates of the acquisition and operational areas are provided in Table 3.1 and distances from the acquisition and operational areas to nearby features are provided in Table 3.2.

Table 3.1. Coordinates of the acquisition and operational areas

Point	Latitude	Longitude
Acquisition area		
1	39° 43' 8.88" S	145° 19' 18.88" E
2	39° 49' 48.26" S	145° 33' 31.48" E
3	40° 08' 2.23" S	145° 19' 17.98" E
4	40° 04' 40.76" S	145° 12' 5.18" E
5	39° 57' 2.28" S	145° 08' 24.4" E
Operational area		
6	39° 33' 26.11" S	145° 25' 02.96" E
7	39° 41' 55.78" S	145° 43' 23.39" E
8	40° 14' 50.30" S	145° 17' 43.91" E
9	40° 06' 16.34" S	144° 59' 17.85" E

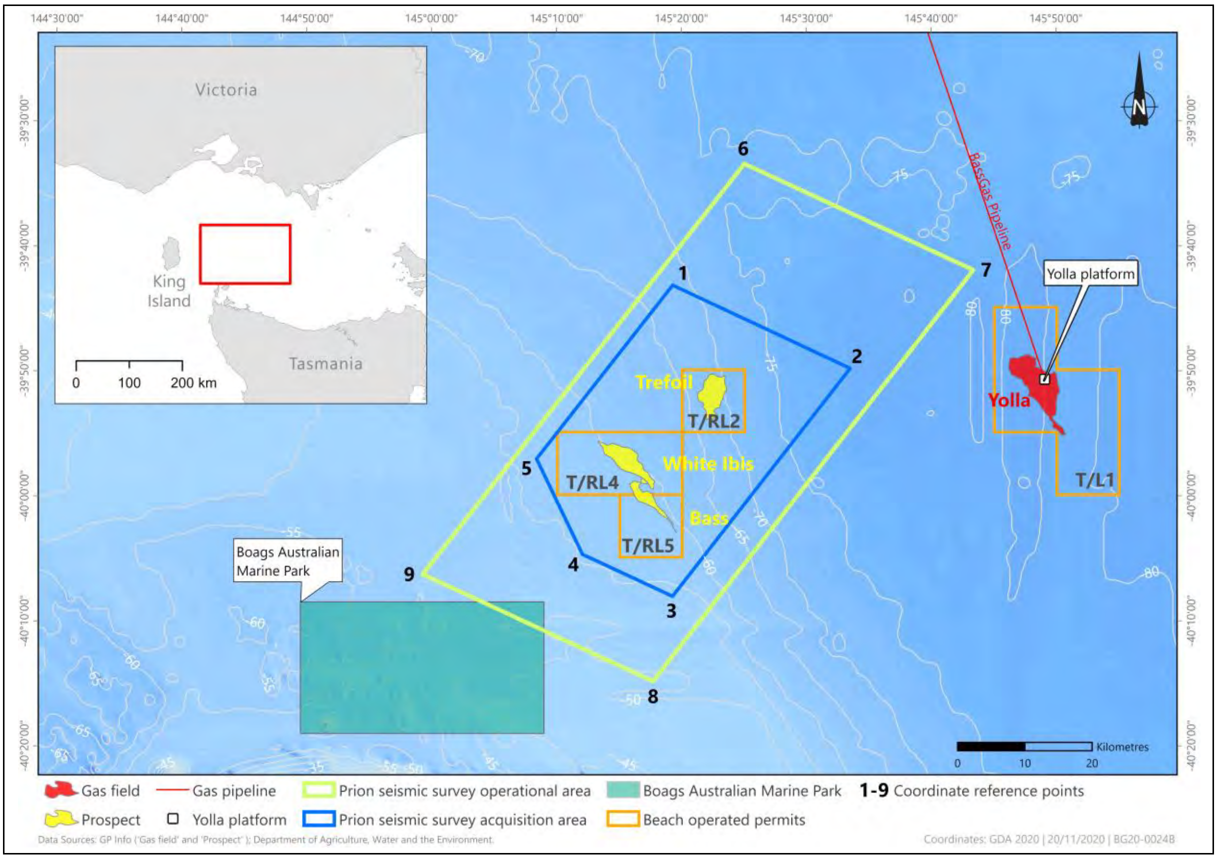


Figure 3.1. Proposed Prion 3DMSS survey area

Table 3.2. Distances to key features from the Prion survey area

Feature	Distance and direction from the **operational** area to the nearest point of the feature	Distance and direction from the **acquisition** area to the nearest point of the feature
Towns		
Stanley (Tas)	57 km south	70 km south
Narracoopa (Tas – King Island)	74 km west	86 km west
Wynyard (Tas)	91 km southeast	100 km southeast
Cape Paterson (Vic)	99 km north	118 km north
Whitemark (Tas – Flinders Island)	201 km east	212 km east
Natural Features		
Curtis Island (Tas)	83 km northeast	100 km northeast
Wilsons Promontory (Vic)	84 km northeast	104 km northeast
Tasmanian Mainland	52 km south	64 km south
King Island (Tas)	75 km west	85 km west
Flinders Island (Tas)	174 km east	187 km east
Marine Protected Areas		

Feature	Distance and direction from the operational area to the nearest point of the feature	Distance and direction from the acquisition area to the nearest point of the feature
Commonwealth		
Boags Australian Marine Park (AMP)	Overlapped by southern part of the operational area	8 km southwest
Beagle AMP	73 km northeast	90 km northeast
Franklin AMP	69 km southwest	84 km southwest
Apollo AMP	116 km northwest	118 km northwest
Zeehan AMP	115 km west	126 km west
Victorian – marine		
Wilsons Promontory Marine National Park (MNP)	77 km northeast	98 km northeast
Wilsons Promontory Marine Park	88 km northeast	108 km northeast
Cape Liptrap Coastal Park	84 km northeast	104 km northeast
Bunurong MNP	94 km north	115 km north
Bunurong Marine Park	98 km north	118 km north
Tasmania - marine		
Kent Group Marine Reserve	129 km northeast	145 km northeast
Subsea Infrastructure		
Tasmanian Gas Pipeline	111 km east	123 km east
Nearest oil or gas producing well (Yolla-A platform)	15 km east	22 km east
Subsea telephone cable – Bass Strait 1 (Sandy Point to Boat Harbour)	16 km east	28 km east
Subsea telephone cable – Bass Strait 2 (Inverloch to Stanley)	Feature within operational area	Feature within acquisition area
Basslink subsea electricity cable	102 km east	115 km east

3.2 Activity Timing

The Prion 3DMSS is scheduled to commence between July 2021 and June 2022, but may not commence until June 2023. This EP is therefore valid for a survey start date of any time up until June 2023. The preferred windows of opportunity are listed below in order of preference, noting that timing of survey commencement is dependent on receipt of EP acceptance, availability of a suitable survey vessel and weather/sea state conditions:

1. October to December 2021 (or 2022) – favourable sea state, avoids the peak blue whale migration period;
2. January to April 2022 (or 2023) – favourable sea state, but overlaps the peak and shoulder blue whale migration periods; or
3. April to July 2022 (or 2023) – less favourable sea state, streamers would need to be towed lower in the water column to mitigate for weather-related downtime and minimise acquiring poor data.

This EP describes the oil spill EMBA and assesses environmental impacts and risks with no seasonal bias in order to take account of any eventuality with survey start times.

The survey is expected to take up to 40 days, with the duration dependent on sea state conditions, whale-instigated shutdowns and technical matters.

Based on the feedback from stakeholder consultation to date, Beach has:

- Reduced the size of the acquisition area so as to avoid known commercial scallop beds to the immediate west of the survey area; and
- Changed the survey direction (to run northeast-southwest in parallel to the known scallop beds) instead of east-west so that line turns (including soft-starts) do not overlap the scallop beds.

In Bass Strait, the summer weather window is the most suitable for acquiring seismic survey data, since storms and high seas (waves greater than 1.5 m) can lead to poor quality data or completely prevent achieving the desired images of the subsurface. Although in Bass Strait the weather can be unpredictable at any time of year, the summer season is distinctly better on average. Wave noise can occur during any season but tends to be more prolonged between May and the end of September.

Beach has selected a survey 'window of opportunity' that it believes balances operational requirements with environmental and socio-economic constraints. Figure 3.2 outlines the key ecological process and species presence in the central Bass Strait Basin throughout the year that supports the selection of this window of opportunity. This figure indicates:

- Sea state conditions optimal for survey occur during the summer (and the spring and autumn shoulders), when the sound interference created by strong winds and waves is less than that in winter, and when sea state conditions are more favourable for vessel movements. Analysis of 56 seismic surveys undertaken in southeast Australia found:
    - Q1 - 25 surveys with an average weather downtime of 13.71% (ranging from 0% to 30.36%).
    - Q2 - 13 surveys with an average weather downtime of 15.84% (ranging from 0% to 43.65%).
    - Q3 - only 1 survey with a weather downtime of 23.24%.
    - Q4 - 16 surveys with an average weather downtime of 14.18% (ranging from 0% to 46.33%).

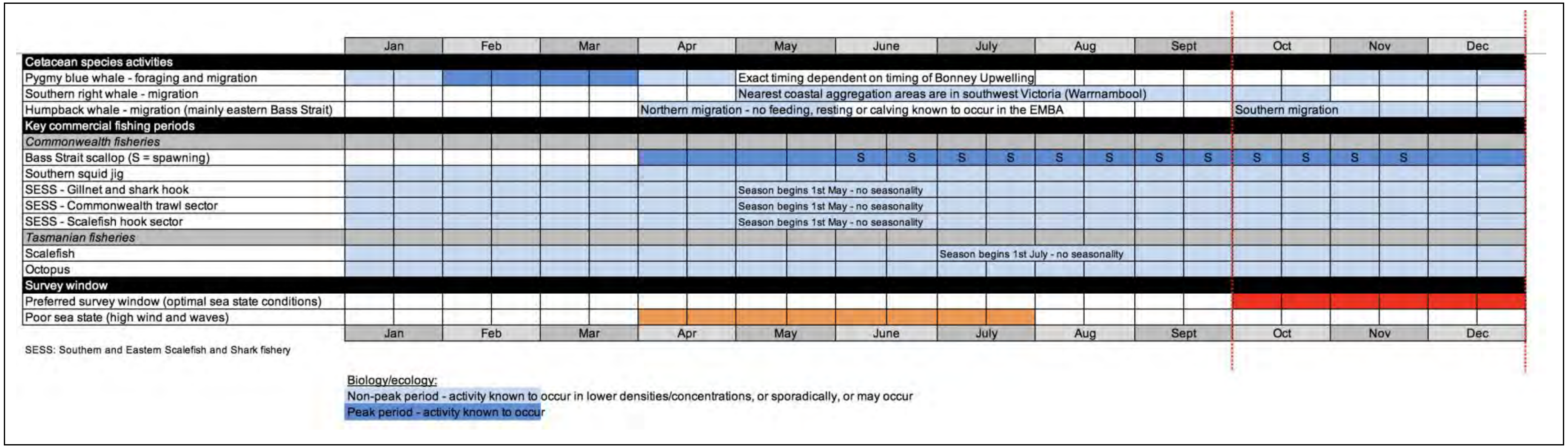


Figure 3.2. Key ecological and socio-economic activities in and around the proposed Prion 3DMSS area

- The overlap between the commercial fisheries (such as the scallop, and shark, gillnet and hook fisheries) operating in central Bass Strait means there is no period of time in which at least one fishery is not operating (and therefore potentially affected by the survey). Spawning periods for many commercially important fish species occur throughout most of the year, making avoidance of any one species' spawning period unachievable. It is noted that autumn and winter are seasons when many of these species do not spawn, but this period is unsuitable for survey acquisition (as previously outlined).

- Australian fur-seals feed year-round but breed onshore.

- Little penguins are present in the region year-round. While breeding occurs over the summer months and therefore overlaps the preferred survey window, this species is not listed as threatened and their numbers in Victoria remain strong.

Beach believes that these factors combine to make summer (and the shoulder periods) the most suitable time to conduct the Prion 3DMSS.

3.3 Survey Objective

The purpose of the survey is to acquire the data required to gain deeper knowledge of the subsurface geology in the area in order to identify commercially viable gas reservoirs for future development potential.

Numerous 2D and 3D MSS have been conducted within the operational area, but none are suitable for reservoir development (Figure 3.3). Previous MSS undertaken in the permits are the:

- **Chappell 3DMSS** in 2011, which had a very small overlap with the northern part of the acquisition area – this survey was acquired with two 3,090 cui airgun arrays, a 18.75 m source interval, 12 streamers with 100 m separation that were 5,100 m long and towed at a depth of 8 m. This survey was acquired with a very sparse sail line interval (600 m).

- **Silvereye 3DMSS** in 2008, which had a small overlap with T/RL4 – this survey was acquired in 2008 by PGS with slightly better parameters than the Shearwater survey (dual source 3,090 cui airgun array, 6 streamers with 100 m streamer separation, each 6,000 m long at 8 m depth and a 300 m sail line interval) but is only covered with a sparse grid of 2D data. This legacy 2D data is useful for prospect identification and early appraisal but 3D data is required for the detailed reservoir planning required for a commercial development.

- **Labatt 3DMSS** in 2008, which had a small overlap with the northern part of the operational area – this survey was acquired by PGS using a dual source 3,090 cui airgun array with 6 streamers that were 6,000 m long and towed at a depth of 8 m with a sail line interval of 300 m.

- **Shearwater 2D/3DMSS** in 2005 which overlapped T/RL2 – this survey was acquired in 2005 by PGS with relatively poor parameters by modern standards (Dual source x 2,500 cui, four streamers x 4,350 m at a depth of 8 m, with a 200 m sail line interval). The data quality provided by this survey does not provide the resolution required to effectively delineate reservoir sands and their connectivity.

Given the constraints of the previous MSS and the fact that coverage of all the permits was not obtained, a higher-resolution survey is required.

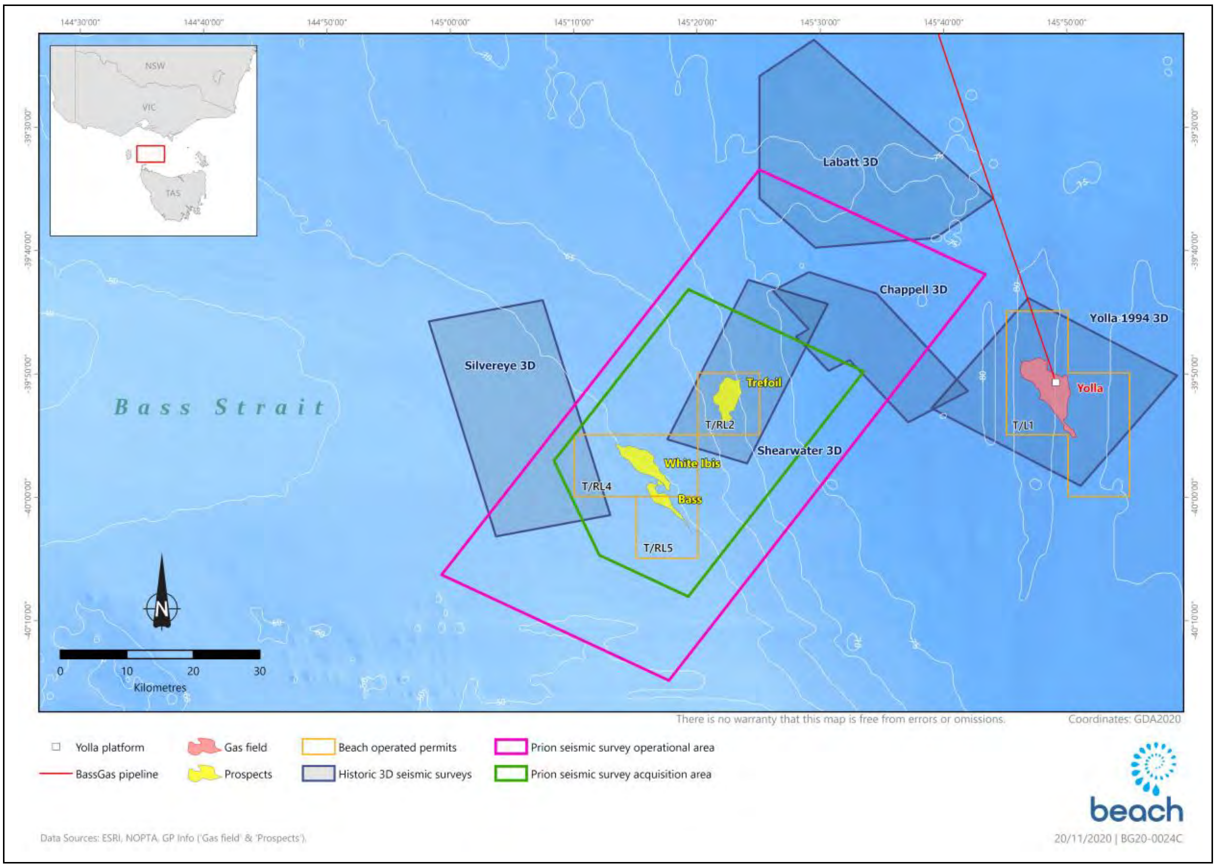


Figure 3.3. Previous MSS conducted in and around the Prion operational area

3.4 Survey Program

The Prion 3DMSS will be a high-resolution towed streamer survey similar to most other modern towed streamer seismic surveys conducted in Australian marine waters (in terms of technical methods and procedures) (Figure 3.4). No unique or unusual equipment or operations are proposed for the production survey. 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 vessel.

It is important to note that this design is likely to be further refined during the survey's planning phase.

The survey vessel will acquire the seismic data by towing three acoustic source arrays operating alternatively, one discharging as the others recompress. The lateral distance between each of the sources will be increased to 100 m to provide improved near-offset sampling. The source volume will be a maximum of 2,495 cubic inches (cui) with an operating pressure of 2,000 pounds per square inch (psi) (see Section 3.5.1). There will be between 10 and 12 hydrophone 'streamer' cables approximately 8,000 m long and 75 m apart towed behind the vessel at a depth of 10 to 25 m below the water surface. The vessel will sail back and forth across the acquisition area along 76 sail lines (nominally) that are approximately 300 m apart (see Section 2.5.2).

A series of acoustic pulses (discharged every 4-8 seconds) 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 be conducted 24 hours a day except when sea states exceed operational parameters.

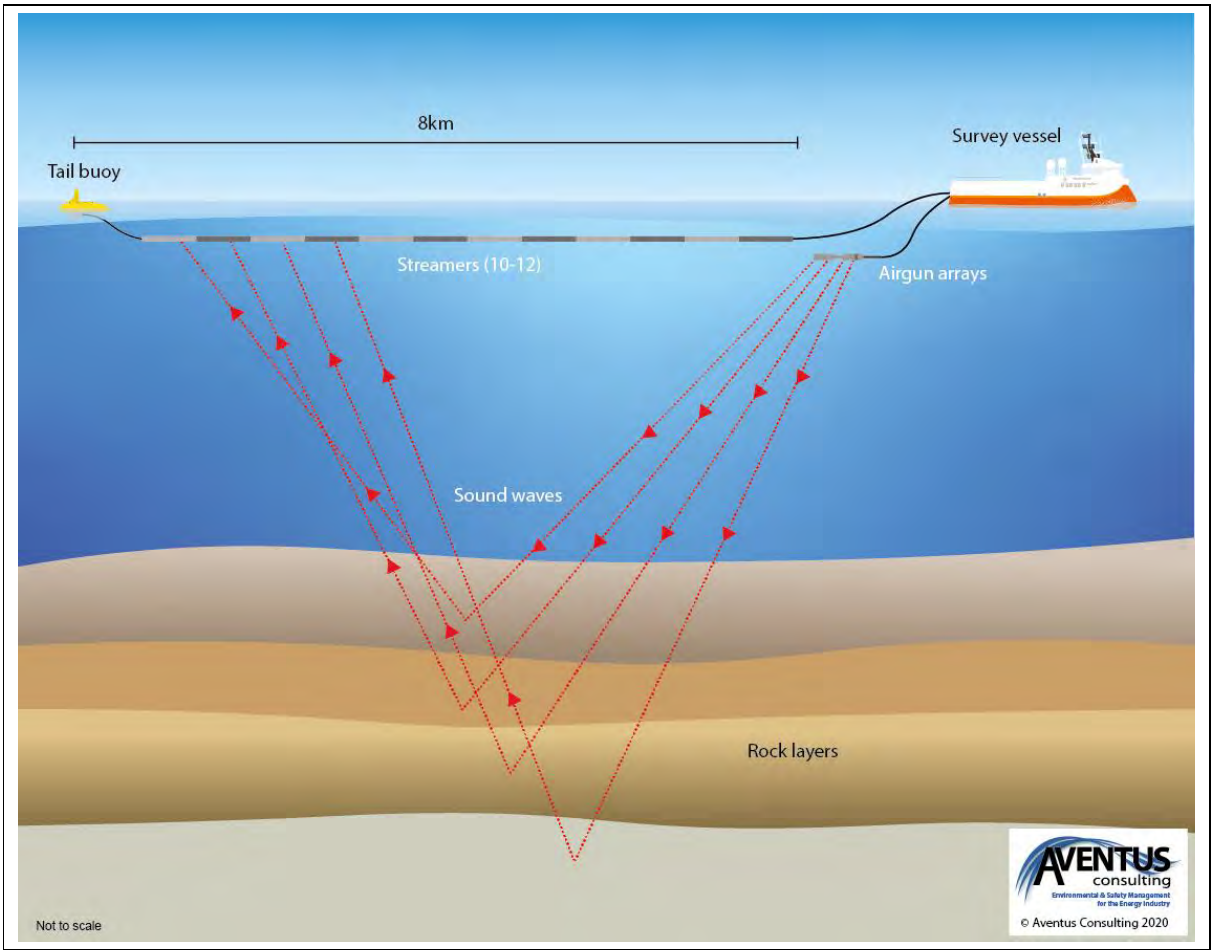


Figure 3.4. Profile view of a typical MSS arrangement

3.4.1 Sound Source

The acoustic source (or 'airgun') will consist of three air gun arrays (each array with 11 airguns) spaced 8 m apart. Figure 3.5 shows the anticipated layout of the airgun arrangement.

The airgun 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. Triggering the airgun 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 airgun, generating a broadband seismic pulse (Jasco, 2020) (Figure 3.6).

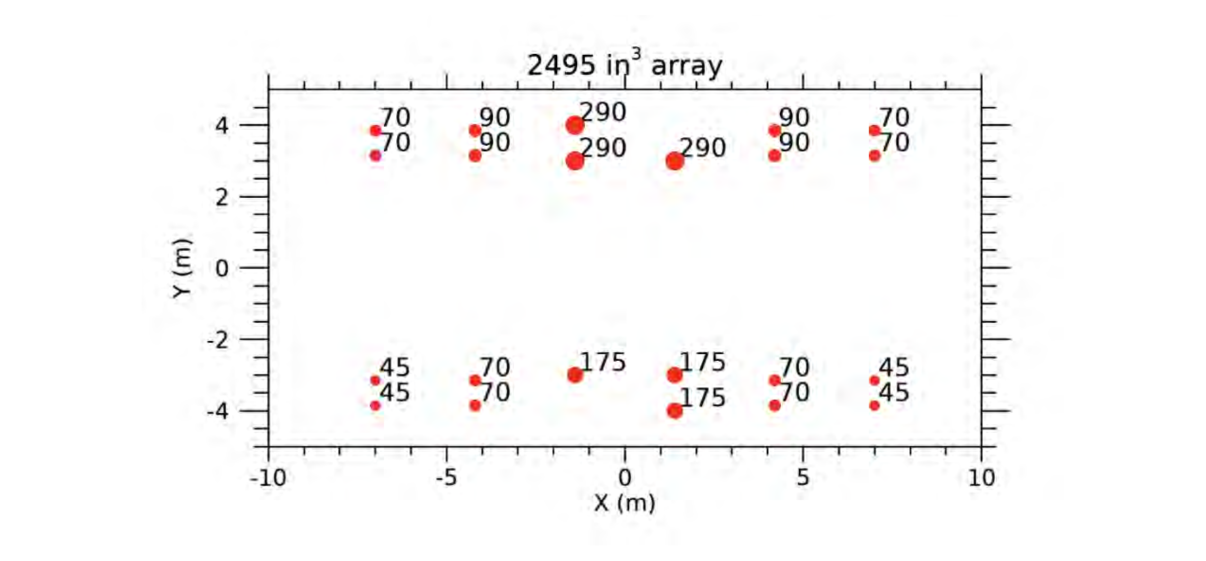
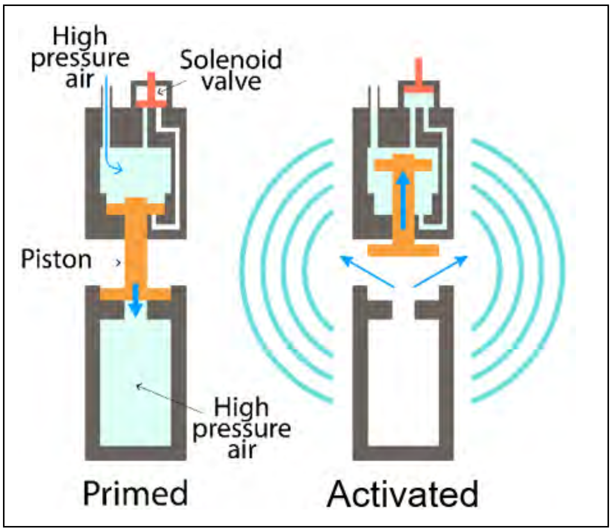


Figure 3.5. Anticipated airgun arrangement for the Prion 3DMSS



Source: Jasco (2020)

Figure 3.6. Functioning of an airgun

A minimum 75 bar-m peak-to-peak amplitude is required to undertake the Prion 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 sound volume of 2,495 cui and an operating pressure of 2,000 psi. The exact parameters of the air gun arrays will be finalised after Beach has selected its survey contractor.

The source array will be towed astern of the survey vessel at a typical depth range of 6 to 10 m below the sea surface. The distance between the air gun array and the streamers will be less than 100 m. Figure 3.7 shows a typical towing arrangement. Photo 3.1 shows a typical airgun used for MSS.

Photo 3.1. Typical airgun used for a 3DMSS (as part of the array, and close up)

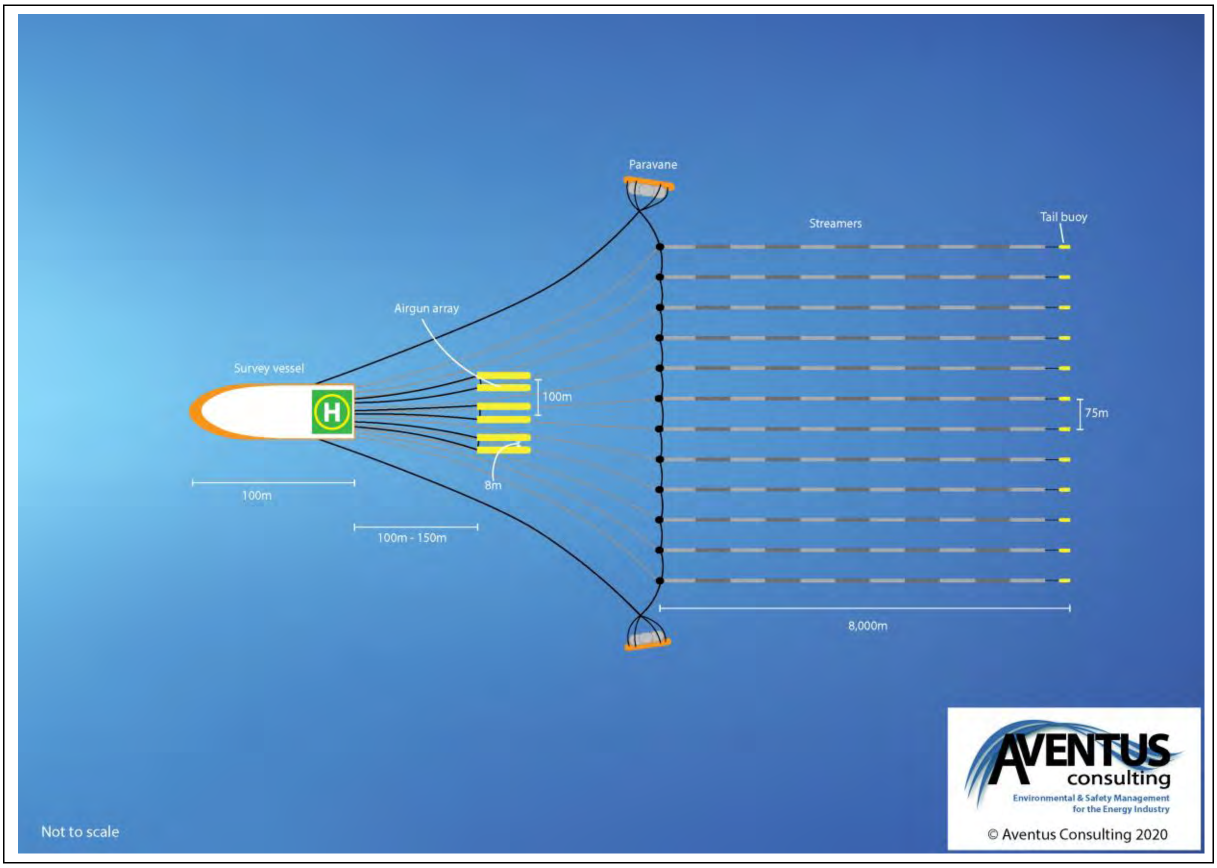


Figure 3.7. Plan view of a typical MSS arrangement

Air gun arrays are strategically arranged to direct most of the energy vertically downward rather than sideways. The shot point interval will be 8.33 m such that there will be 25 m of horizontal spacing between pulses. The data will be recorded in continuous mode. The total number of source pulses is estimated to be 120 per sail line kilometre.

During line turns, a soft-start procedure will be implemented for 30 minutes prior to starting acquisition of the next survey line in line with EPBC Act Policy Statement 2.1.

The underwater Sound Transmission Loss Modelling (STLM) undertaken for this project uses a 2,495 cui array. Table 3.3 provides the peak and per-pulse Sound Exposure Level (SEL) source levels for the airgun 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 3.3. Source level specifications in the horizontal plane for the 2,495 cui array

Direction	Peak pressure level ($L_{S,pk}$; dB re 1 µPa m)	Per-pulse source SEL ($L_{S,E}$; dB 1µPa^{2}m^{2}s)	
		10 – 2,000 Hz	2,000 – 25,000 Hz
Broadside	248.6	224.1	183.8
Endfire	244.6	222.1	187.0
Vertical	254.6	227.5	194.3
Vertical (surface affected source level)	254.6	229.8	197.2

3.4.2 Sail Lines

There are 76 sail lines proposed for the survey. The longest sail lines are 35 km and the shortest are 30 km. Figure 3.8 illustrates the survey line plan (noting this is subject to change). The sail lines will be spaced 300 m apart. The total sail line distance will be 2,608 km, excluding line turns and infill lines.

Line turns are planned to extend for a distance of 8 km outside the acquisition area, and with the turning circle included, are likely to be 25 km long and take 3.5 hours to achieve (based on a vessel speed of 4 knots [7.4 km/hr] and calm seas).

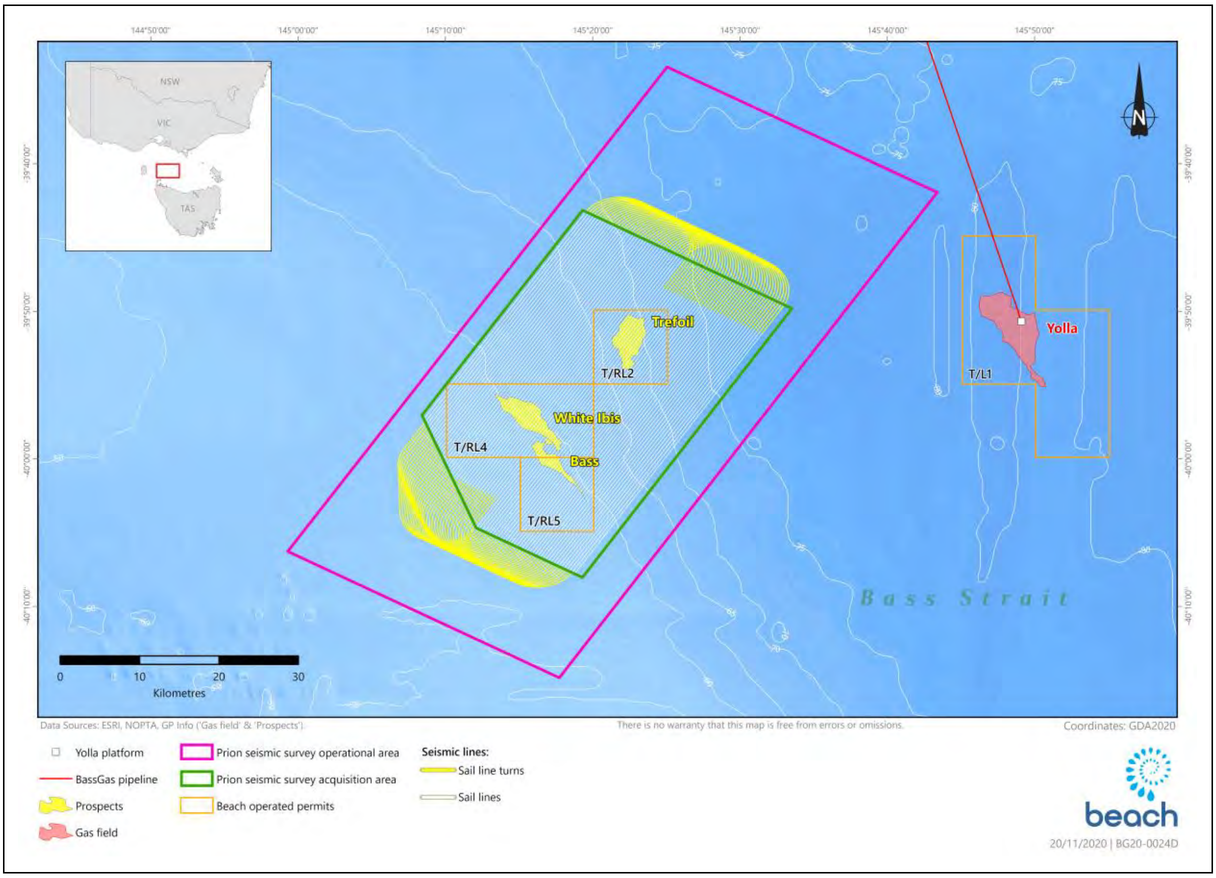


Figure 3.8. Nominal line plan

3.4.3 Streamers

Twelve (12) streamers (nominally) are expected to be used for the survey (with 10 streamers being acceptable, but not preferred). The streamers will be 8,000 m in length with a separation of 75 m between each streamer (Photo 3.2). The length of the streamers means there is potential for megafauna (such as whales, dolphins or seals) to become entangled in them, though there is a very low likelihood of this occurring because of the 75 m separation between the streamers and because the sound generated from the airguns will act as a deterrent to megafauna.

Each streamer will be fitted with streamer retrieval devices (SRD) that inflate when the SRD reaches a maximum depth (Photo 3.3). The tail of each streamer has a Relative Global Positioning System (RGPS) tailbuoy (Photo 3.4). If a streamer is lost, then the RGPS position of the tailbouy 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 streamers will be towed at a depth of 10 to 25 m beneath the sea surface (though depth will vary depending on water depth and sea state; generally the worse the sea state, the deeper the streamers).

Given the deep waters of the proposed 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 airgun arrays.

The survey area is dominated by unconsolidated muddy silty sediments with a general horizontal bedding and vertical thickness of over 60 m, and occasional sand lenses are present (see also Section 5.3.6). At the shallowest point of the proposed acquisition area (50 m), there will be a vertical separation of 25 m between the streamers and the seabed based on the streamers being towed at 25 m below the sea surface.

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 will be of a solid foam construction. The streamers will display appropriate navigational safety measures such as lights and reflective tail buoys.

A paravane (Photo 3.5 and Photo 3.6) is effectively a water kite, connected to each of the outer most streamers (see Figure 3.7). 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 airguns.

Depth monitoring and control devices, referred to as 'birds' (Photo 3.7), 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 3.8.

Photo 3.2. Streamers on reels

Photo 3.3. Streamer recovery devices

Photo 3.4. Tail buoy (with navigation light at top)

Photo 3.5. Paravane stored alongside vessel

Photo 3.6. Paravane being launched

Photo 3.7. Birds

Photo 3.8. A typical view of a streamer spread (from the stern of the *Polarcus Naila*)

3.4.4 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 3.9). 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 Beach's geoscience team to assess prospectivity for natural gas accumulations.

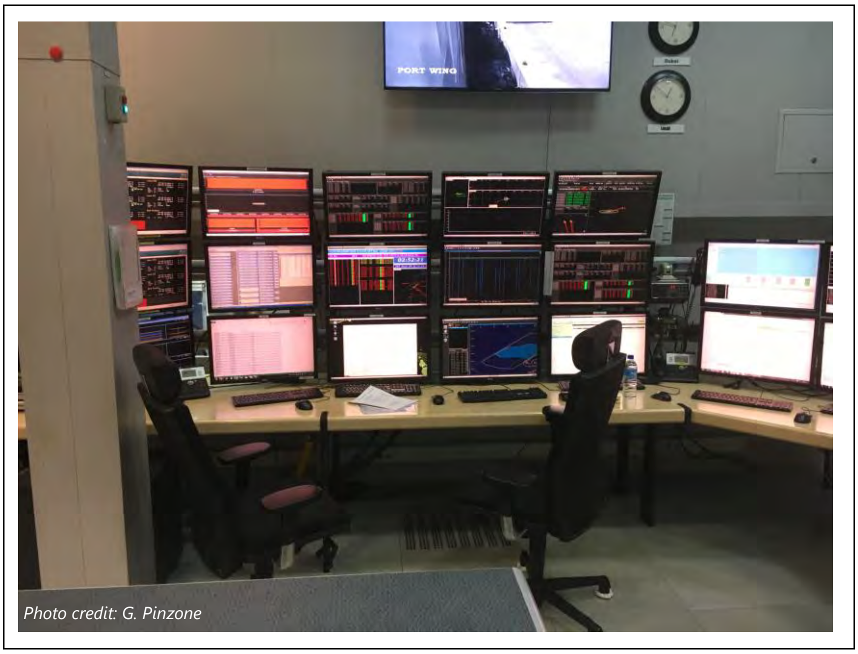


Photo 3.9. Part of the data room on the *Polarcus Naila* survey vessel, typical of most survey vessels

3.4.5 Survey Contractor

A survey contractor has yet to be appointed. Beach will issue an Invite to Tender (ITT) for a seismic survey contractor in early 2021. A contractor will be appointed after Beach has undertaken its contractor review process.

3.5 Survey Vessel

The survey will be conducted using a purpose-built seismic survey vessel, with support from at least two dedicated support vessels (see Section 3.6.4). The survey vessel is likely to be in the order of approximately 100 m in length and 40 m wide and carry up to 70 people. While the specific survey vessel that will be used for this survey is yet to be determined, it is likely to be similar to the MV *Polarcus Naila* that worked offshore Victoria in early 2018 and the MV *Geo Coral* that conducted 2DMSS in the Gippsland Basin through 2019 and 2020 (Photo 3.10).

Photo 3.10. The *MV Polarcus Asima* seismic survey vessel

The survey vessel will not refuel at sea; enough fuel will be taken on at port (which may be either the Port of Melbourne, Geelong, Eden or Portland) for the 40-day duration of the survey. The vessel may need to return to port for refuelling and crew changes; in the case of bad weather, this could happen at least twice. This means there is no potential for a refuelling spill in the operational area. The deep waters of the operational area also mean there is no risk of the survey vessel colliding with submerged features that result in a hull breach and a fuel spill.

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, Beach will have a Client Representative (to provide a quality assurance role) and Marine Mammal Observers (MMO) onboard the survey vessel.

3.5.1 Vessel Environmental Credentials

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

The survey vessel will generate emissions and discharges just as any other commercial vessel does. The survey vessel will be required to meet pollution prevention requirements under the MARPOL Convention, as enacted by the *Navigation Act* 2012 (Cth) (see Table 2.2). As such, it will be required to have current and valid environmental credentials as listed in Table 3.4.

Table 3.4. 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)
ISPP	MARPOL Annex IV, enacted under AMSA Marine Orders Part 96 (Marine Pollution Prevention – Sewage)
GMP	MARPOL Annex V, enacted under AMSA Marine Orders Part 95 (Marine Pollution Prevention – Garbage)
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)

Using Beach's Invasive Marine Species (IMS) Management Plan (Doc S4000AH719916), the survey vessel and support vessels will be subject to a risk assessment procedure to ensure that there is a low risk of introducing IMS 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.

Beach undertakes a pre-qualification of all contractors in which their HSE systems are reviewed to ensure that the contractor's HSE management system 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 Beach. This process includes verifying evidence of HSE management system implementation.

3.5.2 Regulatory Jurisdiction

The survey vessel comes under the regulatory jurisdiction of AMSA under the *Navigation Act* 2012 (Cth) when it is in Commonwealth waters or the Exclusive Economic Zone (EEZ) of Australia.

The survey vessel is considered part of a 'petroleum activity' (as defined by Regulation 4 of the OPGGS(E)) while it is within the operational area with its streamers deployed. For the purposes of this EP, activities performed by the survey vessel when it is outside the survey area (e.g., steaming to or from location) are not covered by the OPGGS(E) and are therefore not addressed in this EP.

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 OPEP (see Chapter 9).

3.5.3 Maritime Safety

The 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 operator 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 (published fortnightly). 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 several nautical miles) 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).

<u>Lighting</u>

The lighting on the survey vessel will comply with COLREG 1972. During survey deployment, recovery and acquisition, the source vessel will display navigation lights indicating the 'restricted ability to manoeuvre.' In addition to the mandatory navigation lighting, the working deck areas (albeit very small) 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 3.4). The tail buoys will have AIS radar reflectors to assist with tracking and provide target warning on other vessels' radars.

<u>Bad Weather Shelter</u>

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).

3.5.4 Support Vessels

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

Beach will instruct the support vessel operators that they must be licensed by the Australian Fisheries Management Authority (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 3.6.3 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.

Because of the smaller size of the support vessels, undertaking due diligence for the support vessels will use the Marine Inspection for Small Workboats (IMCA, 2012) or similar (small boats being defined as less than 50 m in length and less than 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.

3.6 Simultaneous Surveys

Concern has been expressed in the past by environmental non-government organisations (NGOs) that seismic surveys may operate simultaneously in a region, thus creating cumulative underwater sound impacts on marine life. Beach believes that such an event is highly unlikely to eventuate, as the high cost of mobilising a survey vessel to southeast Australia means that nearby titleholders are strongly driven to share the same vessel sequentially, rather than to deploy individual vessels simultaneously.

In addition, the scientific goals of a survey are compromised by simultaneous operations (SIMOPS): sound generated from one survey will interfere with the seismic data acquisition of the other survey, limiting the value of the acquired data for interpretation. All titleholders are keen to avoid this situation. To avoid this happening, separation distances or time sharing is negotiated between the two parties. For example, both titleholders may commit to operating no closer than 40 km (21 nm) from each other, or agree a schedule where the companies alternate data acquisition so that only one company is acquiring data at any one time so as to not interfere with the other.

This arrangement is common in busy oil and gas provinces of the world, such as the Gulf of Mexico and the North Sea, where multiple seismic surveys often operate simultaneously. As planning progresses on this project, Beach and any other company conducting or proposing to conduct an MSS in the region will liaise with each other with the aim of ensuring projects do not overlap each other in location and timing. Where conflicts of location cannot be avoided, separation distances are preferable to limiting the survey duration, or alternatively, time sharing arrangements will be negotiated after SIMOPS analysis is conducted.

The nearest non-Beach operated petroleum titles are located 112 km to the west and 129 km to the northeast of the operational area, making it unlikely that any other MSS operations will occur within 40 km of the Prion 3DMSS.

3.7 Proposal for a Trial of Alternative Acquisition Technology

As an adjunct to the Prion 3DMSS and immediately outside the retention leases, Beach is proposing to trial new MSS technology that may assist in reducing impacts to marine life. This involves using a 'popcorn' acquisition method, marine vibroseis and/or a Continuous Wavefield Acquisition (CWA) method.

This trial is proposed to acquire one survey line of data only outside the permit areas but within the acquisition area. Given the small amount of data it could potentially acquire over the gas fields of interest, it is not considered 'exploration' as defined under the OPPGS Act. As such, this trial is not considered in this EP and will be the focus of a separate EPBC Act Referral.

3.8 Survey Summary

Table 3.5 summarises the survey parameters. It is important to note that this design may be further refined during the survey's planning phase.

Table 3.5. Summary of the Prion 3DMSS

Parameter	Details
Earliest commencement date	July 2021

Latest commencement date	June 2023
Duration of survey	Up to 40 days
Water depths	50 – 80 m
Acquisition area	880 km^2
Source	
Number of source arrays	Three
Source effort	75 bar minimum
Total volume	2,495 cui maximum
Operating pressure	2,000 psi
Shot point interval	8.33 m
Operating pressure	2,000 psi
Shot point interval	8.33 m
Operating pressure	2,000 psi
Streamers	
Number of streamers	10 to 12
Length	8,000 m
Depth below sea surface	10 – 25 m
Horizontal separation	75 m
Type	Solid foam construction
Sail lines	
Number of sail lines	76
Sail line distance	2,608 sail line kilometres of acquisition
Orientation	Northeast - southwest
Line separations	300 m (to provide 100 m between source lines)
Survey vessel	
Contractor	Unknown at time of submission
Survey vessel	Unknown at time of submission
Survey vessel speed	4 knots (7.4 km/hr)
Refuelling	In port only
Support vessels	
Vessel types	At least one guard and one chase vessel
Contractors	Unknown at time of EP submission, but likely to be based locally

4. Stakeholder Consultation

In keeping with Beach's Community and Stakeholder Engagement Policy (Figure 4.1), Beach is committed to open and ongoing engagement with the communities in which it operates and providing information that is clear, timely, relevant and easily understandable. Beach welcomes feedback and is continuously endeavouring to learn from experience in order to manage its environmental and social impacts and risks.

In addition to Beach's Community and Stakeholder Engagement Policy, stakeholder consultation has been undertaken in accordance with the OPGGS(E) requirements and NOPSEMA's stakeholder consultation guidance.

Community and Stakeholder Engagement Policy

1. Policy Introduction

This policy outlines Beach's commitment to engage with its stakeholders to ensure that it develops positive relationships with communities within which it operates. This policy applies in all joint venture operations where Beach is the operator. This policy should be read together with other policies including the Aboriginal Engagement Policy and the Environmental Policy.

2. Scope

This policy applies to all Beach's directors, officers and employees.

3. Position statement

Beach is committed to open and transparent communication with its stakeholders and recognises that its business success is contingent upon building respectful and mutually beneficial relationships while effectively managing its operations. Beach will take the time to listen, understand, give due consideration and respond to the interests and concerns of its stakeholder groups. Beach's aim is to be seen as the operator of choice for its stakeholders, and that its presence in the community is welcomed as a positive experience.

Stakeholders include, but are not limited to, landholders, Aboriginal communities, communities in which Beach operates, interest groups and government.

4. Policy commitment

Beach is committed to:

- Acknowledging that local communities are stakeholders in all operations, that there will be access to reliable and timely information about exploration and development activities and transparent, sincere and respectful consultation with them prior to, during and after operations.
- Clearly communicating the goals and parameters for stakeholder engagement.
- Understanding the social, environmental and economic effects of Beach's activities while delivering business outcomes.
- Seeking to understand stakeholder values, interests and concerns with relevant business operations and in a timely manner address these and deliver on any agreed support or commitments.
- Ensuring its employees and contractors are aware of their obligations toward the protection of local community culture and relationships and the environment.
- Contributing to the community by local employment and engagement of local contractors and suppliers where appropriate and possible.
- Participating in community events where appropriate; and
- Communicating frequently and effectively through a number of means including public meetings, stakeholder forums, its website, annual report, road shows and one-on-one meetings.

Figure 4.1. Beach's Community and Stakeholder Engagement Policy

4.1 Stakeholder consultation objectives

The objectives of Beach's stakeholder consultation in preparation of the EP are to:

- Engage with stakeholders in an open, transparent, timely and responsive manner, building on existing relationships;
- Minimise community and stakeholder concerns where practicable;
- Build and maintain trust with stakeholders; and
- Demonstrate that stakeholders have been appropriately consulted.

The objectives are achieved by:

- Identifying and confirming stakeholders ('relevant persons' whose functions, interests or activities may be affected by the Prion 3DMSS);
- Ensuring stakeholders are informed about the survey and its environmental and social impacts and risks;
- Providing informative, accurate and timely information;
- Ensuring affected stakeholders are informed about the process for consultation and that their feedback is considered in the EP; and
- Ensuring that issues raised by affected stakeholders are adequately assessed, and where requested or relevant, responses to feedback are communicated back to them.

4.2 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 11(A). 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:

1. 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;
2. 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;
3. The Department of the responsible State Minister, or the responsible Northern Territory Minister;
4. 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
5. Any other person or organisation that the titleholder considers relevant.

In this EP, relevant persons are broadly referred to as stakeholders.

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 defined in the EP. In addition, Regulation 16(b) of the OPGGS(E) requires that the EP contain a summary and full text of this consultation.

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 within five days of submission to NOPSEMA (subject to the EP satisfying a completeness check).

4.3 Stakeholder Identification and Classification

Beach has identified and consulted with stakeholders whose functions, interests or activities may be affected by the Prion 3DMSS, as well as those who Beach deems necessary to keep up to date with the activities in Bass Strait. Table 4.1 identifies these stakeholders.

To determine the type of information to provide to a stakeholder, an information category was developed and is detailed in Table 4.2.

Table 4.1. Stakeholders consulted for the Prion 3DMSS EP

Category 1 – Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant	
Director of National Parks (DNP)	Australian Fisheries Management Authority (AFMA)
Australian Communications and Media Authority (ACMA)	Australian Hydrographic Office (AHO)
Department of Agriculture and Water Resource (DAWR)	Department of Agriculture, Water and the Environment (DAWE)
Category 2 – Each Department or agency of a State to which the activities to be carried out under the EP may be relevant	
Victoria	
Department of Jobs, Precincts and Regions (DJPR): - Earth Resources Regulation (ERR) - Victorian Gas Program (VGP) - Emergency Management Branch (EMB)	Tourism Victoria
Victorian Fisheries Association (VFA)	
Tasmania	
Department of Primary Industries, Parks, Water and Environment (DPIPWE)	EPA Tasmania
Category 3 – The Department of the responsible State Minister	
N/A – Commonwealth waters only.	
Category 4 – A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP	
Fisheries - Commonwealth	
Southern Shark Industry Alliance (SSIA)	Southern Bluefin Tuna Industry Association

Sustainable Shark Fishing Association (SSFA)	South Australian Rock Lobster Advisory Council (SARLAC) & South Eastern Professional Fisherman Association (SEPFA)
South-east Trawl Fishing Industry Association (SETFIA)	Commonwealth Fisheries Association (CFA)
Bass Strait Scallop Industry Association (BSSIA)	Petuna Sealord Deepwater Fishing Pty Ltd (SESSF licensee)
Tuna Australia – ETBF Industry Association	Mures Fishing Pty Ltd (SESSF licensee)
Gazak Holdings Pty Ltd (SESSF licensee)	Muollo Fishing Pty Ltd (SESSF licensee)
ANZT Fishing Company Pty Ltd (SESSF licensee)	Trinsand Fisheries Pty Ltd
Fisheries - Victorian	
Seafood Industry Victoria (SIV)	Victorian Rock Lobster Association (VRLA)
Corporate Alliance Enterprises Pty Ltd	Abalone Victoria Central Zone
Victorian Scallop Fisherman's Association	Victorian Recreational Fishing Peak Body (VR Fish)
Toberfish Pty Ltd	
Fisheries – Tasmanian	
Tasmanian Association for Recreational Fishing	Tasmanian Rock Lobster Fisherman's Association
Tasmanian Abalone Council Limited	Tasmanian Seafood Industry Council (TSIC)
Southern Rock Lobster Limited (SRL) (SA, VIC, TAS).	Top Fish Tasmania
Infrastructure asset owners	
Alcatel Submarine Networks UK LTD	Aquasure (Victorian Desalination Plant)
Telstra	Toll Group
Spirit of Tasmania (SoT)	
Conservation groups	
Blue Whale Study Inc	Deakin University (School of Life and Environmental Sciences)
Institute for Marine and Antarctic Studies (IMAS)	
Other organisations	
Ocean Racing Club of Victoria	SCUBA Divers Federation of Victoria
ConocoPhillips (T/49P titleholder)	
Category 5 – Any other person or organisation that the Titleholder considered relevant	
Not applicable.	

Table 4.2. Information category to determine information provided to stakeholder.

<table>
<tr><th>Information Category</th><th>Description</th><th>Information Type</th><th>Follow up</th></tr>
<tr><td>1</td><td>Organisations or individuals whose functions, interests or activities may be impacted by the activity.
Representative body for fishers who provide information to their members.</td><td rowspan="2">Information Sheet and/or provision of information as per organisations consultation guidance.
Provision of further information where required.
Meeting or phone call where required.</td><td>In the event there is no response to initial email/s, follow up is required because routine and non-routine activities may impact on the functions, interests or activities of this stakeholder.</td></tr>
<tr><td>2</td><td>Organisations or individuals who functions, interests or activities will not be impacted by the activity but are kept up to date with Beach's activities in Bass Strait.</td><td>In the event there is no response to initial email/s, follow up is not required because routine and non-routine activities will not impact on the functions, interests or activities of this stakeholder.</td></tr>
</table>

Note that consultation with contractors to Beach who will assist with undertaking the MSS is not addressed in this section of the EP. This includes organisations that Beach has a contract or agreement with for assistance in the event of oil spill response or operational and scientific monitoring. Discussions with these organisations that are not directly linked to undertaking the MSS are not included in the summary of stakeholder consultation in Section 4.5.

Where discussions with these organisations have assisted in the development or refinement of oil spill response strategies described in the OPEP, 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 8.5.1 of the EP.

Beach 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).

Beach acknowledges that other stakeholders not identified in this EP may be affected, and that these may only become known to Beach in such an event.

4.4 Engagement Approach

Consultation has been broadly undertaken in line with the International Association for Public Participation (IAP2) spectrum, which is considered best practice for stakeholder engagement. In order of increasing level of public impact, the elements of the spectrum and their goals are:

- Inform – to provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solutions.
- Consult – to obtain public feedback on analysis, alternatives and/or decisions.
- Involve – to work directly with stakeholders throughout the process to ensure that public concerns and aspirations are consistently understood and considered.
- Collaborate – to partner with the public in each aspect of the decisions, including the development of alternatives and the identification of the preferred solution.

- Empower – to place final decision-making in the hands of the stakeholders.

The manner in which Beach has informed, consulted and involved stakeholders with the MSS are outlined through this section.

Under the regulatory regime for the approval of EPs, the decision maker is the regulator. This being the case, the final step in the IAP2 spectrum, 'Empower', has not been adopted.

Beach 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. Key principles that guide Beach in its stakeholder engagement are outlined in its Community and Stakeholder Engagement Policy (see Figure 4.1).

Beach has a good record of engaging with key its stakeholders including regulators, local communities, local councils, community groups and fishing industry associations.

4.5 Engagement Methodology

The tools and methods that have been and will continue to be used for stakeholder engagement are:

- **Project Information Sheet** – this was issued to most stakeholders on the 3rd of March 2020 and provided information on the survey design, location and timing (**Appendix 3**). The information sheet also included questions and answers (Q&As) and contact details to provide the opportunity to provide feedback. An additional information flyer to inform stakeholders of changes to the acquisition area and the upcoming publication of the EP was issued to stakeholders on the 10th of December 2020.
- **One-on-one briefings** – where stakeholders have expressed concerns, one-on-one meetings with Beach's Community Manager, who is supported by project-specific personnel (such as the Environment Advisor and Project Manager) to discuss their concerns and to provide clarifying and targeted information on the activity. The purpose of these briefings is for Beach to provide activity information and updates, listen to issues and concerns, gain feedback on the project and to identify further opportunities for engagement. Information is tailored to accommodate the different levels of stakeholder understanding. Due to travel restrictions brought about by the COVID-19 global pandemic, such meetings have been by video conference or phone.
- **Project hotline and dedicated project email** – A freecall telephone number (1800 797 011) and email address (community@beachenergy.com.au) is provided in the project information sheet and is included in all project information. The phone number and email address are monitored by the Community Manager.
- **Company website** – the project information flyers have been made available on the Beach website (https://www.beachenergy.com.au/bass-basin/) for ease of access.

4.6 Fisheries-specific Engagement

The main stakeholder group for the activity is commercial scallop fishers. Beach has a substantial history of engagement in with Otway and Bass Basin commercial fisheries. The consultation strategy for potentially impacted fishers is as follows:

- Engage in meetings with commercial fisheries associations (e.g., TSIC, BSSIA, SFAT, SIV) to identify key concerns and how best to consult with individual fishers.
- Request commercial fisheries catch data and fishing intensity effort from AFMA to understand fishing history in and around the survey area.
- Where fishers have identified that they may be potentially impacted by the activity the following has been undertaken:

  - Beach gathered information about their fishing patterns and locations to understand potential impacts.
  - Beach's draft procedure for managing potential direct economic loss was provided to BSSIA and SETFIA for feedback. Pursuant to Beach's Community Engagement Standards, the procedure details how Beach will apply a fair, simple and transparent process for claims of loss caused by Beach's activities.
- Commercial fisheries who have identified they fish in the area, along with commercial fisheries associations relevant to the survey area, will be advised of the survey schedule once it is confirmed (with a minimum of 4 weeks prior to commencement of the activity).
- Beach is conscious that the start date and duration of the survey may change slightly, and this will be assessed by Beach to determine if it will materially change the information provided to fishers to identify if they would be potentially impacted by the activity. If there is no material change, in order to minimise confusion for fishers and the time required for engagement, Beach will inform relevant stakeholders of any changes a minimum of 4 weeks prior to the commencement of the activity. If the changes are material, then updated information will be provided to relevant stakeholders.
- The MSS exclusion/cautionary zone will be communicated to fishers via a Notice to Mariners (NTM). Fishers are able to contact the survey vessel and its support vessels via VHF channel 16 at any time.
- Beach will seek permission from relevant fishers to include them in their SMS notification system and where applicable, engage the services of relevant fishing associations to issue notifications to their members. Once the activity commences, Beach will provide SMS notification each morning to detail the vessel's location so that fishers can plan their fishing activities with the least disruption.

4.7 Summary of Stakeholder Consultation

Of the 55 stakeholders listed in Table 4.1, only 16 proactively responded to Beach after they received the flyer.

Concern was expressed by commercial fisheries associations (TSIC, BSSIA, SFAT, SIV) regarding perceived impacts of MSS on scallop beds and future impacts to scallop catches. This issue is addressed in Section 7.1 of the EP.

Beach arranged an online meeting with these associations, shared the fishery activity assessments undertaken by SEFTIA/Fishwell Consulting for Beach, the sound modelling assessments undertaken by Jasco Applied Sciences and Beach's impact assessments. Beach arranged a subsequent meeting where Jasco Applied Sciences presented a summary of the sound modelling and impact assessment and explained the approach. Open discussions were held at each meeting and all questions and concerns discussed and noted. Beach has shared with these association:

- All meeting presentations;
- The SETFIA/Fishwell fishing impact assessment;
- Research citations and papers referred to in the impact assessment; and
- The sound modelling by Jasco Applied Sciences.

Beach also invited feedback on all information provided and inquired whether there were other research papers the associations wanted Beach to consider. This issue is addressed in Section 7.1 of the EP

Beach consulted directly with BSSIA and SETFIA and sought their feedback on Beach's draft procedure for managing any economic losses by directly impacted fishers and this consultation will continue until Beach finalises the internal procedure.

Beach has also provided its draft sound impact assessment chapter to BSSIA for feedback, and the impact assessment regarding MSS on scallops was provided to TSIC, BSSIA, SFAT and SIV in draft format for their review prior to public exhibition of this EP on the NOPSEMA website.

Beach engaged directly with the Spirit of Tasmania operators regarding their sea routes and was able to assist them with wave data from Beach's Yolla platform for their vessel research. Beach established that through close consultation before and during the 3DMSS, any impacts can be readily managed. TSIC was also provided with a list of references of scientific literature discussing the impacts of MSS on various fauna groups, along with copies of research undertaken on the impacts of MSS sound on invertebrates in Bass Strait.

A summary of key stakeholder consultation undertaken to date, together with Beach's responses and assessment of merit is included in Table 4.3.

A complete copy of original communications to and from all stakeholders is provided in **Appendix 4**.

4.8 Ongoing Consultation

Beach will continue consulting with stakeholders regarding the Prion 3DMSS at appropriate times, taking into consideration Beach's desire to minimise 'consultation fatigue' that many stakeholders have expressed (especially in light of the COVID-19 pandemic declared in March 2020 and the issues this has created for commercial fisheries in particular).

It is envisaged that the only issue that would warrant stakeholder engagement (as distinct from notification) immediately prior to or during the survey would be in the event of a large-scale hydrocarbon release (from the survey and/or support vessels) or major changes to survey design (such as a significant expansion of the survey area).

Survey notification requirements are provided in Chapter 8.

4.9 Management of Objections and Claims

If any objections or claims are raised during ongoing consultation or during the survey, these will be verified through publicly available credible information and/or fishing data from AFMA.

Where the objection or claim is substantiated, it will be assessed in line with the risk assessment process detailed in Chapter 6 and controls applied where appropriate to manage impacts and risks to ALARP and an acceptable level. Stakeholders will be provided with feedback as to whether their objection or claim was substantiated, how it was assessed and if any controls were put in place to manage the impact or risk to ALARP and an acceptable level.

Table 4.3. Summary of stakeholder consultation undertaken

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's 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					
AHO	Responsible for the publication and distribution of nautical charts and other information required for safe shipping and navigation in Australian waters.	2	03/03/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	Beach will continue to consult with the AHO and make the necessary notifications throughout the survey. Notification requirements are included in Section 8.10 of the EP.
			10/12/2020	Beach emailed project information update.	
AFMA	Manager of fisheries in Commonwealth waters.	1	04/12/2019	Beach included geographic coordinates of the survey area and requested licence holders that have fished in the area over the last five years.	The extent of Commonwealth fisheries that overlap the survey area are well understood (see Section 5.7.6 of the EP) and consultation is ongoing with fishing industry representatives. As such, additional attempts to contact this stakeholder are not required.
			04/02/2020	Beach provided an update on survey location and geographic coordinates and arranged a telephone conference.	
			12/02/2020	Meeting held between AFMA and Beach. Beach presented information on the survey design.	
			21/02/2020	AFMA provided contact details for industry associations and AFMA fishery managers to Beach.	
			03/03/2020	Beach emailed the project information sheet and invited return comment.	
			26/03/2020	Meeting with AFMA fisheries managers and association representatives. The survey design and underwater sound modelling results were presented by Beach. Stakeholders raised concerns regarding the proximity of the survey to scallop fishing grounds. Meeting notes available in **Appendix 4**.	
			22/07/2020	Follow up meeting between Beach and scallop industry representatives held. Beach presented updated survey information. Scallop industry	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
				representatives advised on the location of juvenile scallop beds and provided information on scallop survey tows that have been conducted in the survey area. Meeting notes available in **Appendix 4**.	
			18/09/2020	AFMA CEO requested to meet with Beach to discuss the survey parameters further.	
			23/09/2020	Meeting held between AFMA and Beach. Beach explained its engagement with fishers, its ongoing assessment approach and its continued involvement with AFMA and the scallop fishing sector. Beach provided its presentation to AFMA following the meeting.	
			10/12/2020	Beach emailed project information update.	
ACMA	Administrator of submarine cable protection zones.	2	26/02/2020	Beach emailed the project information sheet and invited return comment.	The location of subsea communications cables in relation to the survey area is well understood (see EP Section 5.7.3) and the stakeholder has not raised any concerns. Further consultation is not required.
			27/02/2020	Stakeholder emailed Beach to provide additional contact details and requested further information.	
			03/03/2020	Beach shared shapefiles of the survey area with ACMA as requested.	
			31/03/2020	Stakeholder returned email and raised no concerns regarding the survey.	
			10/12/2020	Beach emailed project information update.	
DNP	Manages the AMP network in Commonwealth waters.	1	26/02/2020	Beach emailed the project information sheet and invited return comment.	Section 5.4.1 of the EP describes the values of the AMPs. Beach has assessed the routine and non-routine activities associated with the survey against the conservation values of relevant AMPs in the South East Marine Network. (see
			23/03/2020	DNP Senior Marine Parks Officer acknowledged receipt of the information and requested further details.	
			25/03/2020	Beach provided survey coordinates and a further description of the activity to DNP.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
			16/04/2020	DNP Senior Marine Parks Officer acknowledged the additional information and outlined expectations regarding emergency response and activity notifications.	**Appendix 1**). No follow up required. Notification requirements are included in Section 8.10 of the EP.
			17/04/2020	Beach acknowledged DNP's expectations and endeavoured to provide further updates when available.	
			10/12/2020	Beach emailed project information update.	
DAWE	Commonwealth department responsible for administration of the EPBC Act, Australian Marine Parks (AMPs) and MNES.	2	03/03/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	Beach will continue to consult with DAWE regarding the necessary biosecurity reporting requirements. Vessel biosecurity controls are provided in Section 7.12 of the EP.
			10/12/2020	Beach emailed project information update.	
DAWR	Biosecurity requirements for vessels entering Australian waters and ports.	1	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	Beach will continue to consult with Maritime Border Control in accordance with biosecurity requirements. Vessel biosecurity controls are provided in Section 7.12 of the EP. Notification requirements are included in Section 8.10 of the EP.
			10/12/2020	Beach emailed project information update.	
Category 2. Each Department or agency of a State to which the activities to be carried out under the EP may be relevant					
Victoria					
DJPR – ERR	Regulator of oil and gas activities in Victorian waters.	1	03/03/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	DJPR (ERR) is the regulator for the Victorian state waters component of offshore oil and gas activities.
			10/12/2020	Beach emailed project information update.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
					Further consultation is not required.
DJPR – VGP	The VGP aims to deliver a comprehensive program of geoscience and environmental research and related activities from 2017-2020.	2	03/03/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	The activity will not impact on the functions, interests or activities of this stakeholder. Further consultation is not required.
			10/12/2020	Beach emailed project information update.	
DJPR – EMB	Control agency for marine pollution emergencies in Victoria waters.	1	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	Additional contact with this stakeholder is only necessary in the event of an MDO spill. Contact details for EMB are provided in Section 9.3 of the EP
			10/12/2020	Beach emailed project information update.	
VFA	Manager of commercial fisheries in Victorian waters.	1	04/09/2019	Beach informed VFA of the survey and requested relevant fisheries information from the survey area.	Additional follow up is not required, as consultation has been undertaken with representatives of the fishing industry and the extent of Victorian fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP).
			17/12/2019	Meeting held between VFA and Beach. It was determined that no VFA-managed fishing activity occurs in the survey area.	
			03/03/2020	Beach emailed the project information sheet and invited return comment.	
			10/12/2020	Beach emailed project information update.	
Tourism Victoria	Peak body representing Victoria's tourism industry.	2	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	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.
			10/12/2020	Beach emailed project information update.	
Tasmania					
EPA Tasmanian	Tasmanian environmental regulator.	2	26/02/2020	Beach emailed the project information sheet and invited return comment.	Routine and non-routine activities will not impact on the

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
				No stakeholder response.	functions, interests or activities of this stakeholder. Further consultation is not required.
			10/12/2020	Beach emailed project information update.	
DPIPWE	Tasmania's leading natural resources agency, responsible for the sustainable management of natural and cultural heritage.	1	25/09/2019	Beach informed DPIPWE of the survey and requested fisheries catch data relevant to the survey area.	Commercial fisheries are described in Section 5.7.6 of the EP and the impacts of the MSS are described throughout Chapter 7. Additional contact with this stakeholder is only necessary in the event of an MDO spill. Contact details for DPIPWE are provided in Section 9.3 of the EP.
			27/09/2019	DPIPWE provided a response and stated that there is no overlap between Tasmanian fisheries and the survey area.	
			03/12/2019	Beach provided an updated survey area and requested relevant fisheries catch data.	
			09/12/2019	DPIPWE provided a response and stated that there is very low fishing effort in the survey area and some information cannot be provided due to confidentiality reasons.	
			26/02/2020	Beach emailed the project information sheet and invited return comment.	
			17/06/2020	Beach provided an updated survey area and requested relevant fisheries catch data.	
			24/06/2020	DPIPWE provided a letter response and stated that there is very low fishing effort in the survey area and some information cannot be provided due to confidentiality reasons (<5 fishers rule).	
			10/12/2020	Beach emailed project information update.	
Category 3 – The Department of the responsible State Minister					
N/A – activity in Commonwealth waters only.					
Category 4 – A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP					
Fisheries – Commonwealth					
Associations					

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
Sustainable Shark Fishing Association (SSFA)	Industry body representing shark gillnetters.	1	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP) and the stakeholder has not expressed any concerns.
			10/12/2020	Beach emailed project information update.	
SETFIA and SSIA Both represented by [redacted].	Peak representative bodies for trawl fishing and shark fishing in south-east Australia.	1	31/01/2020	SETFIA provide a draft report on fishing activity in the survey area including relevant fisheries, catch, value and number of operators.	Information in the report prepared by SETFIA is included in Section 5.7.5 of the EP so that the catch from the fisheries intersected by the survey area can be quantified. The report from SETFIA identified some potential impact to shark fishers due to displacement during the Prion 3DMSS. Beach has consulted with SETFIA/SSIA regarding its procedures for managing any economic loss to shark fishers due to the 3DMSS and will continue close liaison before, during and after the survey.
			03/03/2020	Beach request meeting with SETFIA to discuss the draft fishing activity report.	
			18/04/2020	SETFIA provide the final report on fishing activity in the survey area.	
			14/07/2020	Meeting between SETFIA, Fishwell Consulting and Beach to clarify scallop catch data for the survey area. Fishwell Consulting outlined the data collection methods for the report. Fishwell Consulting advised on recent scallop surveys undertaken in the area. Beach used this information to map the location of potential scallop beds in relation to the survey area. Meeting notes available in **Appendix 4.**	
			04/08/2020	SETFIA emailed Beach and provided advise on a potential compensation framework for affected fishers. Beach requested for a meeting to discuss this matter with the project lead present.	
			12/08/2020	Teleconference held between Beach and SETFIA. SETFIA emailed Beach its follow up actions after the meeting. SETFIA outlined the appropriateness of SSIA in representing shark fishers relevant to the survey area as well as SETFIA's advise on a potential compensation arrangement for the survey.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
			19/08/2020	Beach acknowledged the advice provided by SETFIA regarding a compensation arrangement.	
			27/08/2020	SETFIA emailed a draft proposed compensation arrangement to Beach.	
			09/12/2020	Beach emailed the draft compensation arrangement to SETFIA for discussion and feedback.	
			10/12/2020	Beach provided the relevant EP impact assessment chapter to SETFIA and updated them on EP submission.	
BSSIA	Peak body representing the Bass Strait Central Zone Scallop Fishery.	1	03/03/2020	Beach emailed the project information sheet and invited return comment.	Information gathered from BSSIA and its members has been incorporated into Section 5.7.6 and Section 7.1 of the EP. Beach has agreed to undertake a scallop impact assessment following feedback and data provided by the scallop industry. Beach has assessed the potential biological and economic impacts of the survey as minor, however Beach appreciates the concern of the scallop industry and will continue its close consultation before, during and after the survey. Consultation will include direct engagement on the methodology of the scallop assessment before the Prion 3DMSS and Beach's approach to managing economic loss claims, in the event of impact.
			26/03/2020	Meeting held between Beach, SIV, TSIC, BSSIA and SFAF. Key concern of stakeholders was the proximity of the survey to scallop fishing grounds. Beach later reduced the survey acquisition area to minimise impacts to scallop fishing. Meeting notes available in **Appendix 4**.	
			06/04/2020	Beach provided a summary of the meeting to attendees.	
			24/04/2020	BSSIA submitted a letter of concerns to Beach regarding the potential for impacts from the survey on scallop fishing. Beach acknowledged receipt of the letter.	
			20/05/2020	Beach advised BSSIA that they were waiting for the final report on fisheries catch in the survey area from SETFIA before responding to the concerns raised by BSSIA.	
			10/06/2020	Beach organised a meeting with BSSIA.	
			22/07/2020	Meeting between BSSIA, SFAT and Beach to provide a project update and discussion with the	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
				scallop fishing industry. Jasco Applied Sciences presented the underwater sound modelling results. Stakeholders raised concerns regarding potential impacts to the scallop stocks east of King Island as a result of the survey. Meeting notes available in **Appendix 4**.	
			24/07/2020	Beach issued follow up material that was presented in the previous meeting.	
			03/08/2020	BSSIA and scallop industry representatives submitted a letter raising concerns regarding the impacts on scallops from the survey to Beach.	
			11/08/2020	Beach acknowledged the submission from BSSIA and requested detailed information on scallop fishing locations in order to explore further mitigation options.	
			14/08/2020	Scallop tow data from the acquisition area was provided to Beach in order to inform further mitigation strategies.	
			28/08/2020	Beach informed BSSIA that it was assessing the request for a pre-survey scallop assessment and had commenced discussions with fish stock assessment experts to understand valid design parameters.	
			02/10/2020	Phone call between Beach and BSSIA to discuss the potential pre-survey scallop dredge.	
			29/10/2020	Beach provided the underwater sound modelling report to BSSIA.	
			06/11/2020	Beach responded to specific stakeholders concerns that have been raised and committed to undertake a scallop assessment survey in response to feedback and data provided by the scallop industry. Response provided in **Appendix 4**.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
			16/11/2020	Beach met with stakeholder onboard the MV *Dell Richey* and discussed survey timing and opportunity for stakeholders to supply chase vessels to the project.	
			09/12/2020	Beach emailed the draft compensation arrangement to BSSIA for discussion and feedback.	
			10/12/2020	Beach provided the relevant EP impact assessment chapter to BSSIA and updated them on EP submission.	
Tuna Australia – ETBF Industry Association	Peak body representing the Eastern Tuna and Billfish Fishery.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the extent of Commonwealth fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP) and the stakeholder has not expressed any concerns.
			10/12/2020	Beach emailed project information update.	
Southern Bluefin Tuna Industry Association	Peak body representing the Southern Bluefin Tuna Fishery.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	A above.
			10/12/2020	Beach emailed project information update.	
SARLAC & SEPFA	Peak body that promotes the interests of the South Australian rock lobster fishing industry.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	A above.
			10/12/2020	Beach emailed project information update.	
CFA	Peak body representing the collective rights, responsibilities and interests of a diverse group of commercial fishers in Commonwealth-regulated fisheries.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	A above.
			10/12/2020	Beach emailed project information update.	
Licence holders					

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
Gazak Holdings Pty Ltd	SESSF licensee.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the extent of commercial fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP) and the stakeholder has not expressed any concerns.
			10/12/2020	Beach emailed project information update.	
ANZT Fishing Company Pty Ltd	SESSF licensee.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	As above.
			10/12/2020	Beach emailed project information update.	
Petuna Sealord Deepwater Fishing Pty Ltd	SESSF licensee.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	As above.
			10/12/2020	Beach emailed project information update.	
Mures Fishing Pty Ltd	SESSF licensee.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	As above.
			10/12/2020	Beach emailed project information update.	
Muollo Fishing Pty Ltd	SESSF licensee.	2	03/03/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	As above.
			10/12/2020	Beach emailed project information update.	
Trinsand Fisheries Pty Ltd	SSFJ licensee	1	16/07/2020	Beach emailed the project information sheet and invited return comment.	Information gathered from stakeholder has been incorporated into Section 5.7.6 and Section 7.1 of the EP. Beach has agreed to undertake a scallop impact assessment
			21/07/2020	Meeting held between Beach and Trinsand Fisheries. Stakeholder raised concerns regarding the impact of the survey on squid and scallop stocks. The stakeholder informed Beach of where and when they generally fish across their scallop	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
				and squid licences. Beach agreed to continue to engage with the stakeholder.	following feedback and data provided by the scallop industry. Consultation with stakeholder will be ongoing.
			10/12/2020	Beach emailed project information update.	
Fisheries – Victorian					
Associations					
SIV	Peak industry body for Victorian Fisheries.	1	13/12/2019	Meeting held between Beach and SIV Executive Director to update SIV on Beach activities, including the Prion survey. SIV advised that they do not need to send Prion survey information to its members given Beach is consulting with Commonwealth and relevant Tasmanian fisheries industry representatives.	Additional consultation is not required as the extent of Victorian fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP). Mail out of survey information to SIV members was deemed not necessary but the SIV Executive Director.
			03/03/2020	Beach emailed the project information sheet and invited return comment.	
			26/03/2020	Meeting held between Beach, SIV, TSIC, BSSIA and SFAF. Key concern of stakeholders was the proximity of the survey to scallop fishing grounds. Beach later reduced the survey acquisition area to minimise impacts to scallop fishing. Meeting notes available in **Appendix 4**.	
			06/04/2020	Beach emailed meeting notes and summary to SIV Executive Director and other meeting attendees.	
			10/12/2020	Beach emailed project information update.	
Victorian Scallop Fisherman's Association	Peak body representing the interests of Victorian scallop fishermen.	2	03/03/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	As above.
			10/12/2020	Beach emailed project information update.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
VRLA	Peak body representing the interests of Victorian rock lobster fishermen.	2	03/03/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	As above.
VR Fish	Peak body representing recreational fishers in Victoria.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional attempts to contact this stakeholder are not required given that the survey area is too far offshore for recreational fishing.
			10/12/2020	Beach emailed project information update.	
Licence holders					
Corporate Alliance Enterprises Pty Ltd.	Fishery licence holder.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the extent of commercial fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP) and the stakeholder has not expressed any concerns.
			10/12/2020	Beach emailed project information update.	
Toberfish Pty Ltd	Fishery licence holder.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the extent of commercial fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP) and the stakeholder has not expressed any concerns.
			10/12/2020	Beach emailed project information update.	
Fisheries – Tasmanian					
Tasmanian Association for Recreational Fishing	Peak body representing recreational fishers in Tasmania.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional attempts to contact this stakeholder are not required given that the survey area is too far offshore for recreational fishing.
			10/12/2020	Beach emailed project information update.	
Tasmanian Abalone Council Limited	Peak body representing the interests of the Tasmanian Abalone Fishery.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the survey area is located in water depths too

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
			10/12/2020	Beach emailed project information update.	deep for abalone and the stakeholder has not expressed any concerns.
Southern Rock Lobster Limited (SRL) (SA, VIC, TAS).	Peak body representing the interests of the Australian southern rock lobster industry.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the extent of commercial fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP) and the stakeholder has not expressed any concerns.
			10/12/2020	Beach emailed project information update.	
Tasmanian Rock Lobster Fisherman's Association	Peak body representing the Tasmanian rock lobster fishery.	2	03/03/2020	Beach emailed project information and invited return comment. No stakeholder response.	Additional consultation is not required as the extent of commercial fisheries in relation to the survey area is well understood (see Section 5.7.6 of the EP) and the stakeholder has not expressed any concerns.
			10/12/2020	Beach emailed project information update.	
TSIC	Peak body representing the interests of wild capture fishers, marine farmers and seafood processors in Tasmania.	1	02/03/2020	Beach emailed the project information sheet and invited return comment.	Information gathered from TSIC and its members has been incorporated into Section 5.7.6 and Section 7.1 of the EP. Consultation with TSIC will be ongoing.
			26/03/2020	Meeting held between Beach, SIV, TSIC, BSSIA and SFAF. Key concern of stakeholders was the proximity of the survey to scallop fishing grounds and potential for loss of catch. Beach later reduced the survey acquisition area to minimise impacts to scallop fishing. Meeting notes available in **Appendix 4**.	
			06/04/2020	Beach emailed meeting notes and summary to TSIC and other meeting attendees.	
			10/12/2020	Beach emailed project information update.	
SFAT	Actively promotes and protects the best interests of scallop fishermen and processors	1	03/03/2020	Beach emailed the project information sheet and invited return comment.	Information gathered from BSSIA and its members has been incorporated into Section 5.7.6 and Section 7.1 of the EP.
			26/03/2020	Meeting held between Beach, SIV, TSIC, BSSIA and SFAF. Key concern of stakeholders was the	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
				proximity of the survey to scallop fishing grounds. Beach later reduced the survey acquisition area to minimise impacts to scallop fishing. Meeting notes available in **Appendix 4**.	Beach has agreed to undertake a scallop impact assessment following feedback and data provided by the scallop industry. Consultation with BSSIA will be ongoing.
			06/04/2020	Beach provided a summary of the meeting to attendees.	
			22/07/2020	Meeting between BSSIA, SFAT and Beach to provide a project update and discussion with the scallop fishing industry. Jasco Applied Sciences presented the underwater sound modelling results. Stakeholders raised concerns regarding potential impacts to the scallop stocks east of King Island as a result of the survey. SFAT agreed to provide the location of previous scallop surveys to inform Beach's survey design. Beach provided the information presented to the stakeholders. Meeting notes available in **Appendix 4**.	
			03/08/2020	SFAT and scallop industry representatives submitted a letter raising concerns regarding the impacts on scallops from the survey to Beach.	
			11/08/2020	Beach acknowledged the submission from SFAT and requested detailed information on scallop fishing locations in order to explore further mitigation options.	
			14/08/2020	Scallop tow data from the survey area was provided to Beach in order to inform further mitigation strategies and survey design.	
			28/08/2020	Beach informed SFAT that it was assessing the request for a pre-survey scallop assessment and had commenced discussions with survey experts to understand valid design parameters.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
			29/10/2020	Beach provided the underwater sound modelling report to SFAT	
			06/11/2020	Beach responded to specific stakeholders concerns that have been raised and committed to undertake a scallop assessment survey in response to feedback and data provided by the scallop industry. Response provided in **Appendix 4**.	
			08/12/2020	Phone discussion between Beach and SFAT. SFAT was pleased with Beach's commitment to conduct a scallop assessment survey. Both parties agreed to meet again when Beach had completed its compensation arrangement.	
			10/12/2020	Beach emailed project information update.	
Top Fish Tasmania	Octopus fishery licensee.	1	16/07/2020	Beach emailed the project information sheet and invited return comment.	Information gathered from Top Fish Tasmania has been incorporated into Section 5.7.6 and Section 7.1 of the EP. The survey area covers part of Top Fish's historical but not recent fishing areas and Beach will consult with them regarding timings and locations to enable avoidance of activities. Consultation with Top Fish Tasmania will be ongoing.
			21/07/2020	Stakeholder requested the coordinates of the survey area.	
			28/07/2020	Beach provided the survey area coordinates to the stakeholder and arranged a phone meeting.	
			30/07/2020	Meeting held between Beach and Top Fish to discuss the survey and octopus fishing activities in the area. Top Fish raised concerns regarding the displacement and loss of catch following the survey. Beach and Top Fish agreed to continue communication. Meeting notes provided in **Appendix 4**.	
			02/08/2020	Top Fish offered Beach the use of their vessels for potential scout / chase duties.	
			16/08/2020	Top Fish provided coordinates of their octopus fishing gear positions over the last 18 months.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
			15/11/2020	Beach met with stakeholder onboard MV *Farquharson* to discuss survey timing and potential to use stakeholder vessel for chase duties during the survey.	
			10/12/2020	Beach emailed project information update.	
Infrastructure asset owners					
Alcatel Submarine Networks UK LTD	Operator of the two subsea communications cables linking Victoria and Tasmania.	2	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	Additional consultation is not required. The location of subsea telecommunication infrastructure in the survey area is well understood (see Section 5.7.3).
Toll Group	Logistics and transport company.	2	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	Beach will continue to keep the stakeholder informed about survey planning.
			17/07/2020	Beach emailed project update and requested information on Toll Group's shipping routes and schedules in the survey area.	
			03/08/2020	Toll Group supplied the passage plans and routes to Beach for consideration.	
			10/12/2020	Beach emailed project information update.	
SoT	Bass Strait ferry operator.	1	17/07/2020	Beach emailed project update and requested information on SoT's ferry timetable and routes.	Beach will continue to keep the stakeholder informed about survey planning and consult on survey vessel movements and SoT ferry scheduling.
			14/08/2020	Beach called to discuss SoT ferry timetable and provided wave radar measurements from Yolla-A.	
			27/08/2020	SoT provided ferry schedule and routes to Beach.	
			10/12/2020	Beach emailed project information update.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
SeaRoad	Shipping service in Tasmania.	1	10/12/2020	Beach emailed project information update.	Beach will continue to keep the stakeholder informed about survey planning.
Telstra	Owner of the two subsea communications cables linking Victoria and Tasmania.	2	26/02/2020	Beach emailed the project information sheet and invited return comment.	Additional consultation is not required. The location of subsea telecommunication infrastructure in the survey area is well understood (see Section 5.7.3).
			27/08/2020	Beach emailed updated project information and invited return comment.	
			20/10/2020	Stakeholder returned email thanking latest project update. No concerns were raised.	
			10/12/2020	Beach emailed project information update.	
Aquasure (Victorian Desalination Plant)	Operator of the Victorian water desalinisation facility on the coast near Wonthaggi.	2	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	The emergency response details are included in Section 8.10.
			10/12/2020	Beach emailed project information update.	
Conservation groups					
Blue Whale Study Inc	Organisation concerned with conservation and research outcomes for blue whales.	2	26/11/2019	Beach requested a specialist report on blue whale presence and absence in the Otway and Bass Basins.	The potential impacts to blue whales are addressed in Section 7.1 of the EP. Impacts are avoided because the survey is not located areas of high annual use for the species. Beach will continue to keep the stakeholder informed about survey planning.
			26/02/2020	Beach emailed the project information sheet and invited return comment.	
			16/09/2020	BWS issued a review of scientific literature on the activities of blue whales in the Otway Basin and Bass Strait.	
			10/12/2020	Beach emailed project information update.	
Deakin University (DU) (School of Life and Environmental Sciences)	Marine conservation research.	2	26/02/2020	Beach emailed the project information sheet and invited return comment.	The potential impacts to fur-seals and seabirds are addressed in Section 7.1 of the EP. Beach will continue to keep the stakeholder informed about
			26/02/2020	DU acknowledged receipt of the survey information and inquired if Beach was interested in developing projects with DU.	

Stakeholder	Function, interests and/or activities	Information type	Date	Consultation conducted and stakeholder concerns	Beach's assessment of merit
			26/02/2020	Beach acknowledged that they would raise the possibility of projects with the community group.	survey planning and the potential for combined projects with Deakin University.
			10/12/2020	Beach emailed project information update. Stakeholder wished to discuss potential project between Deakin University and Beach and the impacts of MSS on fur-seals and seabirds in the survey area.	
IMAS	University of Tasmania marine research.	2	10/12/2020	Beach emailed project information update.	Beach will continue to keep the stakeholder informed about survey planning.
Other organisations					
Ocean Racing Club of Victoria	Conducts ocean/offshore and bay yacht races and events in Victoria.	2	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	The stakeholder has not expressed an interest in the survey. As such, no further consultation is required.
			10/12/2020	Beach emailed project information update.	
SCUBA Divers Federation of Victoria	Supports and represents scuba diving clubs and their members in Victoria.	2	26/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	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.
			10/12/2020	Beach emailed project information update.	
ConocoPhillips (T/49P titleholder)	Nearby titleholder with an upcoming seismic survey planned.	2	28/02/2020	Beach emailed the project information sheet and invited return comment. No stakeholder response.	The activities of the nearby titleholder are well understood (see Section 5.7.2 of the EP). Beach will continue to keep the stakeholder informed about survey planning
			10/12/2020	Beach emailed project information update.	
Category 5 – Any person or organisation that the Titleholder considered relevant					
Not applicable.					

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. While each hazard associated with the survey has its own unique EMBA, the largest one has been chosen for this chapter so as to describe all possible values and sensitivities, which is a full loss of marine diesel oil (MDO) from the largest tank of the survey vessel from within the survey area.

The hydrocarbon spill EMBA ('spill EMBA' for simplicity) (Figure 5.1) is therefore defined as:

> *The combined extent of low level hydrocarbon exposure to the sea surface (1 g/m^2), entrained in the water column (10 ppb), dissolved in the water column (10 ppb), and contact to shorelines (10 g/m^2) as a result of a release of 280 m^3 of MDO (over 6 hours) from the survey vessel during annualised metocean conditions.*

This spill EMBA has been established through hydrocarbon spill modelling (see Sections 7.13 and for the spill scenario and modelling results). The EMBA is generated from stochastic modelling and therefore does not represent the possible outcome from a single spill scenario. The EMBA represents the compilation of possible outcomes and encompasses the area predicted to be affected from 200 simulations of the scenario under annualised weather conditions. Because of this, the EMBA is large, covering areas that may not be affected by any single spill event. The maps presented in this chapter illustrate the following phases of MDO fate under the different scenarios:

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

As such, the EMBA is considered to be the combined extent of all phases of oil across the 200 simulations of the spill scenario.

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 on 12th March 2020 and for the EMBA on 28th May 2020 (**Appendix 5**);
- Species Profile and Threats (SPRAT) Database (DAWE, 2020b);
- The Atlas of Living Australia (ALA) database (**Appendix 6**);
- Victorian Biodiversity Atlas (VBA) (DELWP, 2020) (**Appendix 7**)

- 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 8**); and
- Tasmanian 'ListMap' database (ListMap, 2020).

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.

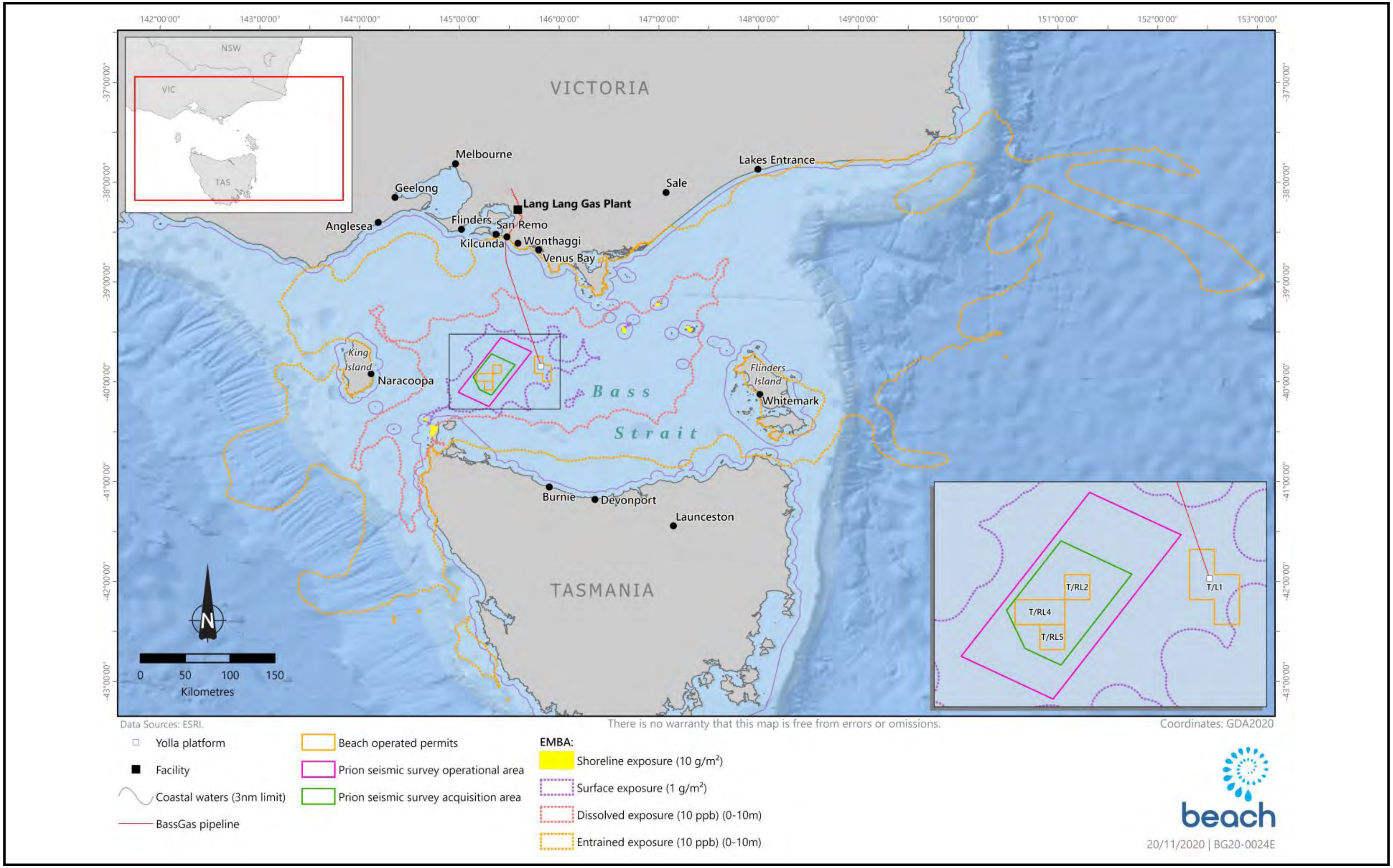


Figure 5.1. The Prion 3DMSS spill EMBA

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

Table 5.1. Presence of receptors within the survey area and the EMBA

Receptor	Survey area	EMBA
Physical		
Mud		
Sand		
Rocky reef		
Sponge gardens	Possible	
Seagrass communities		
Conservation Values		
Australian Marine Parks (AMPs)	Boags AMP (no shot zone)	
World Heritage-listed properties		
National Heritage-listed properties		
Threatened Ecological Communities (TECs)		
Key Ecological Features (KEFs)		
Nationally important wetlands		
Victorian marine protected areas		
Tasmanian marine protected area		
Onshore protected areas		
Biological environment		
Plankton		
Benthic species		
Abalone	Beyond depth range of abalone	
Scallops		
Rock lobsters	Likely lack of necessary reef habitat	
Fish		
BIA, great white shark	Distribution	
Cetaceans		
BIA, pygmy blue whale	Possible foraging	
BIA, southern right whale	Known core range	
BIA, humpback whale		
Pinnipeds	Foraging only	Haul out and breeding sites
Reptiles (turtles)		Vagrant only, no nesting grounds
Seabirds	Foraging, flyovers, BIA for many species (particularly albatross)	
Shorebirds	No coastline present	
Marine pests	Possible	
Cultural heritage values		

Receptor	Survey area	EMBA
Shipwrecks		
Indigenous heritage	None registered	Located on shorelines
Socio-economic environment		
Native title		
Tourism		
Recreational fishing		
Commercial fishing		

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

5.1 Regional Environmental Setting

Bass Strait separates Tasmania from the southern Australian mainland by approximately 230 km at its narrowest point and contains a number of islands, with the largest being King Island and Flinders Island (see Figure 5.1).

The Trefoil, Bass, and White Ibis gas fields are located within the Bass Strait Provincial Bioregion using the Interim Marine and Coastal Regionalisation for Australia (IMCRA) classification (Figure 5.2) (DEH, 2006). At the mesoscale level, the survey area is located in the Central Bass Strait (CBS) bioregion, which is approximately 60,000 km^2 in size with water depths between 50 m at the margins and 80 m at the centre and is on the continental shelf (DEH, 2006). The substrate in the central area of the CBS is predominantly mud (DEH, 2006).

The following IMCRA mesoscale zones are intersected by the EMBA:

- Twofold Shelf;
- Flinders;
- Boags;
- Central Bass Strait;
- Otway;
- Central Victoria; and
- Victorian Embayments.

5.2 Physical Environment

5.2.1 Climate and Meteorology

Bass Strait is located on the northern-most zone of an area known as the ‘Roaring Forties’ with its climate determined chiefly by the presence of sub-tropical high-pressure ridges and migratory low-pressure systems (extra-tropical cyclones). Migrating low pressure systems typically bring a westerly wind regime to Bass Strait and are likely to affect the area every three to five days on average during the winter months.

5.2.2 Temperature and Rainfall

Average air temperatures recorded at King Island airport (110 km west of the survey area, but the closest point for a Bureau of Meteorology [BoM] weather station) for 1995-2019 range from a minimum of 10.0°C to a maximum of 17°C (BoM, 2020).

Mean annual rainfall for the period 1974-2019 is 857 mm, with the highest rainfall totals falling in June, July and August (with an average minimum of 30 mm in February and an average maximum of 117 mm in July) (BoM, 2020).

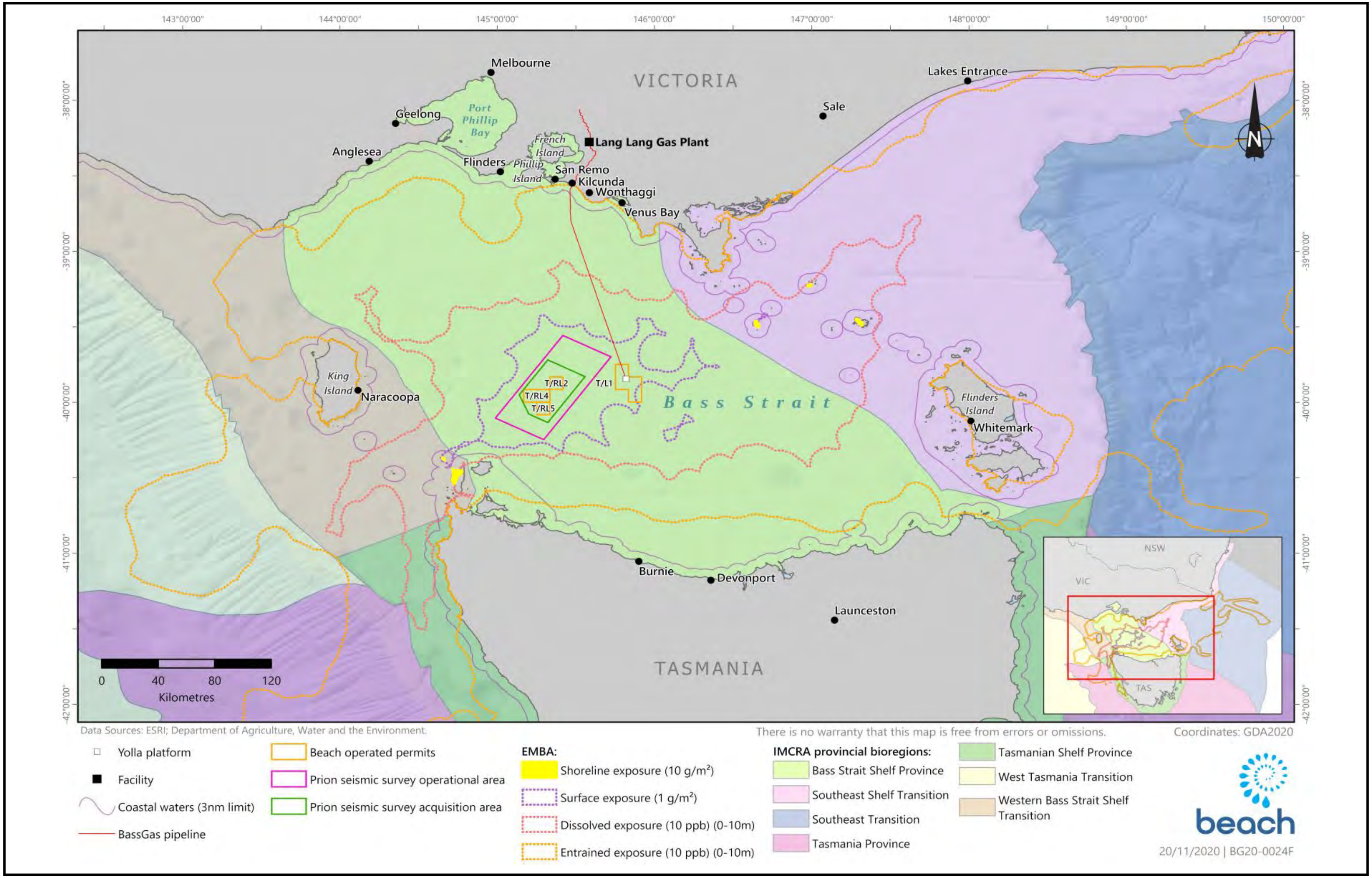


Figure 5.2. IMCRA provincial bioregions

5.2.3 Winds

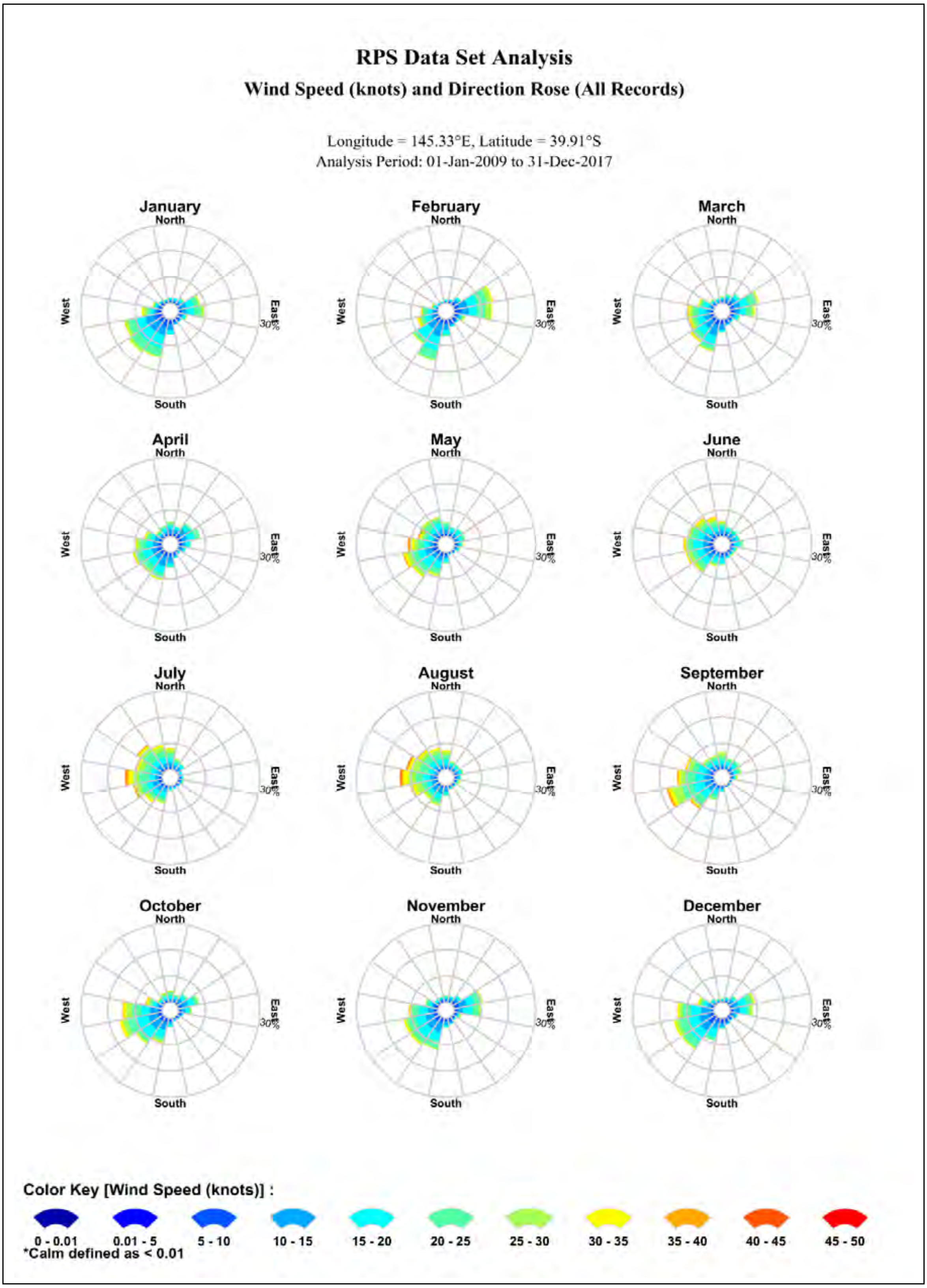
RPS (2020) acquired high-resolution wind data from 2009 to 2017 (inclusive) across their modelling domain from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR). Table 5.2 lists the monthly average and maximum winds derived from the CFSR station located nearest to the survey area.

Figure 5.3 illustrates the monthly wind rose distributions from 2009 to 2017 (inclusive), which clearly indicates that winds from the southwest dominate this region for most of the year.

Table 5.2. Predicted average and maximum wind speeds for the representative wind station nearest the survey area.

Month	Average wind speed (knots)	Maximum wind speed (knots)	General direction (from)
January	15	40	Southwest
February	16	43	South-southwest - East-northeast
March	16	47	South-southwest - East-northeast
April	15	47	West-southwest
May	17	49	West-southwest
June	17	44	Variable
July	19	50	West
August	19	46	West
September	18	46	West-southwest
October	17	42	West-southwest
November	16	40	West-southwest - Southwest
December	16	40	West-southwest - Southwest
Minimum	15	40	
Maximum	19	50	

Source: RPS (2020).



Source: RPS (2020). The convention for defining wind direction is the direction the wind blows from.

Figure 5.3. Modelled monthly wind rose distributions from 2009-2017 (inclusive) for the representative wind station closest to the survey area.

5.3 Oceanography

5.3.1 Tides and Currents

Bass Strait is a relatively shallow area on the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. The strait has a reputation for strong tidal currents, which are primarily driven by tides, winds and density-driven flows. The tides of central Bass Strait are semi-diurnal with the dominant large-scale water movements due to the astronomical tide (Jones, 1980).

The 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 then increases as the distance from the central strait increases with relatively strong tidal currents at either end. The times and magnitudes of the tide 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).

In winter and spring, waters within the strait are well mixed with no obvious stratification while during summer the central regions of the strait become stratified (Baines and Fandry, 1983; Middleton and Black, 1994).

The region is oceanographically complex, with sub-tropical influences from the north and sub-polar influences from the south (DoE, 2015a). There is a slow easterly flow of waters in Bass Strait and a large anti-clockwise circulation (DoE, 2015a). Three key water currents influence Bass Strait:

1. The **Leeuwin Current** transports 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.
2. The **East Australian Current** (EAC) is up to 500 m deep and 100 km wide, flows southwards adjacent to the coast of NSW and eastern Victoria, and carries warm equatorial waters (DoE, 2015a). The EAC is strongest in summer when it can flow at a speed of up to 5 knots, but flows more slowly (2-3 knots) in winter where it remains at higher latitudes.
3. The **Bass Strait Cascade** occurs during winter along the shelf break, which brings nutrient-rich waters to the surface as a result of the eastward flushing of the shallow waters of the strait over the continental shelf mixing with cooler, deeper nutrient-rich water (DoE, 2015a).

Figure 5.4 illustrates the major ocean currents in south-eastern Australian waters during summer and winter (DoE, 2015a).

Table 5.3 provides the average and maximum net current speeds from combined HYCOM and tidal currents near the survey area (RPS, 2020).

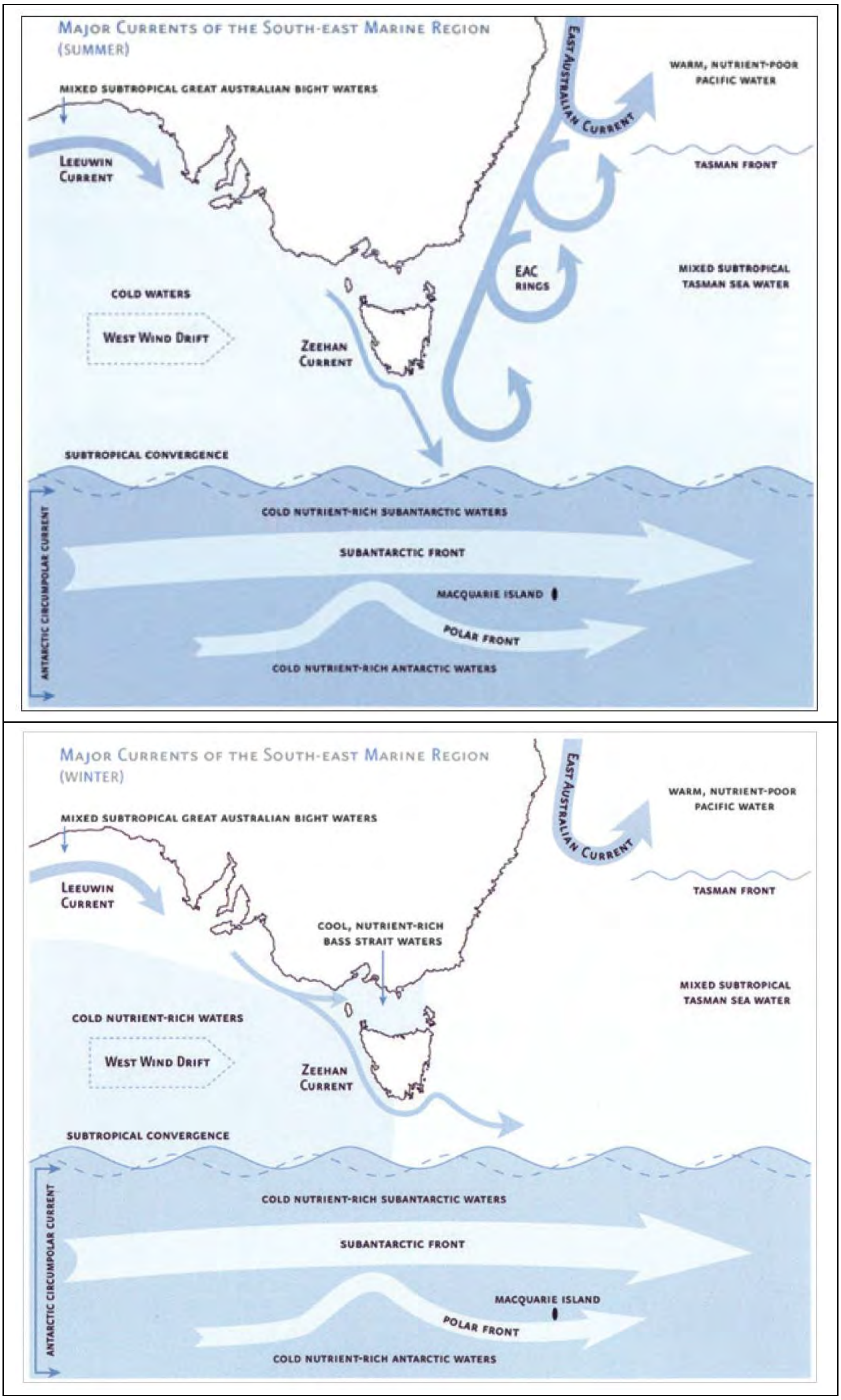
Figure 5.5 illustrates the monthly surface current rose distributions from the combination of HYCOM ocean current data and HYDROMAP tidal data near the survey area from 2009 to 2017 (inclusive) (RPS, 2020). This data indicates that surface currents flow predominantly eastwards.

Semi-diurnal astronomical tides provide the major water level variations in the region with four current reversals each day and a relatively small tidal range of about 1.3 m. The tidal range at the nearby Yolla-A platform (14 km east) is estimated to be about 2.3 m at spring tides and 1.7 m at neap tides and the combined sea and tidal currents vary in intensity with the time of year, typically reaching speeds of up to 1.0 m/s. The lowest and highest astronomical tides at the platform are -1.47 m and +1.33 m, respectively. Tidal currents at the platform move in an ellipse and tend to flood and ebb to the southeast and northwest respectively.

Table 5.3. Predicted monthly average and maximum surface current speeds at the centre of the survey area.

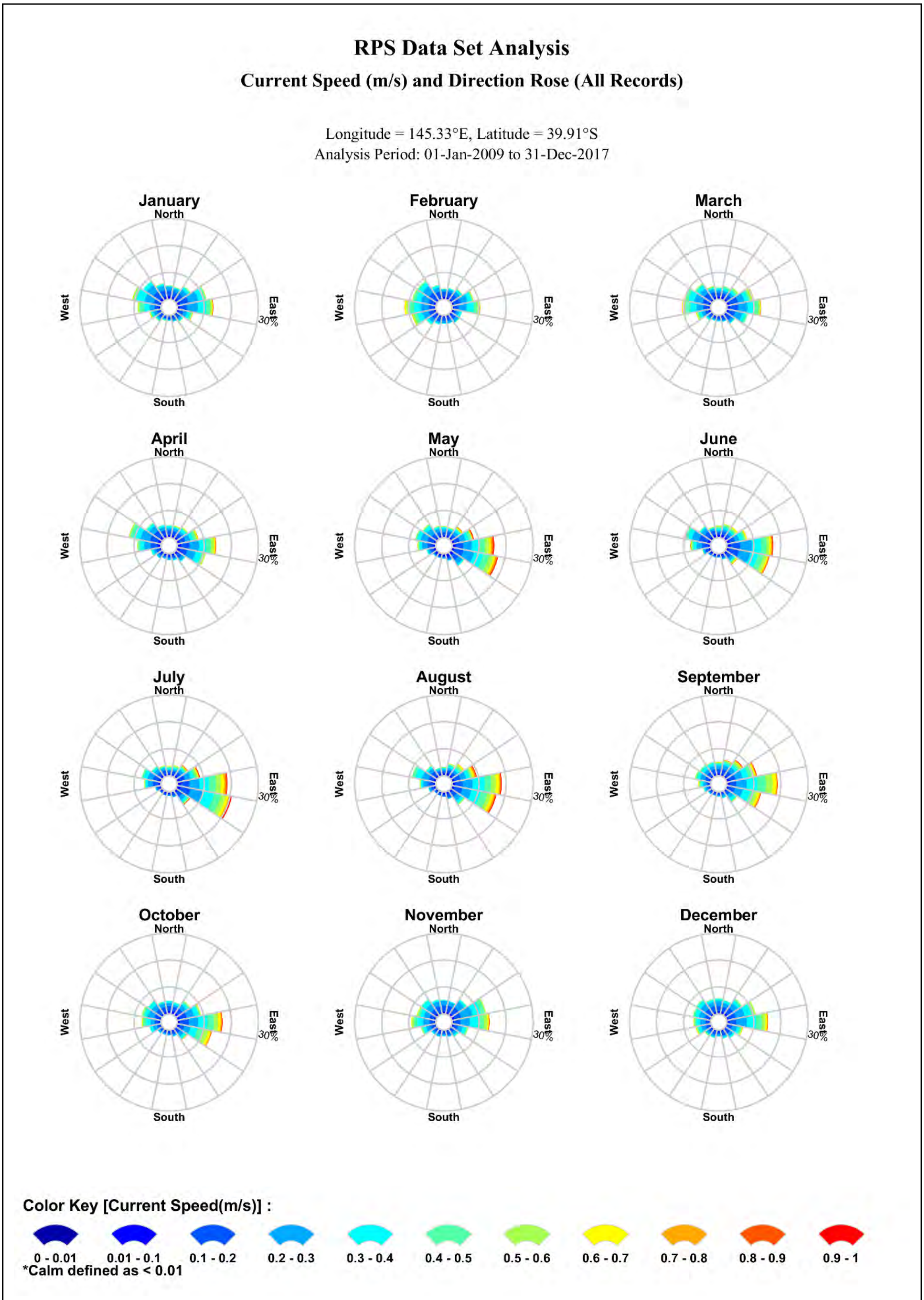
Month	Average wind speed (knots)	Maximum wind speed (knots)	General direction (from)
January	0.24	0.92	East (variable)
February	0.25	0.86	East - West (variable)
March	0.25	1.01	East - West (variable)
April	0.24	1.16	East – West-northwest
May	0.27	1.21	East – East-southeast
June	0.26	1.16	East – East-southeast
July	0.29	1.38	East – East-southeast
August	0.28	1.32	East – East-southeast
September	0.29	1.01	East
October	0.26	1.10	East
November	0.25	0.87	East - East-northeast
December	0.25	0.90	East
Minimum	0.24	0.86	
Maximum	0.29	1.38	

Source: RPS (2020).



Source: DoE (2015a).

Figure 5.4. Major ocean currents in south-eastern Australian waters during summer (top) and winter (bottom)



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

Figure 5.5. Monthly surface water current rose plots from 2009-2017 (inclusive) at the centre of the survey area.

5.3.2 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.

5.3.3 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). The sea surface temperatures in the area reflect the influence of warmer waters brought into Bass Strait by the EAC (IMCRA, 1998; Barton *et al*., 2012).

Waters of eastern Bass Strait are generally well-mixed, but surface warming sometimes causes weak stratification in calm summer conditions. During these times, mixing and interaction between varying water masses leads to variations in horizontal water temperature and a thermocline (temperature profile) develops. The thermocline acts as a low-friction layer separating the wind-driven motions of the upper well-mixed layer of Bass Strait from the bottom well-mixed layer.

RPS (2020) reports that the temperature in the top 40 m of the water column in the region (based on the World Ocean Atlas) varies from 12-18°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.

5.3.4 Water Quality

The nutrient concentrations in CBS 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 CBS (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).

5.3.5 Salinity

RPS (2020) reports that the average monthly salinity consistently remains in the range of 35.0 to 35.6 practical salinity units (based on the World Ocean Atlas database).

5.3.6 Seabed

<u>Bass Strait</u>

The bathymetry of Bass Strait is shown in Figure 5.6 and illustrates that the seafloor is gently sloping with water depths increasing gradually from the shore to reach a maximum of about 80 m in the survey area. The region's seabed is characterised by a mixture of basins, terraces, plateaus, banks, deep escarpments 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.

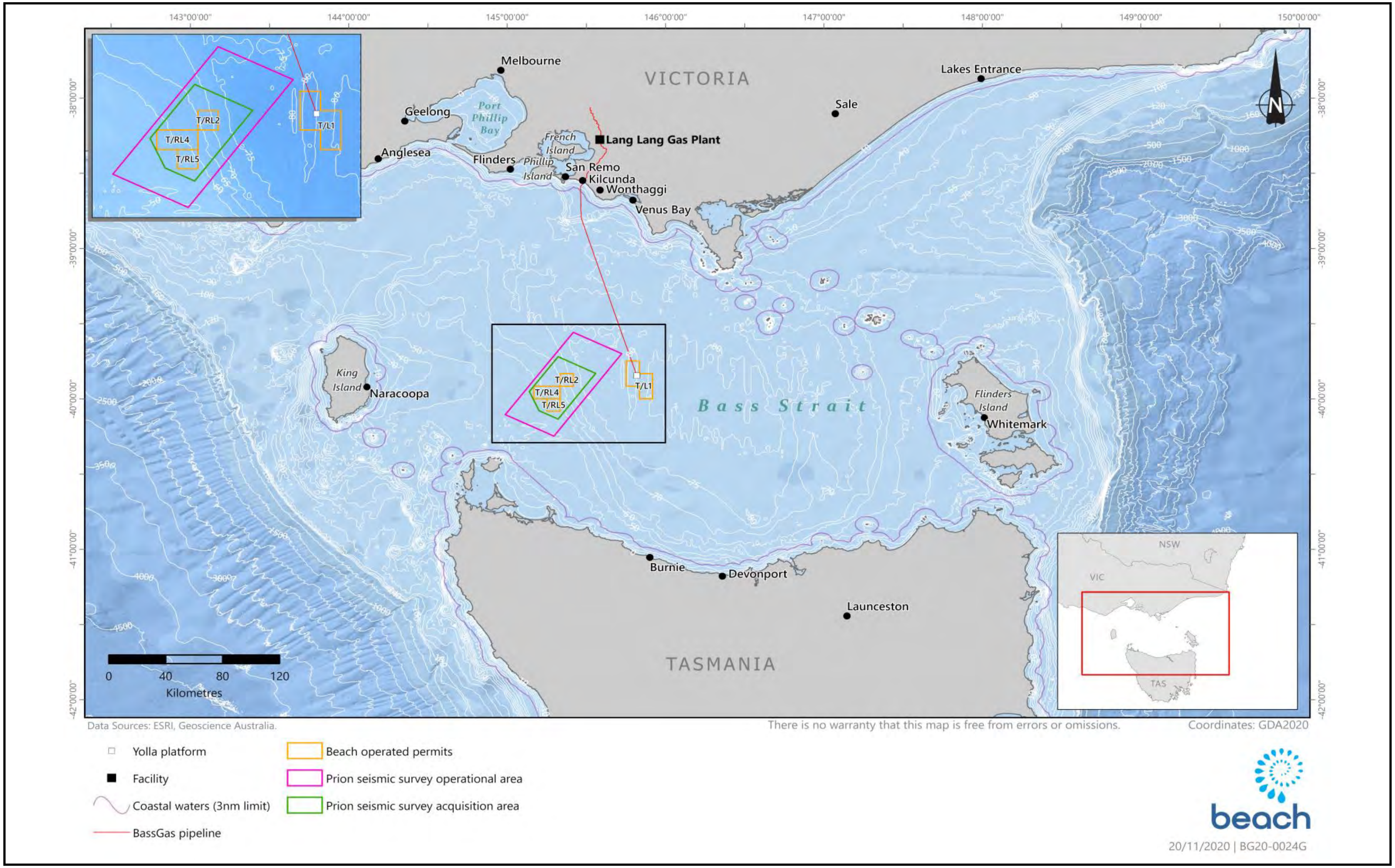


Figure 5.6. Bathymetry of Bass Strait and the survey area

Sedimentation in Bass Strait is generally low due to the poor supply from rivers on the Victorian and Tasmanian coasts and the relatively low productivity of carbonate. In the central part of the basin, carbonate muds are produced by the primary accumulation and disintegration of nannoplankton, as well as through the biodegradation of skeletal carbonate grains accumulating on the seabed (Blom and Aslop, 1988). These muds are transported to the south of the basin to the end of tidal current transport path and settle in the relatively low-energy environment of the enclosed central Bass Basin (indicated by the shaded browns in Figure 5.7). Blom and Alsop (1988) conducted core sampling in central Bass Strait and found accumulated muds to be up to 1 m thick in the central basin while thinning away from the centre towards the margins. These findings are consistent with that observed by Jones and Davies (1983), which found the centre of Bass Strait to comprise fine-grained sediments (muds and silty sands) while the margins of the Strait comprise comparatively coarse-grain gravels and sands. The grain size distribution of surficial sediments as collated by Geoscience Australia (2005), which includes the data of Jones and Davies (1983) and Blom and Aslop (1988), is overlaid with the survey area and presented in Figure 5.7.

<u>Survey area</u>

Surveys undertaken for the nearby BassGas development (14 km east of the survey area) indicate that the seabed has very sort to soft alternating layers of silty carbonate clay and silty sands contained with fragile shell fragments (Thales GeoSolutions, 2001). Given these recent findings are consistent with the scientific literature presented for CBS (Figure 5.7), it is reasonable to assume that the seabed conditions of the survey area are similar but likely consist of fine- and medium-grained sand with some areas of course sand present in the west of the survey area.

<u>Spill EMBA</u>

The seabed in the nearshore parts of the spill EMBA is mapped only at a coarse scale for the Oil Spill Response Atlas (OSRA) using LiDAR data (**Appendix 8**). 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) – only the southern tip of Cape Otway is intersected by the EMBA. Immediately south of Cape Otway is an extensive area of subtidal reefs interspersed with patches of sandy substrate.
- Phillip Island (OSRA Map 15) – only the southern tip of Cape Woolamai is intersected by the EMBA. The nearshore seabed of Cape Woolamai is a mix of subtidal rocky reef and sandy sediments.
- 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 sediments and no reef 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 subtidal 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.
- Corner Inlet West (OSRA Map 21) – the seabed of the entry channel to Corner Inlet is indicated as sandy sediment with seabed channels. Within the inlet there are extensive areas of intertidal mud flats interspersed with smaller areas of sandy sediments.

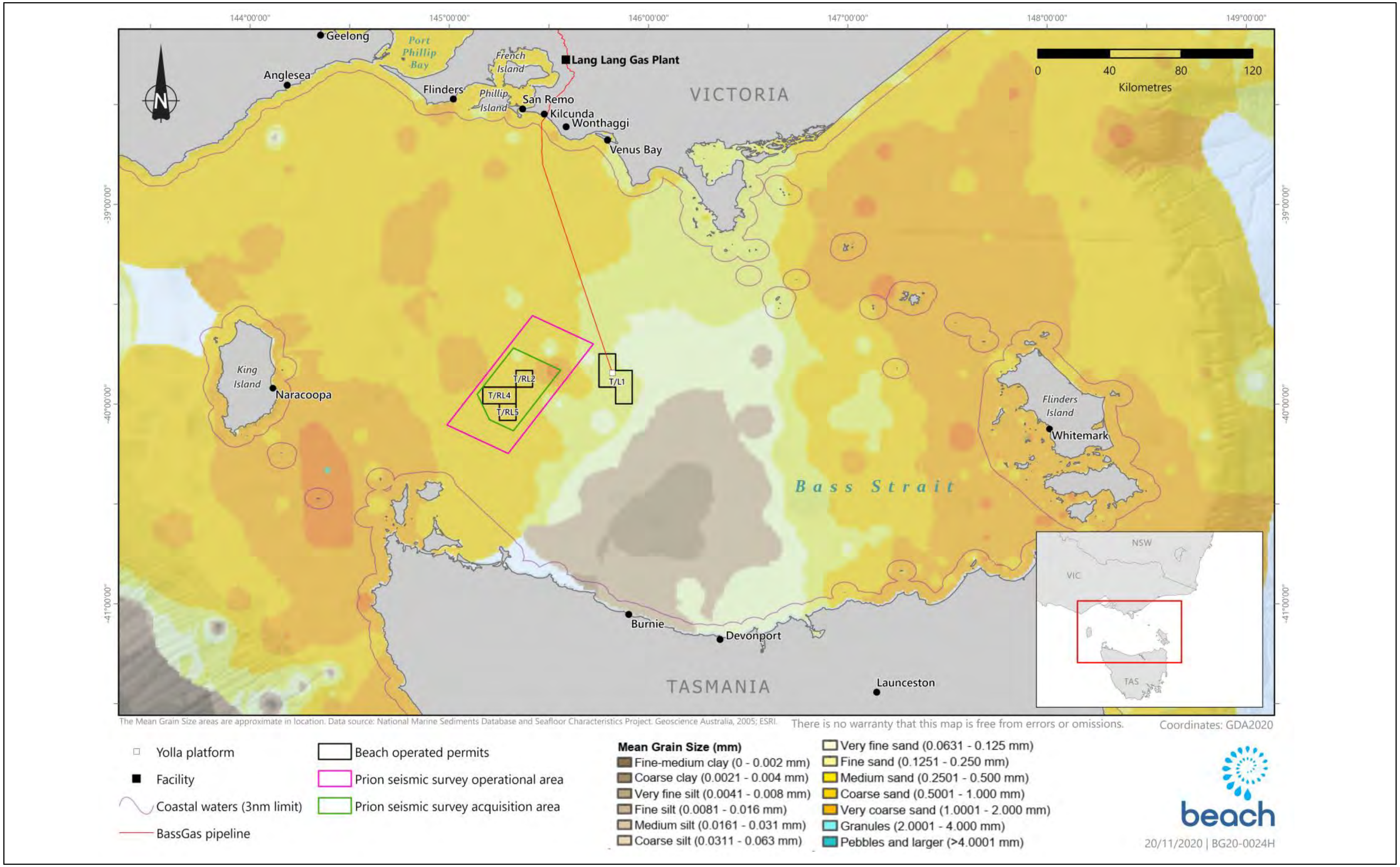


Figure 5.7. Average seabed sediment grain size across Bass Strait

- Ninety Mile Beach West (OSRA Map 23) – the area of Ninety Mile Beach West intersected by the EMBA is dominated by extensive areas of sandy seabed.
- 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.

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 that is intersected by the EMBA is mapped as predominantly sandy, with the only considerable areas of reef located outside the EMBA. Seagrass communities are mapped in the strait between Hunter Island and mainland Tasmania where intertidal mud flats are also present closer to the shore. Nearshore seabed mapping of Kind Island, Flinders Island and the west coast of Tasmania is not included in the Seamap database.

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 large gazers (e.g., dugongs and turtles), provide substrate for epiphytic organisms to colonise and eventually nutrients for detritivores (Parks Victoria, 2005a).

5.3.7 Shorelines

This section describes the shoreline in the areas intersected by the spill EMBA. There are no areas of the mainland Victorian or Tasmanian coastlines that are predicted to be exposed to shoreline loading. Areas potentially exposed to shoreline loading are limited to offshore islands in Bass Strait, some of which are largely uninhabited. These islands include the Kent Island Group, Hogan Island Group, Curtis Island, Hunter Island and Albatross Island.

Note, description of shorelines is based on available literature and Google Earth satellite imagery.

Potential exposure to shoreline hydrocarbons

Hunter Island – the west coast of Hunter Island is predicted to be exposed to shoreline loading of hydrocarbons. The west coast of the Island is predominantly rocky shores, small cliffs (<5 m) and wave cut platforms (ListMap, 2020). Areas of sandy beach are rare and largely only accumulate in sheltered bays and coves, such as at Cuvier Bay (ListMap, 2020).

Kent Group – Erith, Dover and Deal Islands form the largest islands of the Kent Group. The shorelines that intersect the EMBA are predominantly rocky with areas of cliff and shore platform. There are significant areas of sediment accumulation that form beaches, typically located within the sheltered bays that provide the necessary protection from wave and tidal action. The shorelines form part of the Kent Group National Park.

Curtis Island – the shoreline of Curtis Island is entirely rocky coast and cliff with no significant stretches of sandy beach. The offshore outcrops of Cone Islet and Sugarloaf Rock are similar to Curtis Island; rocky shore and cliff are the dominant shoreline type.

Hogan Island – Hogan Island is a 232-ha island located between the Furneaux Group and Wilsons Promontory. The coast of the island is comprised of rocky shores and outcrops with only small accumulations of sand present in sheltered rocky coves.

Albatross Island – Albatross Island is an 18-ha island located 11 km northwest from Hunter Island. The shoreline of Albatross Island is exclusively rocky with no significant accumulations of sand to form beaches. The island is recognised breeding habitat for shy albatross and other seabirds.

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

Victoria

Note, description of Victorian shorelines is based on OSRA mapping, which is available in **Appendix 8**.

- Apollo Bay (OSRA Map 07) – The EMBA intersects only the southern-most extent of Cape Otway. The shoreline is dominated by rocky intertidal shore platform.
- Phillip Island (OSRA Map 15) – only the Cape Woolamai coast intersected by the EMBA, which is dominated by sandy beach and sand dunes with some isolated areas of cobble/shingle beach. The sandy beach provides habitat for coastal bird species.
- Kilcunda (OSRA map 17) – the coast intersected by the EMBA is a distinct mix of intertidal shore platforms and sandy beaches.
- 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 5.4.4), Australian fur-seals and New Zealand fur-seals (see Section 5.4.6). 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.
- Ninety Mile Beach West (OSRA Map 23) – the shoreline intersected by the EMBA is exclusively sandy beach.
- 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 noted 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 EMBA does not intersect Mallacoota Inlet. 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.

Parks Victoria (2006a) notes that the following values of the shoreline types described for the spill EMBA (noting these are focused on the Bunurong MNP and Bunrong Marine Park areas):

- Sandy beaches – provide important habitat for invertebrates such as amphidpods, isopods, molluscs, polychaetes and crustaceans, while the beach-washed material (wrack) provides food sources for birds and detritus for invertebrates such as bivalves and crabs.
- Intertidal reef platforms and rocky shores – upper areas of the rock platforms support green, red and blue-green algae while the extensive mid-intertidal communities are dominated by Neptune's necklace (*Hormosira banksii*) and the green algae sea lettuce (*Ulva spp*.), which grow in small rock pools and cracks. Lower intertidal platforms that are subject to regular submergence are dominated by brown algae and branching and encrusting coralline red algae. The intertidal reef platforms are feeding and roosting areas for many shorebird species.

Tasmania

Potential exposure to dissolved and/or entrained phase hydrocarbons

Flinders Island – the west and north coast of Flinders Island is primarily composed of wave cut platforms, low cliffs (<5 m) and sandy and gravel beaches (ListMap, 2020). The northeast coast of the island is dominated by an almost uninterrupted 38 km stretch of sandy beach, which is backed by remnant coastal scrub (ListMap, 2020). Shorebirds and other threatened bird species nesting sites are present on the small offshore island shorelines intersected by the EMBA as well as numerous seal haul-out sites.

Cape Barren Island and surrounds – the west coast of Cape Barren island contains a mix of rocky headlands, low cliffs (<5 m), rocky shores and sandy beaches present only in sheltered coves and bays, such as Dyas Bay and Deep Bay (ListMap, 2020). The surrounding islands of Long Island, Clarke Island and Preservation Island display similar shoreline features to Cape Barren Island with rocky cliffs, intertidal shore platforms and small areas of sandy beaches present.

King Island – the northern most extent of King Island consists of a rocky headland containing Cape Wickham Lighthouse, shore platforms, cliffs and numerous offshore rocky outcrops (ListMap, 2020). The northeast and east coast of King Island is dominated by a long uninterrupted stretch of sand beach from Wickham until the Sea Elephant River estuary (ListMap, 2020). South of the estuary continues with sandy beach until the township of Naracoopa where the shoreline changes to a mix of rocky shores and cliffs with sandy beaches present in sheltered coves around Surprise Bay until the township of Currie on the western coast (ListMap, 2020).

Tasmanian northwest coast – South of Woolnorth to the southern-most extent of the EMBA (36 km northwest of Corinna) is characterised by a mix of rocky shores/cliff face, sand beaches in sheltered coves/bays and occasional river estuaries (including the Arthur River) (ListMap, 2020). There are no major townships along this extent of shoreline though some tourist cabins are present at the Arthur River estuary.

5.4 Biological Environment

The key sources of information for the species that may be present in the spill EMBA are the results of the EPBC Act PMST, VBA and ALA databases.

5.4.1 Benthic Assemblages

Bass Strait

Marine invertebrates in Bass Strait include porifera (e.g., sponges), cnidarians (e.g., jellyfish, corals, anemones, seapens), bryozoans, arthropods (e.g., sea spiders), crustaceans (e.g., rock lobster, brine and fairy shrimps), molluscs (e.g., scallops, sea slugs), echinoderms (e.g., sea cucumbers), and annelids (e.g, polychaete worms).

Studies by the Museum of Victoria (Wilson and Poore, 1987; Poore *et al*., 1985) found that invertebrate diversity was high in southern Australian waters, and the distribution of species was irregular 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). Surveys of the seabed near the Yolla-A platform (14 km east of the survey area) prior to drilling and construction showed sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and predatory snails (whelk) (Thales GeoSolutions, 2001).

Whilst there is little targeted information available on the nature or distribution of epibiota in the survey area and central Bass Strait, 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), from scientific dredging conducted in 1989 (Parry *et al*., 1990), and from targeted investigations for pipeline and power link proposals in the area. 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*, 2005). 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 (2020), 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 (such as those found in abundance off the west coast of Flinders Island) 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).

Spill EMBA

The PMST results do not identify any benthic species within the survey area. However, A search of the VBA database for the EMBA records the occurrence of 47 benthic species, including sea snails (11), starfish (13), crabs (5), sea urchins (5) and sea cucumbers (5) as well as commercial important species such as green-lip and black-lip abalone (*Haliotis* spp.). The full list of benthic species recorded within the EMBA from the VBA database is available in **Appendix 7.** The most abundantly recorded species include:

- Black-lip abalone (*Haliotis rubra*) – 260 records. Commercially important mollusc species that is found from northern NSW to SA and around Tasmania. The species is found from the low-water mark to water depths of 25 m and prefer to feed at night.
- Short-spined sea urchin (*Heliocidaris erythrogramma*) – 142 records. Widely distributed species that occurs across southern Australia from WA to southern QLD. The species feeds on algae and is found in coastal reefs and rubble areas up to water depths of 35 m.
- Feather star (*Cenolia trichoptera*) – 119 records. Widely distributed and abundant species that occurs across southern Australia from WA to northern NSW.
- Ocellate seastar (*Nectria ocellata*) – 106 records. This species is distributed from SA to southern NSW and around Tasmania. The species is often the most common seastar found on exposed rocky reefs in Victoria and Tasmania.
- Seastar (*Nectria macrobrachia*) – 61 records. This species is distributed from WA to Victoria and is found amongst rocks and algae in the subtidal zone up to water depths of 180 m.

A search of the ALA database for the EMBA records the occurrence of hundreds of benthic species from the phylums Annelida, Arthropoda, Brachiopoda, Bryozoa, Cnidaria, Echinodermata, Mollusca and Porifera. Together, the ALA database search for the EMBA records the occurrence of a rich diversity of bristle worms, crabs, lobsters, amphipods, shrimp, barnacles, sea anemones, corals, jellyfish, starfish, brittle stars, sea urchins, sea cucumbers, bivalves, sea snails, squid, octopus, cuttlefish, chitons and sponges. The full list of benthic species recorded within the EMBA from the ALA database is available in **Appendix 6**.

The Bunurong MNP, located 98 km northeast of the survey area near Kilcunda in Victorian state waters, has extensive intertidal rock platforms that exhibit a diverse range of marine life. The subtidal rocky reefs include numerous microhabitats extending several kilometres offshore in relatively shallow water (Parks Victoria, 2006a).

The diversity of intertidal and shallow subtidal invertebrate fauna is the highest recorded in Victoria on sandstone. A high proportion of the common invertebrates occurring along the Victorian coast are found in the Bunurong MNP (Parks Victoria, 2006a), which is also described in Table 5.11. For example:

- Seven of the eight species of brittle stars:
- Nine of 11 sea cucumbers;
- Eight of 11 barnacles;
- All five sea anemones; and
- 15 of 20 chitons (flat eight-plated grazing molluscs).

The underwater reefs in the Bunurong MNP look different to those in other parts of Victoria. For example, crayweed, a large brown seaweed that covers many Victorian reefs, is mostly absent here. Instead a multitude of more unusual plants and animals flourish. The species richness of the Bunurong seaweeds is comparatively high and includes green, blue-green, brown and encrusting coralline red algal species (Parks Victoria, 2006a).

The subtidal marine flora of the area is characterised by a mixed group of brown, red and green algae. The seagrass *Amphibolis antarctica* is also an important component. Invertebrates found in the subtidal zone include limpets, barnacles, blacklip abalone, crabs, seastars, urchins, feather stars and brittle stars, sea snails and small crustaceans (Parks Victoria, 2006a).

The Point Hicks MNP, located 372 km northeast of the survey area, features a diverse assemblage of sessile invertebrates that inhabit its subtidal reef areas including sponges, bryozoans, corals, gorgonians and octocorals (Parks Victoria, 2006c). Within the holdfasts of the marine flora present in and around the park, a rich assemblage of bryozoans, hydroids, sponges and ascidians have been recorded. Large invertebrates including sea stars, ophiuroids, crinoids, gastropods, fan worms and nudibranchs are also present.

Scallops

Commercial scallop (*Pecten fumatus*) is a commercially important species that was recorded in the ALA database search for the EMBA Commercial scallops 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 (a sudden increase in water temperature is thought to trigger spawning), 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, 2020). Scallop settlement is highly variable both temporally and spatially (VFA, 2020). 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 Figure 5.28, areas adjacent to the survey area (and at times within the survey area) 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. Consultation with fishing industry representatives indicates that the peak fishing period for the last six years occurs during September – December depending on the year. Outside of this period, there is almost no commercial scallop fishing activity in proximity to the survey area (see Section 5.7.6).

Southern rock lobster

The southern rock lobster (SRL) (*Jasus edwardsii*) is a commercially important species that was recorded in the ALA database search of the 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. SRL are found to depths of 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 rock lobster is complex. After mating in autumn, fertilised eggs are carried under the tail of the female for approximately three months before being released, typically between September and November.

Once released, rock lobster larvae, or phyllosoma, live in the plankton and undergo eleven developmental stages over a period of one to two years while being carried by ocean currents. During metamorphosis, juvenile rock lobster shift from a planktonic to a benthic existence (DPI, 2009).

Rock lobsters grow by moulting or shedding their exoskeleton. 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. 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).

Adult rock lobsters are carnivorous and feed mostly at night on a variety of bottom dwelling invertebrates such as molluscs, crustaceans and echinoderms. Major predators include octopus and various large fish and sharks. In Victoria, the abundance of rock lobster decreases from west to east reflecting a decreasing area of suitable rocky reef habitat (DPI, 2009). It is expected that where rocky reef is present in the spill EMBA, SRL are more likely to be present. However, consultation with the fishing industry indicates that the survey area remains largely unfished for SRL. Therefore, this is interpreted to indicate that there is not sufficient suitable habitat (i.e., rocky reef) in the survey area for SRL.

Cephalopods

Commercially targeted squid species were recorded in the ALA database search for the survey area and EMBA including Gould's squid *(Nototodarus gouldi*), which 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 5.7.6) and the population size in Bass Strait swings with variability 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 spill EMBA and the survey area.

The pale octopus (*Octopus pallidus*) was also recorded in the ALA database search for 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). In contrast, the 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 (Atlas of Living Australia, 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 5.7.6) where they are harvested using unbaited pots. Both species are likely to be present in the spill EMBA.

<u>Survey area</u>

A search of the VBA database for the survey area did not identify any benthic species. However, a search of the ALA database for the survey area records the occurrence of dozens of benthic species including starfish, brittle stars, sea snails, bivalves, crabs, shrimp, lobsters and bristle worms. The full list of benthic species recorded within the survey area from the ALA database is available in **Appendix 6**.

5.4.2 Plankton

Plankton is a key component in oceanic food chains and comprises two elements; phytoplankton and zooplankton, as described herein. Phytoplankton (photosynthetic microalgae) comprise 13 divisions of mainly microscopic algae, including diatoms, dinoflagellates, gold-brown flagellates, green flagellates and cyanobacteria and prochlorophytes (McLeay *et al*., 2003). Phytoplankton drift with the currents, although some species have the ability to migrate short distances through the water column using ciliary hairs. 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 occasionally planktonic blooms.

Zooplankton is the faunal component of plankton, comprising small crustaceans (such as krill), fish eggs and fish larvae. Zooplankton includes species that drift with the currents and also those that are motile. More than 170 species of zooplankton have been recorded in eastern and central Bass Strait, with copepods making up approximately half of the species encountered (Watson & Chaloupka, 1982). The high diversity may be due to considerable intermingling of distinctive water bodies and may be higher in eastern than in western Bass Strait. Although a high diversity of zooplankton has been recorded, Kimmerer and McKinnon (1984) found that seven dominant species make up 80% of individuals. The dominant species in order of abundance included:

- *Oithona similis*;
- *Calanus australis*;
- *Oikopleura* spp.;
- *Paracalanus indicus*;
- Thaliacea;
- *Penilia avirostis*; and
- *Evadne spinifera*.

An assessment of zooplankton was undertaken to determine pre- and post-MSS abundance of zooplankton at sites within CarbonNet's Pelican MSS area (213 km northeast of the survey area) and at reference sites during January and February 2018. Pre-MSS plankton samples collected were dominated by copepods, cladocerans and salps while post-MSS plankton samples were dominated by the dinoflagellate *Noctiluca scintillans*. Other groups present included siphonophores, fish larvae, fish eggs, polychaetes, ghost shrimps and cnidarians. There was variance between and within assessments, with samples exhibiting levels of diversity and abundance typical of healthy temperate coastal waters. Neither lobster nor scallop larvae were present in any of the samples assessed (CarbonNet, 2018).

5.4.3 Marine Flora

Literature searches indicate there is a paucity of public information regarding the distribution and abundance of marine flora in Bass Strait, particularly in relation to the deeper water of the survey area and spill EMBA. A search of the VBA database for the survey area did not contain any marine flora records. However, a search of the VBA database for the EMBA reports 114 species of marine flora including red, green and brown algae species. The most commonly recorded genus' in the EMBA include *Caulerpa*, *Cystophora*, *Melanthalia*, *Phyllotricha, Plocamium*, *Rhodymenia* and *Sargassum.* The full list of marine flora species recorded in the VBA database within the EMBA is available in **Appendix 7**. The most abundantly recorded species include:

- *Ecklonia radiata* (golden kelp) – 585 records. Widely distributed kelp species that grows in beds on reefs and where sheltered can form dense forests.
- *Phyllospora comosa* (crayweed) – 563 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.

- *Phacelocarpus peperocarpus* (red algae) – 335 records. Species is distributed throughout southern Australia from WA to NSW and around Tasmania.
- *Jania rosea* (red algae) – 291 records. Seaweed with hard, calcareous, branching skeleton and found in sheltered reef habitats, often in crevices or other shaded areas.
- *Ballia callitricha* (red algae) – 206 records. Species is distributed throughout cool and subantarctic waters in the Southern Hemisphere and is usually found in deep water or under an algal canopy.

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. Seagrasses trap soil and other material washed from the land by binding them together and stopping it from clouding the water column, which would otherwise prevent sunlight reaching plants on the seabed.

Variation exists among rocky reefs depending on the level of exposure to waves, the rock type, its weathering and the presence of rock pools, crevices and boulders which all in turn determine the composition of marine fauna. In the nearshore environment, seaweed forests are made up of a large brown kelp. In these environments the marine plants attach themselves to solid structures and extend their blades into the waters reaching toward the sunlight. Together the plants form a dense canopy of blades blocking out light and shading the surface of the solid substrate allowing for smaller species of algae to form. The kelp species typically populating these forests include giant kelp (*Macrocystis pyrifera*) and bull kelp (*Durvillea potatorum*). At Point Hicks MNP, which is located within the EMBA, kelp and seagrasses are a prominent part of the subtidal reefs. Common kelp (*Ecklonia radiata*) and crayweed (*Phyllospora comosa*) are found along the open coast in dense stands (Parks Victoria, 2006c). Giant species of seaweeds such as string kelp (*Macrocystis pyrifera*) and bull kelp also occur.

Tasmanian marine flora remains poorly known because of a lack of professional algal workers (DPIPWE, 2020). However, the cold temperate species of Tasmania include the largest Australian seaweeds, most notably giant kelp, bull kelp, strap kelp, common kelp and other large brown algae including crayweed. At King Island, bull kelp is commercially harvested where it washes onto beaches in large quantities (Parsons, 2010) (see Section 5.7.6).In the Boags Bioregion on the north coast of Tasmania are the southern-most beds of the long-lived seagrass, the southern strapweed (*Posidonia australis*), as well as the majority of habitat for another seagrass, sea nymph (*Amphibolis antarctica*) (Parsons, 2011). There are extensive marine flora communities in the strait between Robbins Island and the north coast of Tasmania. This area also contains prolific beds of southern strapweed and is one of only two known Tasmanian sites for a warm temperate seagrass species, the fibrous strapweed (*Posidonia angustifolia*). Whilst updated seabed mapping is required in this area, 1990s data suggest that this small section of Tasmania's coast may contain more than 10% of the state's seagrass beds (Parsons, 2011).

At Flinders Island, mapping in the 1990s revealed exceptional seagrass beds along its western shores that are significant in their magnitude, density and unusually large depth range (Parsons, 2011). Vast beds, extending as far as 10 km offshore from the coast were detected, and are likely to be a major contributor to nutrients in eastern Bass Strait. While the dominant species (southern strapweed), generally occurs to maximum depths of 15 m, beds have been recorded in depths of up to 20 m along the west coast of Flinders Island, reflecting the exceptional water clarity in this region. Even at this depth, the limit of surveying, seagrass reaches a high density suggesting that the beds extend into even deeper water. This area is only one of two locations in Tasmania where the related fibrous strapweed has been observed.

5.4.4 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 EMBA. The species descriptions provided in this chapter are focussed 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 56 bird species (seabirds and shorebirds) under the EPBC Act as potentially occurring in the survey area and EMBA (Table 5.4, **Appendix 5**). The majority of these are listed as migratory and marine species. The results of the PMST primarily comprise 16 albatross, eight petrels, two parrots, three shearwaters, three godwits, six terns, two swift, two curlew, one prion, four snipes, three gulls, seven plovers, one tattler and seven sandpipers. Six of these bird species are listed as critically endangered, 10 are endangered and 22 are listed as vulnerable. Fifty-one (51) of the species presented in Table 5.4 from the PMST search were recorded in the search for the EMBA area only and were not identified in the search for the survey area only.
- ALA – records 20 shorebirds and 52 seabird species including shearwaters, albatross, petrels, jaegers and prions, summarised in Table 5.4 and the full list presented in **Appendix 6**.
- VBA – records 63 shorebirds and 52 seabird species from the EMBA, summarised in Table 5.4 and the full list presented in **Appendix 7**.

Many of the bird species listed in Table 5.4 are protected by international agreements (Bonn Convention, JAMBA, CAMBA and ROKAMBA) and periodically pass through Bass Strait to and from the Bass Strait islands, mainland Victoria and Tasmania (DAWE, 2020b). Species listed as threatened are described in this section. Figure 5.8 illustrates the presence of these bird species throughout the year.

Table 5.4. Birds that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
PMST							
True seabirds (33 species)							
Albatross							
Diomedea antipodensis	Antipodean albatross	V	Yes	Yes	-	FFR	Generic RP in place for all albatross in Australia,
Diomedea gibsoni	Gibson's albatross	V	Yes	Yes	-	-	
Diomedea epomophora (sensu stricto)	Southern royal albatross	V	Yes	Yes	-	-	
Diomedea exulans (sensu lato)	Wandering albatross	V	Yes	Yes	-	FFR	
Diomedea sanfordi	Northern royal albatross	E	Yes	Yes	-	-	

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Phoebetria fusca	Sooty albatross	V	Yes	Yes	-	-	+ AS for all albatross
Thalassarche bulleri	Buller's albatross	V	Yes	Yes	-	FFR	
Thalassarche bulleri platei	Northern Buller's albatross	V	-	-	-	-	
Thalassarche cauta	Shy albatross	E	Yes	Yes	-	FFR	
Thalassarche chrysostoma	Grey-headed albatross	E	Yes	Yes	-	-	
Thalassarche eremita	Chatham Albatross	E	Yes	Yes	Yes	-	
Thalassarche impavida	Campbell albatross	V	Yes	Yes	-	FFR	
Thalassarche melanophris	Black-browed albatross	V	Yes	Yes	-	FFR	
Thalassarche salvini	Salvin's albatross	V	Yes	Yes	-	-	
Thalassarche steadi	White-capped albatross	V	Yes	Yes	-	-	
Thalassarche sp. Nov.	Pacific albatross	V	-	Yes	-	-	
Petrels							
Fregetta grallaria grallaria	White-bellied storm-petrel	V	-	-	-	-	-
Halobaena caerulea	Blue petrel	V	-	Yes	-	-	CA
Macronectes giganteus	Southern giant petrel	E	Yes	Yes	-	-	Generic RP and AS for giant petrels
Macronectes halli	Northern giant petrel	V	Yes	Yes	-	-	
Pterodroma leucoptera leucoptera	Gould's petrel	E	-	-	-	-	RP
Pelagodroma marina	White-faced storm-petrel	-	-	Yes	Yes	FFR	-
Pelecanoides urinatrix	Common diving petrel	-	-	Yes	Yes	FFR	-

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Pterodroma mollis	Soft-plumaged petrel	V	-	Yes	-	FFR	CA
Other seabirds							
Ardenna carneipes	Flesh-footed shearwater	-	Yes	Yes	-	-	-
Ardenna grisea	Sooty Shearwater	-	Yes	Yes	-	-	-
Ardenna tenuirostris	Short-tailed shearwater	-	Yes	Yes	Yes	FFR	-
Catharacta skua	Great skua	-	-	Yes	-	-	-
Haliaeetus leucogaster	White-bellied sea-eagle	-	-	Yes	Yes	-	-
Morus serrator	Australasian gannet	-	-	Yes	Yes	FFR	-
Pachyptila turtur subantarctica	Fairy prion (southern)	V	-	-	-	-	CA
Pandion haliaetus	Osprey	-	Yes	Yes	Yes	-	-
True shorebirds (53 species)							
Actitis hypoleucos	Common sandpiper	-	Yes	Yes	-	-	-
Apus pacificus	Fork-tailed swift	-	Yes	Yes	Yes	-	-
Ardea alba	Great egret	-	-	Yes	Yes	-	-
Ardea ibis	Cattle egret	-	-	Yes	Yes	-	-
Arenaria interpres	Ruddy turnstone	-	Yes	Yes	Yes	-	-
Botaurus poiciloptilus	Australasian bittern	E	-	-	Yes	-	CA
Calidris acuminata	Sharp-tailed sandpiper	-	Yes	Yes	-	R	-
Calidris alba	Sanderling	-	Yes	Yes	Yes	R	-
Calidris canutus	Red knot	E	Yes	Yes	-	-	CA
Calidris ferruginea	Curlew sandpiper	CE	Yes	Yes	-	-	CA
Calidris melanotos	Pectoral sandpiper	-	Yes	Yes	-	-	-
Calidris ruficollis	Red-necked stint	-	Yes	Yes	Yes	-	-

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Calidris tenuirostris	Great knot	CE	Yes	Yes	Yes	R	CA
Charadrius bicinctus	Double-banded plover	-	-	Yes	Yes	R	-
Charadrius leschenaultii	Greater sand plover	V	Yes	Yes	Yes	-	CA
Charadrius mongolus	Lesser sand plover	E	Yes	Yes	Yes	-	CA
Charadrius ruficapillus	Red-capped plover	-	-	Yes	Yes	-	-
Eudyptula minor	Little penguin	-	-	Yes	Yes	B, F	-
Himantopus himantopus	Pied stilt	-	-	Yes	Yes	-	-
Hydroprogne caspia	Caspian tern	-	Yes	Yes	Yes	-	-
Gallinago hardwickii	Latham's snipe	-	Yes	Yes	Yes	-	-
Gallinago megala	Swinhoe's snipe	-	Yes	Yes	Yes	-	-
Gallinago stenura	Pin-tailed snipe	-	Yes	Yes	Yes	-	-
Larus dominicanus	Kelp gull	-	-	Yes	Yes	-	-
Larus novaehollandiae	Silver gull	-	-	Yes	Yes	-	-
Larus pacificus	Pacific gull	-	-	Yes	Yes	-	-
Lathamus discolour	Swift parrot	CE	-	Yes	Yes	-	CA
Limnodromus semipalmatus	Asian Dowitcher	-	Yes	Yes	Yes	-	-
Limosa lapponica baueri	Bar-tailed godwit	V	Yes	Yes	Yes	-	-
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	CE	Yes	Yes	Yes	-	CA
Limosa limosa	Black-tailed godwit	-	Yes	Yes	Yes	-	-
Neophema chrysogaster	Orange-bellied parrot	CE	-	Yes	-	-	RP
Numenius madagascariensis	Eastern curlew	CE	Yes	Yes	-	-	CA

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Numenius minutus	Little curlew	-	Yes	Yes	Yes	-	-
Numenius phaeopus	Whimbrel	-	Yes	Yes	Yes	-	-
Phalacrocorax fuscescens	Black-faced cormorant	-	-	Yes	Yes	-	-
Philomachus pugnax	Ruff (reeve)	-	Yes	Yes	Yes	-	-
Pluvialis fulva	Pacific golden plover	-	Yes	Yes	Yes	-	-
Pluvialis squatarola	Grey plover	-	Yes	Yes	Yes	-	-
Recurvirostra novaehollandiae	Red-necked avocet	-	-	Yes	Yes	-	-
Rostratula australis	Australian painted snipe	E	-	Yes	Yes	-	CA
Sterna (Sternula) albifrons	Little tern	-	Yes	Yes	Yes	-	-
Sterna fuscata	Sooty tern	-	-	Yes	Yes	-	-
Sterna (Sternula) nereis nereis	Australian fairy tern	V	-	-	-	-	CA
Sterna striata	White-fronted tern	-	-	Yes	Yes	FFR	-
Thalasseus bergii	Crested tern	-	Yes	Yes	Yes	-	-
Thinornis rubricollis rubricollis	Hooded plover (eastern)	V	-	Yes	Yes	-	CA
Tringa brevipes	Grey-tailed tattler	-	Yes	Yes	Yes	R	-
Tringa glareola	Wood sandpiper	-	Yes	Yes	Yes	-	-
Tringa nebularia	Common greenshank	-	Yes	Yes	Yes	-	-
Tringa stagnatilis	Marsh sandpiper	-	Yes	Yes	Yes	-	-
Xenus cinereus	Terek sandpiper	-	Yes	Yes	Yes	-	-
ALA							
No additional species identified.							
VBA							
No additional species identified.							

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.

Key		
EPBC Act status (@ December 2020)	CD	Conservation Dependent
	V	Vulnerable
	E	Endangered
	CE	Critically endangered
BIA (Biologically Important Area)	A	Aggregation
	B	Breeding
	D	Distribution (i.e., presence only)
	F	Foraging
	FFR	Foraging, feeding or related behaviour
	M	Migration
	R	Roosting
Recovery plans	AS	Action Statement
	CA	Conservation Advice
	CMP	Conservation Management Plan
	RP	Recovery Plan

Figure 5.8. The annual presence and absence of seabirds and shorebirds in the survey area and spill EMBA.

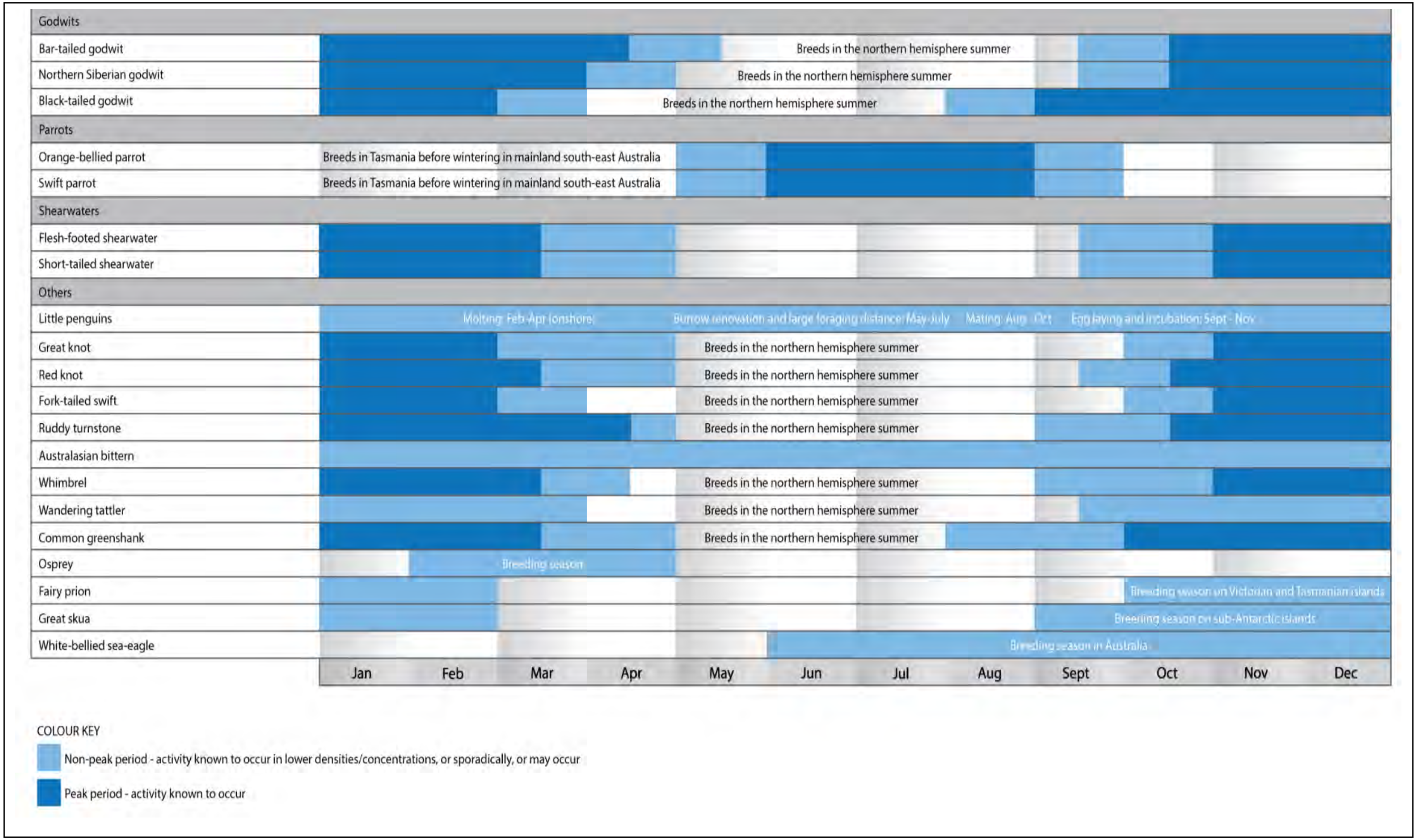


Figure 5.8 (cont'd). The annual presence and absence of seabirds and shorebirds in the survey area and spill EMBA.

Seabirds

Albatross and Petrels

The majority of the EPBC Act listed seabird species are albatrosses and petrels that are considered to be the most dispersive and oceanic of all birds, spending more than 95% of their time foraging the Southern Ocean in search of prey and usually only returning to land to breed (DSEWPC, 2011a). Albatrosses prefer small, remote islands in the Southern Ocean (DSEWPC, 2011a) for breeding. Albatross Island is the closest breeding habitat to the survey area located (approximately 41 km to the southwest) and is located within the EMBA. Other albatross and petrel breeding islands located within Australian jurisdiction include Mewstone, Pedra Branca and Macquarie Island, all of which are outside the EMBA. The petrel species listed in Table 5.4 are widely distributed throughout the southern hemisphere. They nest on isolated islands and breed on sub-Antarctic and Antarctic islands. The northern giant-petrel and southern giant-petrel share some of the same breeding areas listed for the albatross (DSEWPC, 2011a). Outside the breeding season (October to February), petrels disperse widely and move north into sub-tropical waters (DSEWPC, 2011a). Most petrel species feed on krill, squid, fish, other small seabirds and marine mammals (DSEWPC, 2011a). Albatorss and petrels are threatened by incidental catch resulting from human fishing operations.

Great skua

A comparison of presence and absence for the great skua between the database searches for the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	Yes	No
EMBA	Yes	Yes	Yes

The great skua (*Catharacta skua*) is a large migratory seabird distributed throughout all southern Australian waters (though not listed as migratory under the EPBC Act). This species breeds in summer on nested elevated grasslands or sheltered rocky areas on sub-Antarctic islands, with most adult birds leaving their colonies in winter. Great skuas feed on other seabirds, fish, molluscs and crustaceans, and is likely to be present in the survey area and EMBA (though scarce) during winter (Flegg, 2002).

Osprey

A comparison of presence and absence for the osprey between the database searches for the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	No

The osprey (*Pandion haliaetus*) is a common, medium-sized raptor that is present around the entire Australian coastline, with the breeding range restricted to the north coast of Australia (including many offshore islands) and an isolated breeding population in South Australia (DAWE, 2020b). Breeding occurs from February to April. Ospreys occur mostly in coastal areas but occasionally travel inland along waterways, where they feed on fish, molluscs, crustaceans, reptiles, birds and mammals. They are mostly resident or sedentary around breeding territories, and forage more widely and make intermittent visits to their breeding grounds in the non-breeding season (Birdlife Australia, 2020). Due to their broad habitat, osprey may be present in the EMBA.

Southern fairy prion

A comparison of presence and absence for the southern fairy prion between the database searches for the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	Yes	No
EMBA	Yes	Yes	Yes

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 (TSSC, 2015a). In Australia, it is known to breed only on Macquarie Island (1,915 km southeast of the survey area), and on the nearby Bishop and Clerk islands (TSSC, 2015a).

White-bellied sea eagle

A comparison of presence and absence for the white-bellied sea eagle between the database searches for the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	No	Yes

The white-bellied sea eagle (*Haliaeetus leucogaster*) is distributed along the coastline in coastal lowlands with breeding from Queensland to Victoria in coastal habitats and terrestrial wetlands in temperate regions (DAWE, 2020b). The breeding season is from June to January with nests built in tall trees, bushes, cliffs or rock outcrops. Breeding pairs are generally widely dispersed. The species forages over open water (coastal and terrestrial) and feeds on fish, birds, reptiles, mammals and crustaceans and normally launches into a glide to snatch its prey, usually with one foot, from the ground or water surface (Birdlife Australia, 2020). The species is widespread and makes long-distance movements. This species may be present along the coastlines adjacent to the EMBA.

Shearwaters

A comparison of shearwater presence and absence between the database searches for the survey area and EMBA is presented over page.

Shearwaters are medium-sized long-winged seabirds most common in temperate and cold waters. They come to islands and coastal cliffs to breed, nesting in burrows and laying a single white egg. Shearwaters feed on small fish, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp), and other soft-bodied invertebrates and offal. These species forage almost entirely at sea and very rarely on land (TSSC, 2014).

Three of the EPBC Act-listed species recorded in the EMBA by the PMST database (sooty, flesh-footed and short-tailed) are trans-equatorial migrants that cross the Pacific Ocean for the northern hemisphere summer (TSSC, 2014). It is possible these species may overfly the EMBA. Of the three species, the short-tailed is most likely to be encountered in the spill EMBA due to the proximity of breeding locations among the Furneaux Group (Flinders Island, etc).

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Sooty shearwater	Yes	Yes	Yes	Yes	No	Yes
Flesh-footed shearwater	Yes	Yes	No	Yes	No	Yes
Short-tailed shearwater	No	Yes	Yes	Yes	No	Yes
Buller's shearwater	No	No	No	Yes	No	Yes
Wedge-tailed shearwater	No	No	No	Yes	No	Yes
Streaked shearwater	No	No	No	Yes	No	Yes
Little shearwater	No	No	No	Yes	No	Yes
Fluttering shearwater	No	No	Yes	Yes	No	Yes
Hutton's shearwater	No	No	No	Yes	No	Yes

Shorebirds

Plovers

A comparison of plover presence and absence between the database searches for the survey area and EMBA is presented below.

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Double-banded plover	No	Yes	No	Yes	No	Yes
Greater sand plover	No	Yes	No	Yes	No	Yes
Lesser sand plover	No	Yes	No	Yes	No	Yes
Red-capped plover	No	Yes	No	Yes	No	Yes
Pacific golden plover	No	Yes	No	Yes	No	Yes
Grey plover	No	Yes	No	Yes	No	Yes
Hooded plover	No	Yes	No	Yes	No	Yes
Oriental plover	No	No	No	Yes	No	No
Ringed plover	No	No	No	Yes	No	No

The seven plovers that may occur within the spill EMBA (double-banded, greater sand, lesser sand, red-capped, Pacific golden, grey and hooded) are medium- to large-sized migratory 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 present in Australia during the warmer months, depending on the species and its migration pathway. The hooded plover (*Thinornis rubricollis rubricollis*) and red-capped plover (*Charadrius ruficapillus*) breed in Australia, building their 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 (DoE, 2014a; Birdlife Australia, 2020). The extensive sandy beaches of Ninety Mile Beach are recognised habitat for the hooded plovers.

Terns

A comparison of tern presence and absence between the database searches for the survey area and EMBA is presented below.

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Little tern	No	Yes	No	Yes	No	No
Sooty tern	No	Yes	No	Yes	No	No
Australian fairy tern	Yes	Yes	No	Yes	No	No
White-fronted tern	No	Yes	No	Yes	No	No
Crested tern	No	Yes	No	Yes	No	No
Caspian tern	No	Yes	No	Yes	No	No
Common tern	No	No	No	Yes	No	Yes
Arctic tern	No	No	No	Yes	No	Yes

There are eight tern species that may occur within the spill EMBA (Caspian, fairy, little, sooty, white-fronted, crested, common and arctic). Many of the tern species present along the southern Australian coastline are widespread and occupy beach, wetland, grassland and coastal habitats. Terns rarely swim; they hunt for prey in flight, dipping to the water surface or plunge-diving for prey usually small baitfish in coastal waters and typically close to land (DSEWPC, 2011b).

The NCVA (DAWE, 2020c) indicates that the foraging BIA for the fairy tern (*Sterna nereis nereis*) (listed as vulnerable under the EPBC Act) occur in and offshore of the gulfs of South Australia (outside the EMBA). They are also known to breed on the offshore islands and coast of Spencer Gulf (outside the EMBA) (Edyvane, 1999). Flegg (2002) reports that the species is widespread on southern and western Australian coasts, and breeds on coastal beaches and islands.

There are two distinct populations of little tern (*S. albifrons*) in Australia, with the south-eastern population being that which occurs within the EMBA. The little tern (listed as migratory and marine under the EPBC Act) has an estimated population of 3,000 breeding pairs in eastern Australia (DAWE, 2020b). It is a migratory species that breeds in eastern Australia during spring and summer, leaving the colonies in late summer-autumn and vacating southern Australia (Birdlife Australia, 2020). In eastern Australia, breeding normally occurs within wetland areas. Little terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths, lakes and exposed ocean beaches (Birdlife Australia, 2020). Habitat for this species occurs at the Gippsland Lakes, Corner Inlet and Western Port Bay. Little terns feed on small fish, crustaceans, insects and molluscs by plunging in shallow water or gleaning from the water surface. The little tern may occur within the EMBA.

The crested tern (*Thalasseus bergii*) is widely distributed around the coast of Australia and breeds on offshore islands in nests densely packed together. The crested tern lives along the coast of ocean beaches and in coastal lagoons. The species rarely flies far from shore out to sea or inland. It flies above the water in search of prey on the surface before plunging down to take small fish from the surface (Birdlife Australia, 2020). Due to its known distribution in Bass Strait, it is likely that the crested tern will be present in the spill EMBA.

Knots

A comparison of knot presence and absence between the database searches for the survey area and EMBA is presented below.

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Red knot	No	Yes	No	Yes	No	Yes
Great knot	Yes	Yes	No	Yes	No	Yes

The red knot and great knot are the only two species of knot that may occur within the spill EMBA. These species have a coastal distribution around the entire Australian coastline when they are present during the southern hemisphere summer (breeding in eastern Siberia in the northern hemisphere summer). Knots are a medium-sized wader that prefer sandy beach, tidal mudflats and estuary habitats, where they feed on bivalve molluscs, snails, worms and crustaceans (Birdlife Australia, 2020). Lake Reeve has supported the largest concentration (5,000) of red knot (*Calidris canutus*) recorded in Victoria. Knots are likely to be present on the shorelines of the EMBA.

Godwits

A comparison of godwit presence and absence between the database searches for the survey area and EMBA is presented below.

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Bar-tailed godwit	No	Yes	No	Yes	No	Yes
Northern Siberian bar-tailed godwit	No	Yes	No	No	No	No
Black-tailed godwit	No	Yes	No	Yes	No	Yes

There are three EPBC Act-listed godwit species that may occur within the EMBA (bar-tailed, Northern Siberian and black-tailed). 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. Godwits 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 (Birdlife Australia, 2020). They have been recorded eating annelids, crustaceans, arachnids, fish eggs and spawn and tadpoles of frogs, and occasionally seeds. The Nooramunga Marine and Coastal Park (intersected by the EMBA 127 km to the northeast of the survey area) has recorded the largest concentrations of bar-tailed godwit (*Limosa lapponica*) in south-eastern Australia. Most Australian sightings of northern Siberian bar-tailed godwits are in northwest Australia with no known sightings in the EMBA (TSSC, 2016a). Godwits may be present along shorelines of the spill EMBA.

Sandpipers

A comparison of sandpiper presence and absence between the database searches for the survey area and EMBA is presented over page.

There are seven sandpiper species (common, sharp-tailed, curlew, pectoral, wood, marsh, terek, broad-billed) that may occur within the survey area and the EMBA. They breed in Europe and Asia and migrate to Australia during the southern summer. Sandpipers are small wader species found in coastal and inland wetlands, particularly in muddy estuaries, feeding on small marine invertebrates (Birdlife Australia, 2020; DoE, 2015b). Up to 3,000 sharp-tailed sandpiper and up to 1,800 curlew sandpiper are known to congregate to feed at the Gippsland Lakes. Sandpipers may be present along shorelines of the spill EMBA depending on the time of year.

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Common sandpiper	Yes	Yes	No	Yes	No	Yes
Sharp-tailed sandpiper	Yes	Yes	No	Yes	No	Yes
Curlew sandpiper	Yes	Yes	No	Yes	No	Yes
Pectoral sandpiper	Yes	Yes	No	No	No	Yes
Terek sandpiper	No	Yes	No	Yes	No	Yes
Marsh sandpiper	No	Yes	No	Yes	No	Yes
Wood sandpiper	No	Yes	No	Yes	No	Yes
Broad-billed sandpiper	No	No	No	Yes	No	Yes

Snipes

A comparison of snipe presence and absence between the database searches for the survey area and EMBA is presented below.

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Latham's snipe	No	Yes	No	Yes	No	Yes
Swinhoe's snipe	No	Yes	No	No	No	No
Pin-tailed snipe	No	Yes	No	No	No	No
Australian painted snipe	No	Yes	No	Yes	No	Yes

There are four snipe species that may occur within the EMBA (Latham's, Swinhoe's, pin-tailed and Australian painted). These snipe species (other than the Australian painted snipe, which is endemic to Australia) are present during the southern hemisphere summer with breeding in Asia and Russia in the northern hemisphere summer). They are medium-sized waders that roost among dense vegetation around the edge of wetlands during the day and feed at dusk, dawn and during the night on seeds, plants, worms, insects and molluscs. There are few if no confirmed records of the pin-tailed and Swinhoe's snipe in Victoria (Birdlife Australia, 2020), while the Australian painted snipe is known to occur at Mallacoota Inlet (outside the EMBA, 430 km to the northeast of the survey area) (DSEWPC 2013a). Snipes may be present along shorelines of the spill EMBA depending on the time of year.

Swift parrot

A comparison of presence and absence for the swift parrot between the database searches of the survey area and EMBA is presented over page.

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 north-west 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, 2016b). Given its habitat preferences, this species is unlikely to land within the spill EMBA though is likely to overfly on its migration to mainland Australia.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	Yes

Orange-bellied parrot

A comparison of presence and absence for the orange-bellied parrot between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

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 (DEWLP, 2016). The species forage on the ground or in low vegetation (Brown and Wilson, 1980; DEWLP, 2016, 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*).

Most known breeding activity occurs within 10 km of Melaleuca Lagoon, outside of the spill EMBA, which is 359 km south of the survey area. Key non-breeding habitat is known to occur around Corner Inlet in Victoria 120 km northeast of the survey area, the entry to the inlet is intersected by the EMBA. King Island is known as a key location in the migration route between breeding and non-breeding sites, principally within the Lavinia State Reserve, which is located 74 km west from the survey area and is within the EMBA (DELWP, 2016).

Curlews

A comparison of presence and absence of curlew between the database searches of the survey area and EMBA is presented below.

Species	**PMST**		**ALA**		**VBA**	
	Survey area	**EMBA**	**Survey area**	**EMBA**	**Survey area**	**EMBA**
Little curlew	No	Yes	No	Yes	No	Yes
Eastern curlew	Yes	Yes	No	Yes	No	Yes

The two curlew species (eastern and little) recorded in the EMBA are medium-sized migratory birds that breed in the far north of Siberia and winters in Australasia. The eastern curlew (*Numenius madagascariensis*) is the world's largest shorebird and is widespread in coastal regions in the north-east and south of Australia, including Tasmania. It is commonly found on intertidal mudflats and sandflats where it uses its long beak to pick the surface and probes for crabs. Curlews are also found on sheltered coasts, especially estuaries, mangrove swamps, bays, harbours and lagoons (DoE, 2015c).

The eastern curlew was amended from endangered to critically endangered in 2015 because research shows population decline potentially caused by wetland reclamation in some areas of Asia. In Victoria, the main strongholds are in Corner Inlet (120 km northeast from the survey area) and Western Port Bay (outside the EMBA and 125 km from the survey area), with smaller populations in Port Phillip Bay and scattered elsewhere along the coast. Eastern curlews are found on islands in Bass Strait and along the northwest, northeast, east and southeast coasts of Tasmania. Historically, sightings have been recorded in Bass Strait and depending on the time of year curlews may be present in the coasts of the spill EMBA (DoE, 2015c).

The little curlew breeds in Siberia and is seen on passage through Mongolia, China, Japan, Indonesia and New Guinea. In Australia, the little curlew is a bird of coastal and inland plains of the north where it often occurs around wetlands and flooded ground. They often form large flocks, occasionally comprising thousands of birds and sometimes associate with other insectivorous migratory shorebirds. Given the little curlew is present in Queensland and the Northern Territory but not in Victoria, it is unlikely to be encountered in the survey area or the spill EMBA (Birdlife Australia, 2020).

Australasian bittern

A comparison of presence and absence for the Australasian bittern between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	Yes

The Australasian bittern (*Botaurus poiciloptilus*) was recorded in the EMBA by the PMST. The Australasian bittern is a large, stocky, heron-like bird that occurs from southeast Queensland to southern South Australia. In Victoria, the species is mainly found in coastal areas and the Murry River region of central Victoria (TSSC, 2019). The Australasian bittern occurs mainly in freshwater wetlands and, rarely, in estuaries or tidal wetlands (TSSC, 2019). The species is threatened by the clearing and modification of wetlands for urban and agricultural development, as well as the extraction of water from wetlands for irrigation (TSSC, 2019). The Australasian bittern may be present in the coastal areas of the EMBA though it is unlikely.

Little penguin

A comparison of presence and absence for the little penguin between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	Yes	No
EMBA	Yes	Yes	Yes

There is a little penguin BIA (breeding and foraging) that is intersected by the spill EMBA, which is displayed in Figure 5.9. 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 5.5 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). 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 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. One of Australia's largest little penguin colonies of approximately 26,000 breeding individuals exist on the Summerland Peninsula, Phillip Island (outside the spill EMBA). There are also smaller colonies on rocky islands off Wilsons Promontory, Flinders Island and King Island (Arnould and Berlincourt, 2013).

Table 5.5. 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

Egrets

A comparison of presence and absence for egrets between the database searches of the survey area and EMBA is presented below.

Species	PMST		ALA		VBA	
	Survey area	EMBA	Survey area	EMBA	Survey area	EMBA
Little egret	No	No	No	Yes	No	Yes
Plumed egret	No	No	No	No	No	Yes
Eastern reef egret	No	No	No	Yes	No	Yes
Intermediate egret	No	No	No	Yes	No	No
Great egret	No	Yes	No	Yes	No	Yes
Cattle egret	No	Yes	No	Yes	No	Yes

Six species of egret (little, plumed, eastern reef, intermediate, great and cattle) are recorded in the database search results for the EMBA. Egrets can be found around the world and inhabit both freshwater and saltwater marshes. The plumed egret (*Ardea intermedia plumifera*) is primarily found in freshwater swamps, billabongs, floodplains and wet grasslands and as such is unlikely to be present in the EMBA. The little egret (*Egretta garzetta*) (listed as threatened under the FFG Act) frequents tidal mudflats, saltwater and freshwater wetlands, and mangroves. Little egrets feed on a wide variety of invertebrates, as well as fish and amphibians. Due to its preference for coastal and saltwater habitats, the little egret is likely to be encountered in the EMBA.

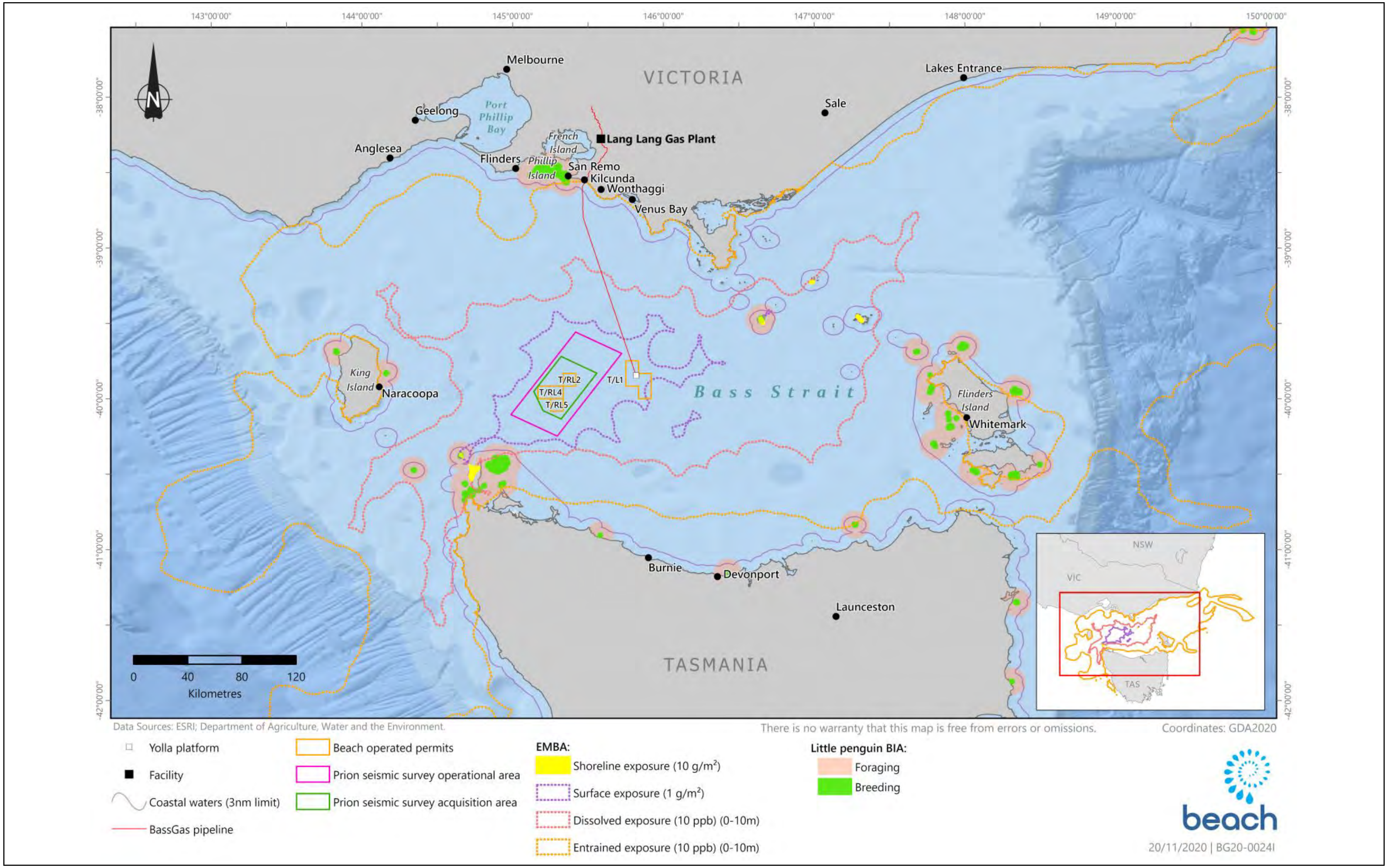


Figure 5.9. Little penguin breeding and foraging BIA

5.4.5 Cetaceans

The PMST identified 24 whale species and eight dolphin species that may reside within or migrate through the spill EMBA. These species are listed in Table 5.6. Of these, 16 whale and two dolphin species were recorded in the PMST search for the EMBA only and were not recorded in the search for the survey area. A description of species listed in Table 5.6 is focused on threatened species.

A search of the VBA and ALA databases for the survey area did not identify any cetacean species. All species captured in the VBA and ALA databases search for the EMBA were noted in the PMST results for the EMBA presented in Table 5.6.

Figure 5.10 illustrates the presence and absence of the threatened cetacean species in the EMBA throughout the year.

Table 5.6. Cetaceans that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
PMST							
Whales							
Balaenoptera acutorostrata	Minke whale	-	-	Yes	-	-	-
Balaenoptera borealis	Sei whale	V	Yes	Yes	-	-	CA
Balaenoptera bonaerensis	Antarctic Minke Whale	-	Yes	Yes	Yes	-	-
Balaenoptera edeni	Bryde's Whale	-	Yes	Yes	Yes	-	-
Balaenoptera musculus	Blue whale	E	Yes	Yes	-	F, D	RP
Balaenoptera physalus	Fin whale	V	Yes	Yes	-	-	CA
Erardius arnuxii	Arnoux's beaked whale	-	-	Yes	Yes	-	-
Caperea marginata	Pygmy right whale	-	Yes	Yes	-	-	-
Eubalaena australis	Southern right whale	E	Yes	Yes	-	M	CMP
Globicephala macrorhynchus	Short-finned pilot whale	-	-	Yes	-	-	-
Globicephala melas	Long-finned pilot whale	-	-	Yes	Yes	-	-
Hyperoodon planifrons	Southern bottlenose whale				Yes		

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Kogia breviceps	Pygmy sperm whale	-	-	Yes	Yes	-	-
Kogia simus	Dwarf sperm whale	-	-	Yes	Yes	-	-
Megaptera novaeangliae	Humpback whale	V	Yes	Yes	-	-	CA
Mesoplodon bowdoini	Andrew's beaked whale	-	-	Yes	Yes	-	-
Mesoplodon densirostris	Blainville's beaked whale	-	-	Yes	Yes	-	-
Mesoplodon grayi	Gray's beaked whale	-	-	Yes	Yes	-	-
Mesoplodon hectori	Hector's beaked whale	-	-	Yes	Yes	-	-
Mesoplodon layardii	Strap-toothed beaked whale	-	-	Yes	Yes	-	-
Mesoplodon mirus	True's beaked whale	-	-	Yes	Yes	-	-
Physeter macrocephalus	Sperm whale	-	Yes	Yes	Yes	-	-
Tasmacetus shepherdi	Shepherd's beaked whale	-	-	Yes	Yes	-	-
Ziphius cavirostris	Cuvier's beaked whale	-	-	Yes	Yes	-	-
Dolphins							
Delphinus delphis	Common dolphin	-	-	Yes	-	-	-
Grampus griseus	Risso's dolphin	-	-	Yes	-	-	-
Lagenorhynchus obscurus	Dusky dolphin	-	Yes	Yes	-	-	-
Lissodelphis peronii	Southern right whale dolphin	-	-	Yes	Yes	-	-
Orcinus orca	Killer whale	-	Yes	Yes	-	-	-

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Pseudorca crassidens	False killer whale	-	-	Yes	-	-	-
Tursiops aduncus	Indian bottlenose dolphin	-	-	Yes	Yes	-	-
Tursiops truncates s. str.	Bottlenose dolphin	-	-	Yes	-	-	-
ALA							
No additional species identified.							
VBA							
No additional species identified.							

Definitions and key as per Table 5.4.

Sei Whale

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

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	No

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 (Horwood 2009 in TSSC, 2015b).

Sei whale global population is estimated to have declined by 80% over the previous three generation period (TSSC, 2015b). Sei whales were the most commonly observed whales during Australian National Antarctic Research Expedition voyages in the 1960s and 1970s, with the majority recorded south of 60°S in the Southern Ocean (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.

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).

Sightings of sei whales within Australian waters includes areas such as the Bonney Upwelling off South Australia (outside the EMBA), where opportunistic feeding has been observed between November and May (TSSC, 2015b).

Based upon the species preference for offshore waters, the absence of a BIA for the species in Australia and the small number of sei whale sightings in southeast Australia, it is considered unlikely that this species occurs within the EMBA.

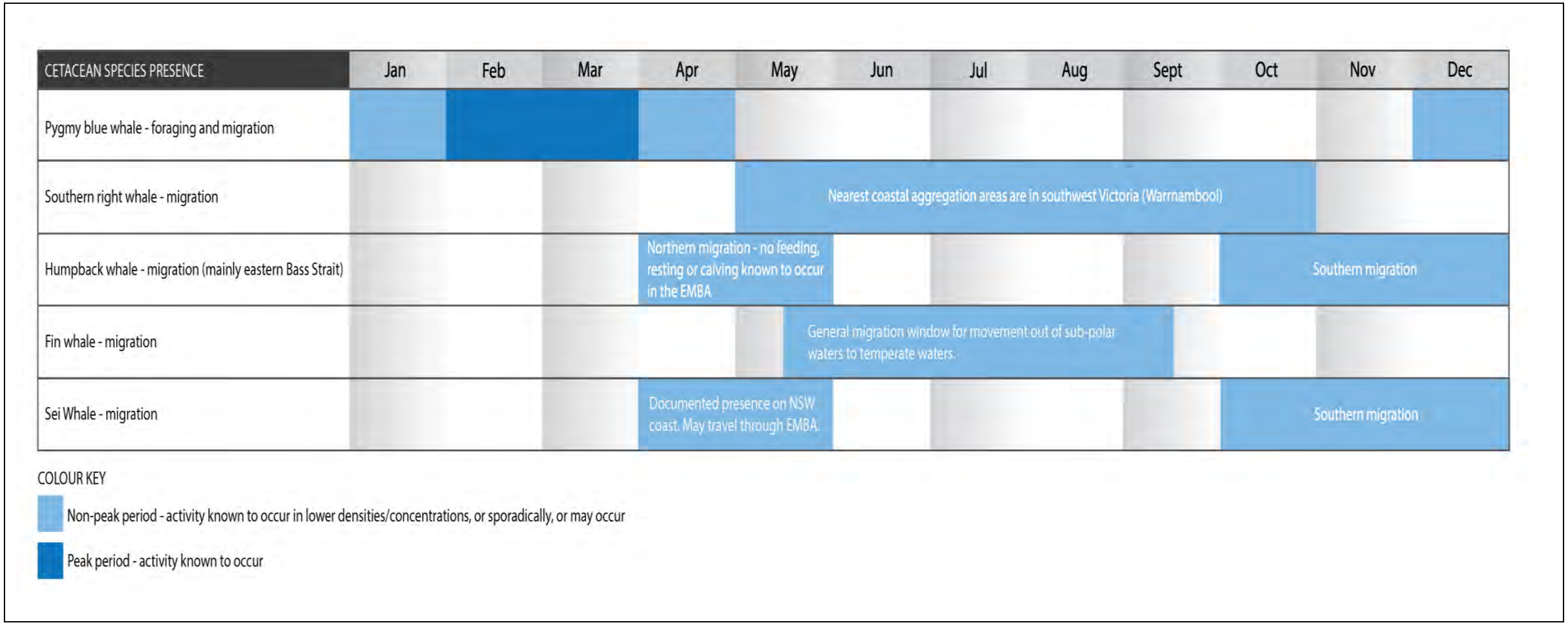


Figure 5.10. The annual presence and absence of threatened cetacean species in the survey area and spill EMBA

Blue Whale

A comparison of presence and absence for the blue whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

Blue whales (*Balaenoptera musculus)* are the largest living animals on earth, growing to a length of over 30 m, weighing up to 180 tonnes and living to 90 years (DoE. 2015d). The DoE (2015d) recognises three overlapping populations:

- Antarctic blue whale population (*B. musculus intermedia*) are those blue whales occupying or passing through Australian waters that feed on krill predominantly if not exclusively in Antarctic waters.
- Indo-Australian pygmy blue whales (PBW) (*B. musculus brevicauda*) are those PBW occupying or passing through waters from Indonesia to western and southern Australia and are not generally found in Antarctic waters, and appear to feed in more temperate waters.
- Tasman-Pacific PBW (*B. musculus brevicauda*) are those PBW generally considered to be occupying or passing through waters in southeast Australia and the Pacific Ocean and are not generally found in Antarctic waters, and appear to feed in more temperate waters.

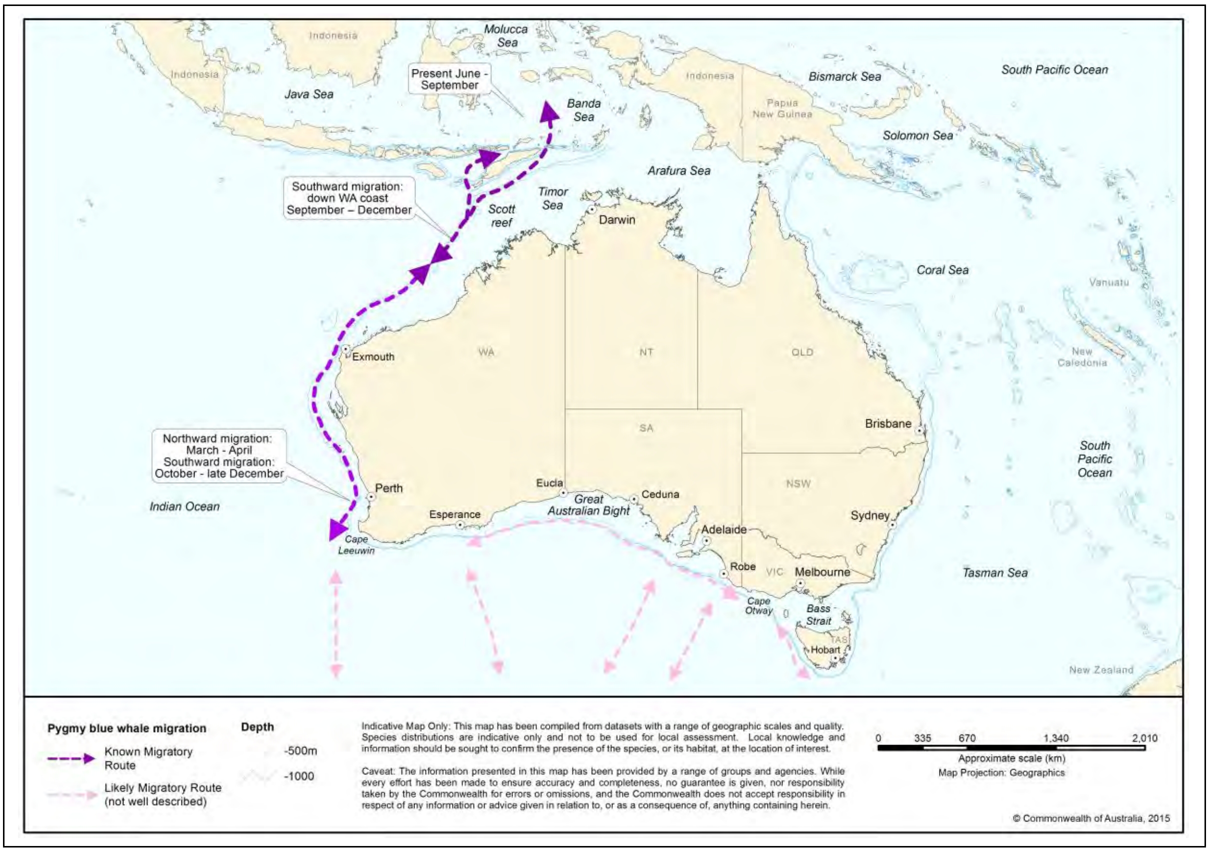
The Antarctic sub-species has been acoustically detected off the west and north coasts of Tasmania predominately from May to December. Based on the seasonality of recordings, these areas possibly form part of their migratory route, breeding habitat or a combination of the two (DoE, 2015d).

Indo-Australian PBW inhabit Australian waters as far north as Scott Reef, the Kimberley region and west of the Pilbara and as far south as southwest Australia across to the Great Australian Bight and the Bonney Upwelling, and to waters as far east off Tasmania (Figure 5.11). They have known feeding grounds in the Perth Canyon off Western Australia and the Bonney Upwelling System and adjacent waters off Victoria, South Australia, and Tasmania. These areas are utilised from November to May. They migrate between these feeding aggregation areas, northwards and southwards along the west coast of Australia, to breeding grounds that are likely to include Indonesia.

The Tasman-Pacific PBW is the sub-species that migrates through Bass Strait, found in waters north of 55°S (DoE, 2015d). Blue whales are a highly mobile species that feed on krill (euphausids, *Nyctiphane australis*). A BIA for ‘possible foraging area’ for the PBW intersects the survey area, with known and annual high use foraging areas (abundant food source) occurring off the southwest Victorian coast and intersected by the spill EMBA but not the survey area (Figure 5.12).

The time and location of the appearance of blue whales in the South-east Marine Region generally coincides with the upwelling of cold water in summer and autumn along the southeast South Australian and southwest Victoria coast (the Bonney Upwelling) and the associated aggregations of krill that they feed on (DoE, 2015d; Gill and Morrice, 2003; Gill, 2020). This is a key feeding area for the species and the earliest reported sighting of a blue whale in the Otway Shelf is from October 2014 (Gill, 2020). The Bonney Upwelling generally starts in the eastern part of the Great Australian Bight in November or December and spreads eastwards to the Otway Basin around February as southward migration of the sub-tropical high-pressure cell creates favourable winds for upwelling. PBW predominately occupy the western area of the Bonney Upwelling from November to December, and then move southeast during January to April, though the within-season distribution trends on the Otway Shelf and in Bass Strait are unknown (Gill, 2020; DoE, 2015d).

Blue whales appear to occur in very low densities in Bass Strait during most seasons compared to the Otway Shelf further west. Data recorded from an acoustic logger located approximately 80 km east of the survey area in 2015-16 estimated densities of PBW around the site to be 7-73 times less than around an acoustic logger located south of Cape Bridgewater on the Otway Shelf (McCauley *et al*, 2018). In 2004, an acoustic logger located in approximately the same area of Bass Strait estimated PBW densities between 8-33 times greater than recorded in 2015-16. This was a season of strong upwelling and high chlorophyll-*a* production late in the upwelling season in 2004. Gill (2020) posits that krill-enriched water from the upwelling system was forced into Bass Strait by westerly winds and currents and was followed by foraging blue whales tracking the food source. Throughout time, upwelling strength is variable and mass krill production in central Bass Strait is uncommon (Gill, 2020). As such, the majority of PBW foraging activity in the region is recorded on the Otway Shelf and the broader upwelling system that extends to southeast South Australia.



Source: DoE (2015d).

Figure 5.11. PBW migration routes

The DoE (2015d) states that migratory routes for PBW off the east coast of Australia are unknown (as seen by the absence of migratory routes in Figure 5.11). However, blue whale migration patterns are thought to be similar to those of the humpback whale, with the species feeding in mid-to high-latitudes (south of Australia) during the summer months and moving to temperate/tropical waters in the winter for breeding and calving. PBW migration is oceanic and no specific migration routes have been identified in the Australasian region (DoE, 2015d).

The Tasman-Pacific PBW, which only occupies waters north of 55°S, potentially migrates through Bass Strait although there is little information about this (DoE, 2015d). The DoE (2015d) states that migratory routes for PBW off the east coast of Australia are unknown (as seen by the absence of migratory routes in Figure 5.11).

During construction of the Yolla-A platform (14 km east of the survey area), a sea noise logger was deployed from April to October 2004. The presence of several whale species was evident in the recordings although the proximity of the whales could not be determined; blue whales were mainly evident in winter and in late autumn PBW passed through Bass Strait. There was no obvious evidence of humpback whales, other whale species or fish choruses (McCauley, 2005).

Fin Whale

A comparison of presence and absence for the fin whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	No

The fin whale (*B. physalus)* is the second largest whale species after the blue whale, growing up to 27 m long and weighing up to 70 tonnes (TSSC, 2015c). Fin whales are considered a cosmopolitan species and occur from polar to tropical waters, and rarely in inshore waters. The full extent of their distribution in Australian waters is uncertain but they occur within Commonwealth waters and have been recorded in most state waters and from Australian Antarctic Territory waters (TSSC, 2015c).

Fin whales are generally thought to undertake long annual migrations from higher latitude summer feeding grounds to lower latitude winter breeding grounds (TSSC, 2015c). It is likely they migrate between Australian waters and Antarctic feeding areas (the Southern Ocean), sub-Antarctic feeding areas (the Southern Subtropical Front) and tropical breeding areas (Indonesia, the northern Indian Ocean and south-west South Pacific Ocean waters) (TSSC, 2015c).

Fin whales have been sighted inshore in the proximity of the Bonney Upwelling along the continental shelf in summer and autumn months (TSSC, 2015c). The sighting of a cow and calf in the Bonney Upwelling in April 2000 and the stranding of two fin whale calves in South Australia suggest that this area may be important to the species' reproduction, perhaps as a provisioning area for cows with calves (TSSD, 2015c). However, there are no defined mating or calving areas in Australia waters.

The conservation advice (TSSC, 2015c) identifies vessel strike and anthropogenic noise as threats to the species. Based on the fin whale preference for offshore waters, the absence of a BIA in Australian waters and the minimal sightings in Bass Strait, it is considered unlikely that this species occurs within the spill EMBA.

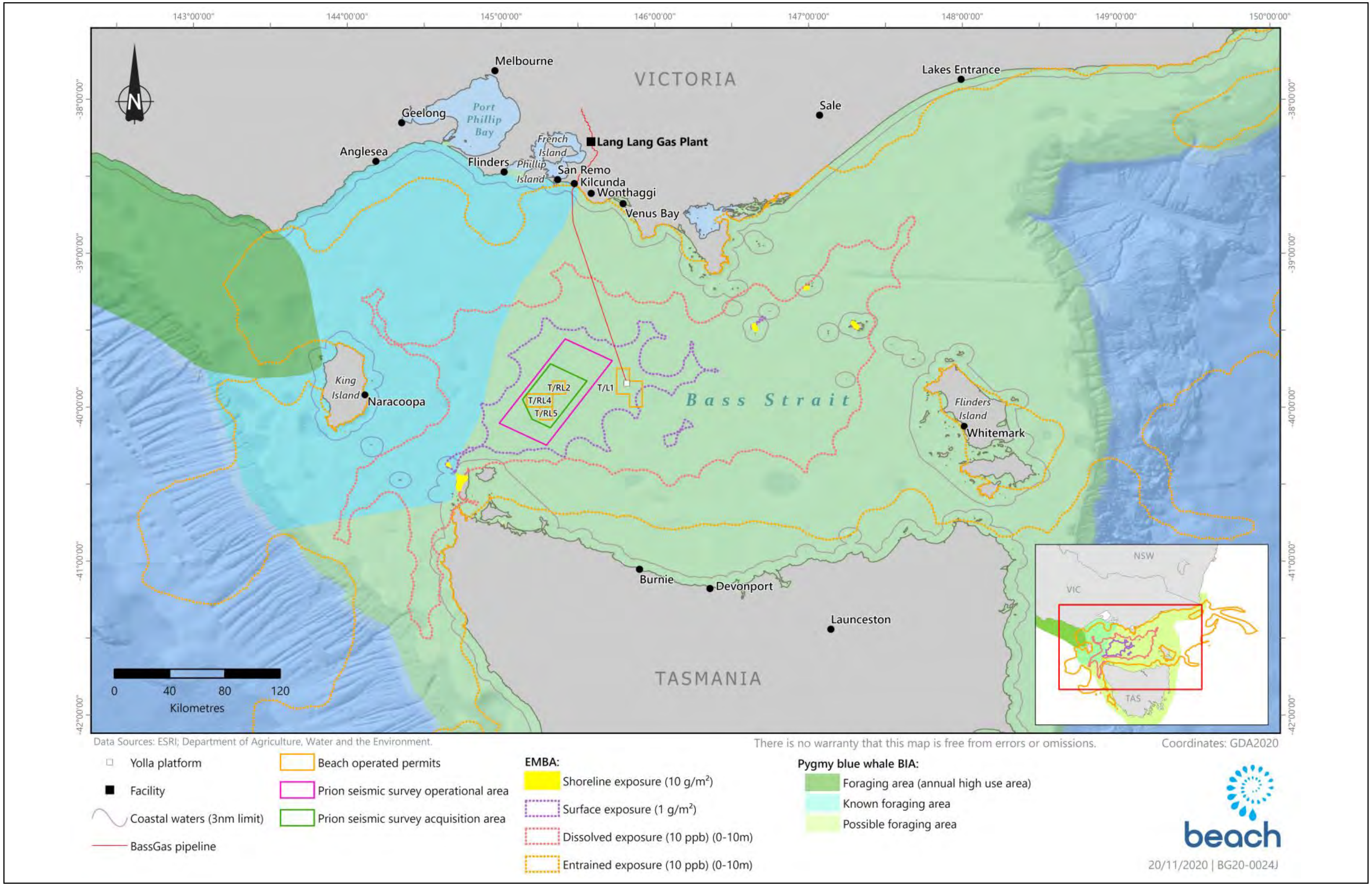


Figure 5.12. PBW BIA intersected by the survey area and spill EMBA

Southern Right Whale

A comparison of presence and absence for the southern right whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

Southern right whales (SRW) (*Eubalaena australis*) are medium to large black (or less commonly grey-brown) baleen whales (DSEWPC, 2012b). They are recognisable by the lack of a dorsal fin, rotund body shape and whitish callosities (patches of keratinised skin colonised by cyamids - small crustaceans) on the head. They have a maximum length of approximately 17.5 m and an approximate weight of 80 tonnes, with mature females slightly larger than males (DSEWPC, 2012b).

Nineteenth century whaling drastically reduced SRW numbers. An estimated 55,000 to 70,000 whales were present in the southern hemisphere in the late 1700s (DSEWPC, 2012b). By the 1920s there may have been fewer than 300 individuals remaining throughout the southern hemisphere (DSEWPC, 2012b). Other reports suggest the number of individuals in Australia was reduced to 1,500 (Charlton *et al*., 2014). The current Australian population is estimated at 3,500 individuals (Charlton *et al*., 2014).

The SRW is typically distributed between 16°S and 65°S in the southern hemisphere and is present off the Australian coast between May and October (sometimes as early as April and as late as November) (DSEWPC, 2012b).

SRW tend to be distinctly clumped in aggregation areas (DSEWPC, 2012b). Aggregation areas are well known with a well-recognised area in Victoria at Warrnambool. The number of whales visiting Victoria is a small fraction of the main population that spends winter along the coasts of South Australia and Western Australia (DSEWPC, 2012b). A number of additional aggregation areas for SRW are emerging that might be of importance particularly to the south-eastern population. In these areas small but growing numbers of non-calving whales regularly aggregate for short periods of time. These areas include coastal waters off Peterborough, Port Campbell, Port Fairy and Portland in Victoria located more than 300 km west of the survey area, with waters less than 10 m deep preferred (DSEWPC, 2012b).

The NCVA identifies a BIA for migration/resting of the SRW through all of Bass Strait (Figure 5.13). The closest known aggregation/breeding/calving area to the survey area is at Logan's Beach on the coast near Warrnambool approximately 280 km to the northwest. The area around Wilson's Promontory is a migration/resting area where breeding may occur. The southeast Tasmanian coast is designated as a migration/resting area where breeding is likely to occur (Figure 5.14).

A defined near-shore coastal migration corridor is considered unlikely given the absence of any predictable directional movement for the species (DSEWPC, 2012b). Critical habitat for the SRW is not defined under the EPBC Act (DSEWPC, 2012b) though the BIA shown in Figure 5.13 around Warrnambool, Wilson's Promontory and southeast Tasmania may be considered critical habitat as female SRW show calving site fidelity, which combined with their low and slow reproductive rate make calving sites of critical importance to the species recovery (DSEWPC, 2012b).

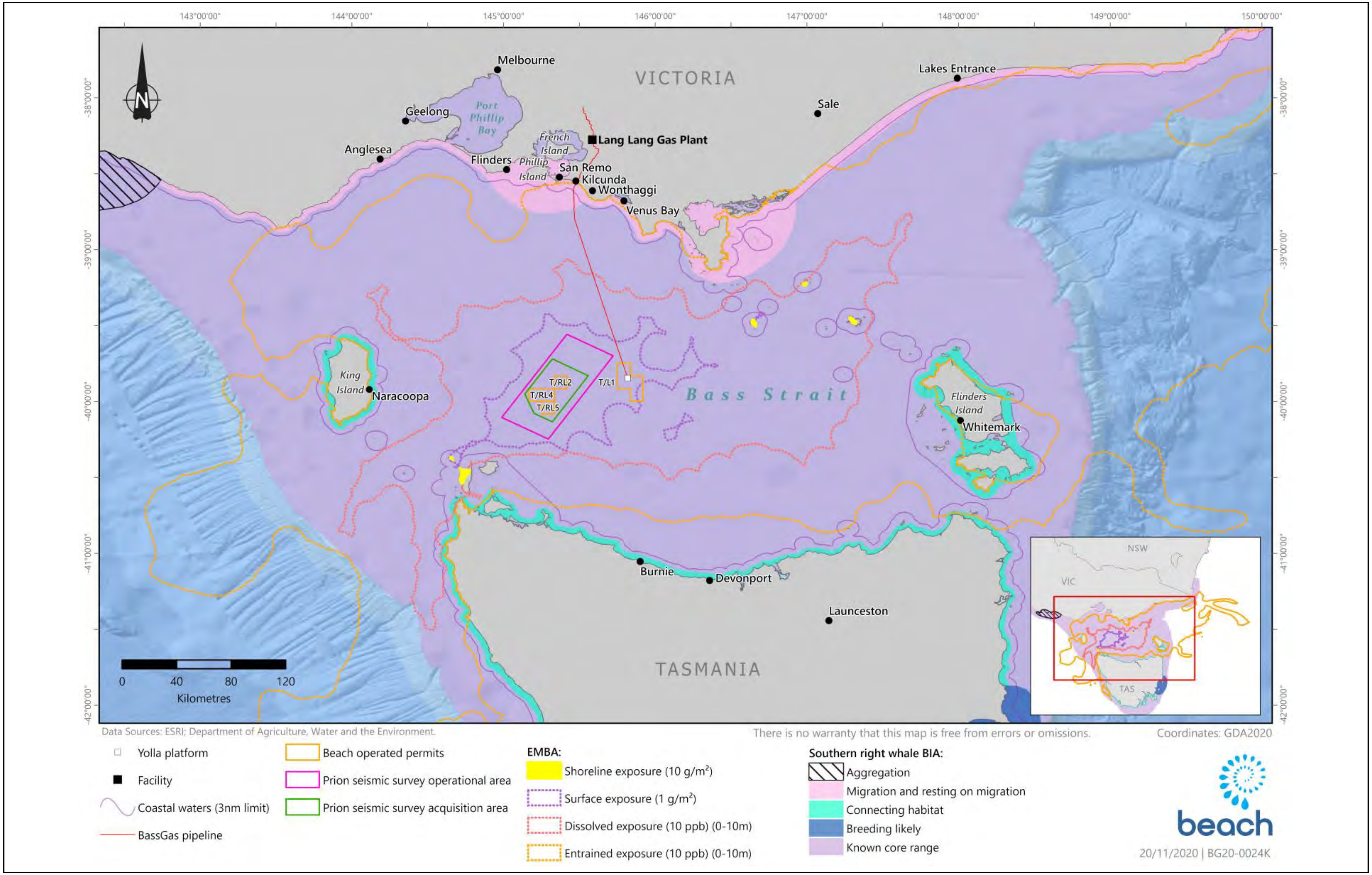
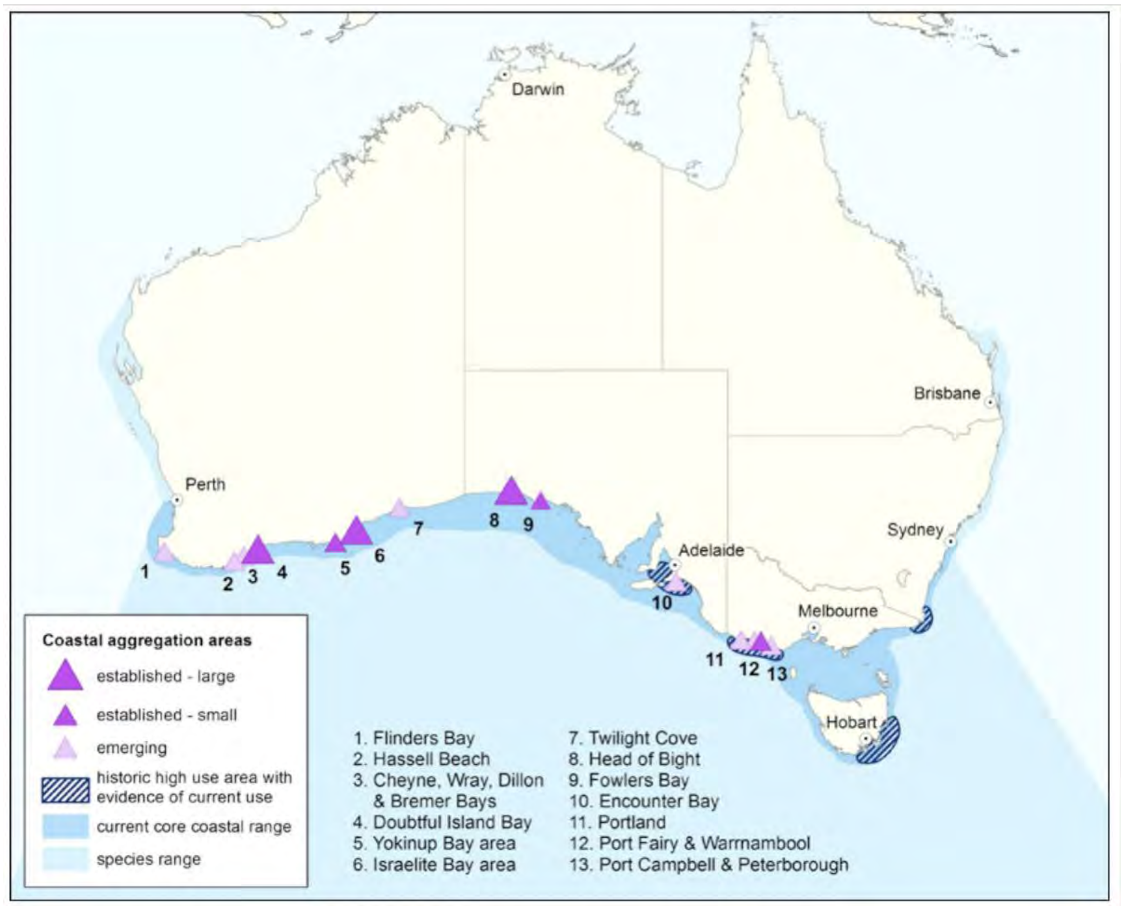


Figure 5.13. SRW BIA intersected by the survey area and spill EMBA



Source: DSEWPC (2012b).

Figure 5.14. SRW aggregation areas

<u>Humpback Whale</u>

A comparison of presence and absence for the humpback whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

The humpback whale (*Megaptera novaeangliae*) is a moderately large (15-18 m long) baleen whale that has a worldwide distribution and a geographic segregation. In the 19th and 20th centuries, humpback whales were hunted extensively throughout the world's oceans and as a result it is estimated that 95% of the population was eliminated. Commercial whaling of humpback whales ceased in 1963 in Australia, at which time it is estimated that humpback whales were reduced to between 3.5 and 5% of pre-whaling abundance (TSSC, 2015d).

The EPBC Act Threatened Species Scientific Committee (TSSC) states that a 2012 and 2014 review of the conservation status of the species considered that it no longer meets any criteria for listing as threatened under the EPBC Act though it remains listed as vulnerable (TSSC, 2015d).

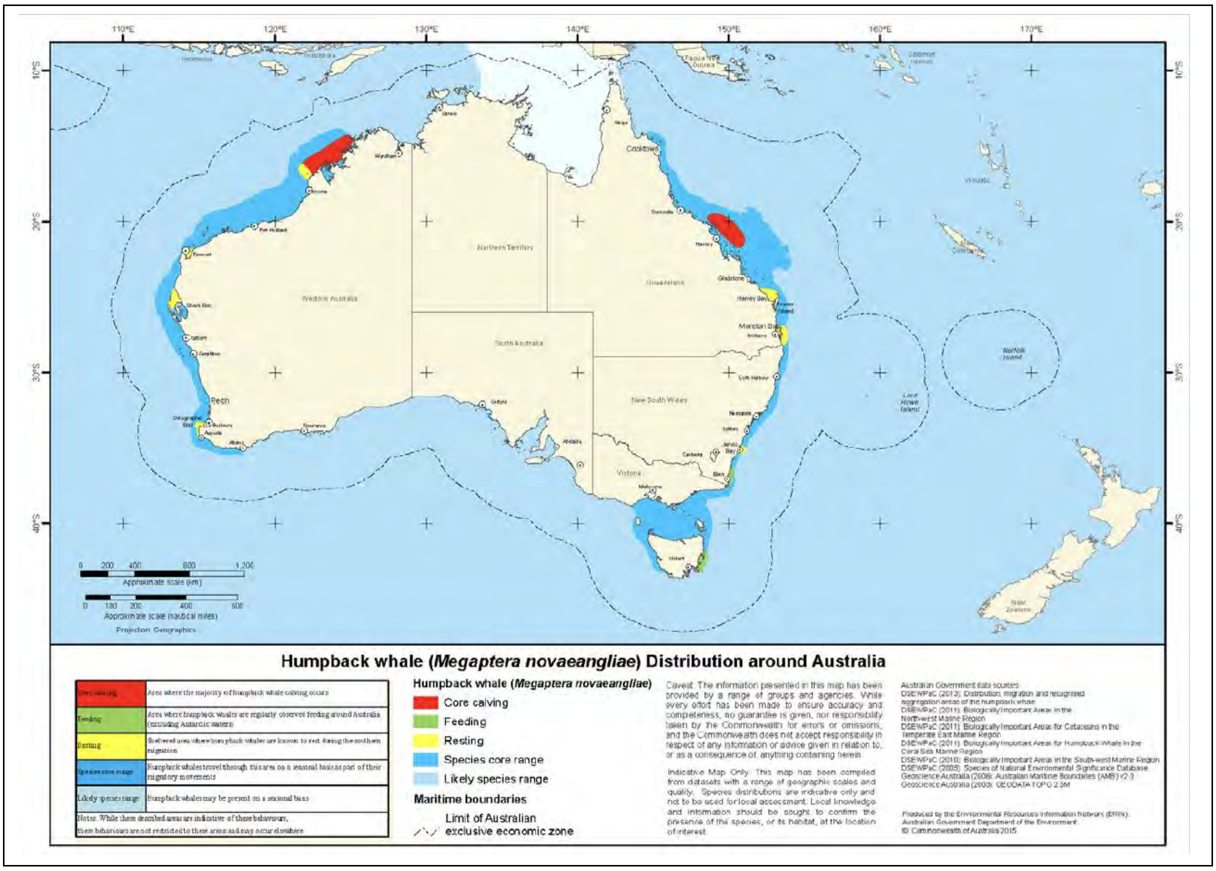
Humpback whales are found in Australian offshore and Antarctic waters. They primarily feed on krill in Antarctic waters south of 55°S. The eastern Australian population of humpback whales is referred to as Group E1 by the

International Whaling Commission, one of seven distinct breeding stocks in the southern hemisphere (TSSC, 2015d).

Bass Strait represents part of the core range of the E1 Group. Feeding, resting or calving is not known to occur in Bass Strait (TSSC, 2015d) though migration through Bass Strait occurs (Figure 5.15). 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 (Figure 5.16) at Twofold Bay, Eden off the New South Wales south coast.

Humpback whales migrate from their summer feeding grounds in Antarctic waters northward up the Australian east coast to their breeding and calving grounds in sub-tropical and tropical inshore waters (TSSC, 2015d). The northern migration off the southeast coast starts in April and May with the southern migration occurring from November to December. This migration tends to occur close to the coast along the continental shelf boundary in waters about 200 m deep (TSSC, 2015d) (Figure 5.16).

The conservation advice for the humpback whale (TSSC, 2015d) identifies vessel strike and anthropogenic noise as threats to the species. The spill EMBA overlaps the core migration range of humpback whales. It is likely that humpback whales migrate through the spill EMBA during April, May, November and December.



Source: TSSC (2015d).

Figure 5.15. Humpback whale distribution around Australia

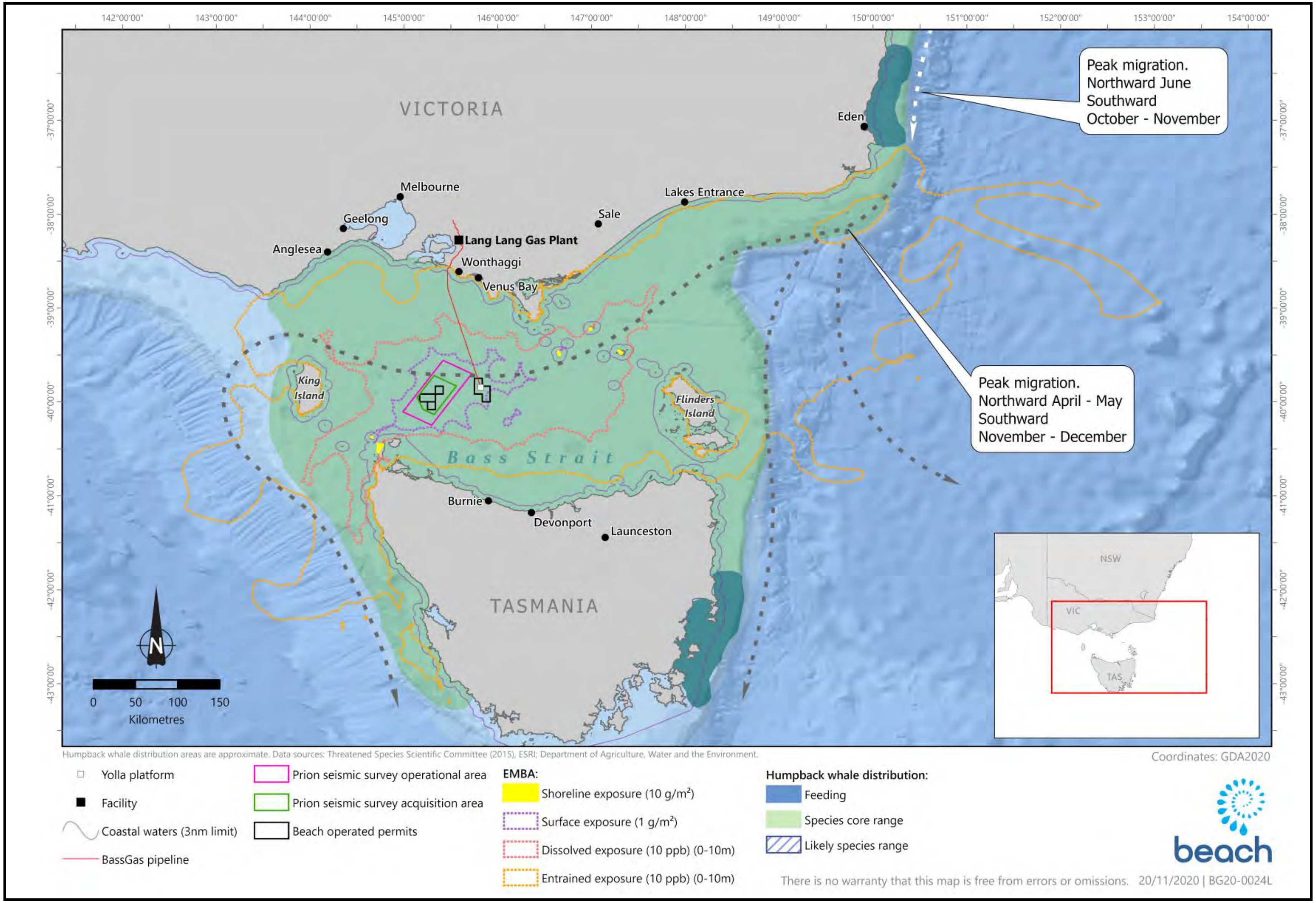


Figure 5.16. Humpback whale BIA intersected by the survey area and the spill EMBA

Pygmy right whale

A comparison of presence and absence for the pygmy right whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	No	No

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 30°S and 55°S. 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 or no records from eastern Victoria 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 lack of sightings off eastern Victoria, the absence of a BIA in Australian waters and the nearshore location of the survey area, it is considered unlikely that this species occurs within the Project area.

Antarctic minke whale

A comparison of presence and absence for the Antarctic minke whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	No

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.

Sperm whale

A comparison of presence and absence for the sperm whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	No

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 15ºC (DAWE, 2020b). The major food for Sperm whales comprises oceanic cephalopods, frequently taken at depth (DAWE, 2020b). 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 Bass Strait, sperm whales are unlikely to be present in the survey area.

Dusky Dolphin

A comparison of presence and absence for the dusky dolphin between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	No	No

The dusky dolphin (*Lagenorhynchus obscurus*) 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 (the very first described specimen of the species by French naturalists was from off the coast of Tasmania in 1826 and key locations are yet to be identified (Bannister *et al.*, 1996). The dusky dolphin occurs across southern Australia from Western Australia to Tasmania and there are 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 are present in the spill EMBA.

Killer Whale

A comparison of presence and absence for the killer whale between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

The killer whale (*Orcinus orca*) is the largest member of the dolphin family and is thought to be the most cosmopolitan of all cetaceans. It appears to be more common in cold deep waters though killer whales 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 of killer whales 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 occur in the spill EMBA, however given the distance to the nearest seal colonies is approximately 80 km from the survey area, the area around the survey area is unlikely to represent an important habitat for killer whales and significant numbers of this species are not expected in the spill EMBA.

5.4.6 Pinnipeds

There are two pinniped species recorded under the EPBC Act PMST as potentially occurring within the survey area and EMBA (Table 5.7). An additional three threatened pinniped species were identified in the VBA and ALA 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 6** and **Appendix 7**. Figure 5.17 illustrates the annual activities and presence of the two pinniped species.

Table 5.7. Pinnipeds that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
PMST							
Arctocephalus forsteri	New Zealand fur-seal	-	-	Yes	-	-	-
Arctocephalus pusillus	Australian fur-seal	-	-	Yes	-	-	-
VBA							
Mirounga leonine	Southern elephant seal	V	-	Yes	Yes		CA
ALA							
Arctocephalus tropicalis	Subantarctic fur-seal	E	-	Yes	Yes	-	CA
Neophoca cincerea	Australian sea-lion	V	-	Yes	Yes	-	RP

Definitions and key as per Table 5.4.

Figure 5.17 illustrates the presence of the two EPBC Act-listed pinniped species in the EMBA throughout the year.

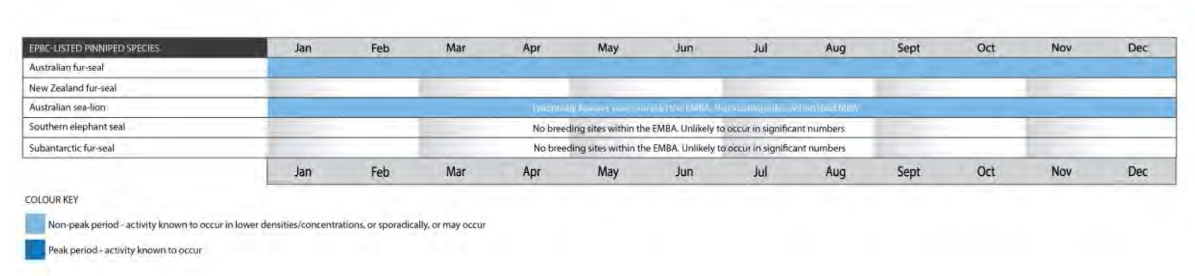


Figure 5.17. Annual activities and presence of EPBC Act-listed pinnipeds in the survey area and spill EMBA

<u>Australian fur-seal</u>

A comparison of presence and absence for the Australian fur-seal between the database searches of the survey area and EMBA is presented over page.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

The Australian fur-seal (*Arctocephalus pusillus*) is common in the spill EMBA and is not listed as a threatened or migratory species under the EPBC Act.

Australian fur seals are endemic to south-eastern Australian waters and have a relatively restricted distribution around the rocky islands of Bass Strait. It is estimated that there are 60,000 Australian fur seals in Bass Strait and the waters around Tasmania. The species has been recorded in the waters off South Australia, Victoria, Tasmania and New South Wales and are the only species of seal known to breed on Victorian and Tasmanian islands in Bass Strait (Kirkwood *et al.*, 2009).

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 (Kirkwood *et al.*, 2009). The largest of the established colonies occur at Lady Julia Percy Island (26% of the breeding population and 320 km northwest of the survey area) and at Seal Rocks adjacent Phillip Island (25% of the breeding population and 114 km north of the survey area), in Victoria. These areas are not located within the spill EMBA.

Other Australian fur-seal breeding colonies in Bass Strait and within the EMBA include:

- Rag Island (1,000 fur seal & 270 pups in 2007, 118 km northeast of the survey area);
- Kanowna Island (15,000 adults and 3,000 pups, 79 km northeast of the survey area);
- Anser Group of Islands (all more than 81 km northeast of the survey area);
- The Skerries (395 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, 121 km northeast of the survey area) (Kirkwood *et al.*, 2009, Shaughnessy, 1999; OSRA) (Figure 5.18).

Barton et al (2012), Carlyon et al (2011) and OSRA (2015) list the haul-out sites known in Bass Strait (only Beware Reef is not located within the spill EMBA):

- Beware Reef (337 km northeast of the survey area) – a haul-out site where the seals are present most of year;
- Gabo Island (433 km northeast of the survey area) – 30-50 individuals; and
- The Hogan Island group (121 km northeast of the survey area) – about 300 animals.

Australian fur seals have a relatively restricted distribution around the islands of Bass Strait where it is the most common seal (Kirkwood *et al.*, 2005). Adult tagged seals have shown travel paths from Flinders Island to King Island presumably passing through central Bass Strait. Their preferred habitat, especially for breeding, is a rocky island with boulder or pebble beaches and gradually sloping rocky ledges.

During the summer months Australian fur seals are observed repeatedly travelling between northern Bass Strait islands and southern Tasmania waters following the Tasmanian east coast. 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, including off Cape Otway in western Victoria. They forage on benthos at depths of between 60 m and 80 m (Hume *et al.*, 2004; Arnould and Kirkwood, 2007; Robinson *et al.*, 2008) generally within 100 km to 200 km of the breeding colony for up to five days at a time (Hume *et al.*, 2004). The lactation period lasts for between 10 and 11 months and some females may nurse pups for up to three years (Arnould and Hindell, 2001).

Male Australian fur seals are bound to colonies during the breeding season from late October to late December. Outside the breeding season they forage up to several hundred kilometres (Hume *et al.*, 2004) and are away for long periods even up to nine days (Kirkwood *et al.*, 2005). The sexes generally forage in the same environment (Kirkwood *et al.*, 2005); this suggests that males target different prey than females as observed in similar New Zealand fur seals where males prey on larger fish and seabird species compared to females. The survey area is likely to represent foraging grounds for some Australian fur seals.

New Zealand fur-seal

A comparison of presence and absence for the New Zealand fur-seal between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

New Zealand fur-seals (*A. fosteri*, also sometimes referred to as long-nosed fur-seals) are mostly found in central South Australian waters (Kangaroo Island to South Eyre Peninsula) with 77% of their population is found here (outside the EMBA) (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) (Kirkwood *et al.*, 2009) (see Figure 5.18). Lower density breeding areas occur in Victoria (Shaughnessy, 1999). Breeding locations in Victoria occur at Kanowna Island, off Wilson's Promontory (located 83 km northeast of the survey area) and the Skerries (located approximately 395 km northeast of the survey area) (Kirkwood *et al.*, 2009) – both are located within the spill EMBA.

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).

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.

The total Australian population of New Zealand fur seals is 58,000. The population has been slow to recover from the previous intense sealing operations from 1798 to 1820, partially as the species are slow reproducers, producing one pup per year when they reach sexual maturity at four years. Up to 15% of pups die before they reach two months of age, primarily as a result of fishing net and other marine debris entanglements.

Haul-out sites in Bass Strait, as reported by Barton et al (2012) and OSRA mapping, are listed below (only Beware Reef is outside the EMBA):

- Beware Reef (337 km northeast of the survey area);
- Kanowna Island (83 km northeast of the survey area) – about 300 individuals;
- The Hogan Islands Group (121 km northeast of the survey area); and
- West Moncoeur Island (south of Wilson's Promontory, 85 km northeast 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 (all of which occur in the EMBA):

- Rag Island (1,000 fur seal & 235 pups in 2006, 118 km northeast of the survey area);

- Kanowna Island (10,700 adults and 2,700 pups, 83 km northeast of the survey area);
- Anser Group of Islands (all more than 81 km northeast of the survey area);
- The Skerries (395 km northeast of the survey area) – 300 individuals and 78 pups (in 2002); and
- Judgment Rock in the Kent Island Group (about 2,500 pups per year, 122 km east of the survey area) (Kirkwood *et al*., 2009)

There is no BIA for the New Zealand fur-seal in Bass Strait. Given the relatively close proximity of the survey area to breeding colonies and haul-out sites south of Wilson's Promontory, it is likely that the species feeds around the survey area, and certainly within the spill EMBA. These waters are unlikely to represent important critical feeding or breeding habitat.

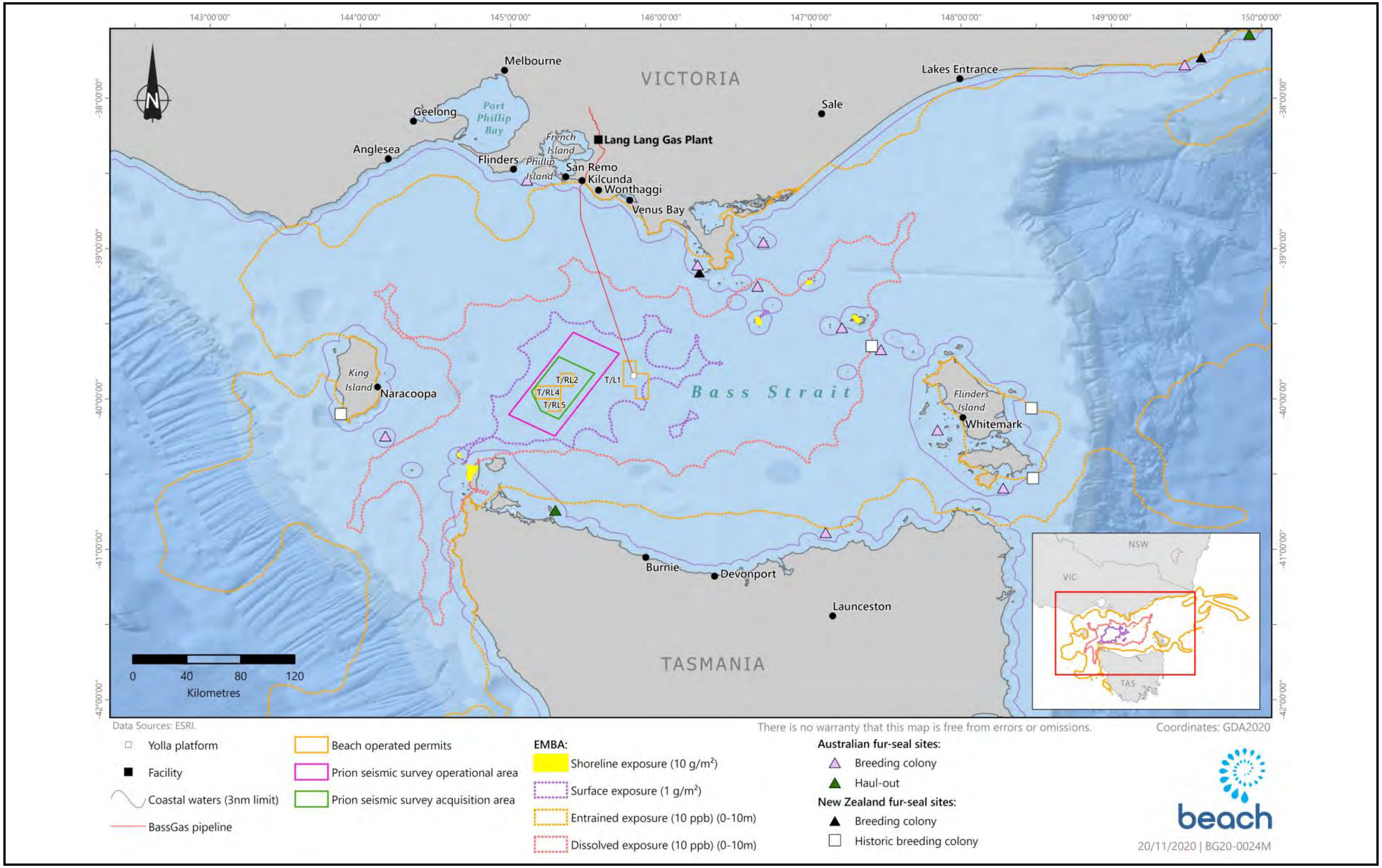


Figure 5.18. Australian and New Zealand fur-seal colonies and haul-out sites intersected by the survey area and spill EMBA

Southern elephant seal

A comparison of presence and absence for the southern elephant seal between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	Yes

The southern elephant seal (*Mirounga leonine*) has been recorded in the VBA database once within the spill EMBA. 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.

Elephant seals 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, 2016c). Within Australian jurisdiction, southern elephant seals breeds and hauls-out on Macquarie Island (1,900 km southeast of the survey area) and Heard Island (5,500 km southwest of the survey area). Historically, southern elephant seal populations occurred on islands of western Bass Strait before these were extirpated by European sealers (TSSC, 2016c). Currently, occasional pupping is seen on Maatsuyker Island (426 km south of the survey area) in southern Tasmania where 12 individuals were recorded in 2015. Given the known distribution of southern elephant seals, it is unlikely they will be encountered in significant numbers in the survey area or spill EMBA.

Subantarctic fur-seal

A comparison of presence and absence for the subantarctic seal between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

The subantarctic fur-seal has a wide southern hemisphere distribution and a dispersed breeding distribution on isolated subantarctic and subtemperate islands (TSSC, 2016). In the Australian region, the only breeding colonies are established on Macquarie Island. Some wide-ranging vagrants occasionally reach beaches in Tasmania and are few in number on the southern Australian coast. Since 1970, 50 individuals have been recorded between New South Wales and Western Australia (TSSC, 2016). Based on the absence of breeding colonies in Bass Strait and limited number of recordings over a 50-year period, subantarctic fur-seals are unlikely to occur in the survey area or spill EMBA.

Australian sea-lion

A comparison of presence and absence for the Australian sea-lion between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

The Australian sea-lion (*Neophoca cincerea*) is endemic to southern Australia and its core range is located from Kangaroo Island (SA) (795 km northwest of the survey area) to the Houtman Abrolhos Islands (WA) (2,982 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. Given the distance of the survey area from its core range, the species is unlikely to be present in the survey area and spill EMBA, though it may in low numbers as vagrant individuals.

5.4.7 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 EMBA are listed in Section 5.7.6. There are two major groups of fish: pelagic fish that live in the water column and mostly near the surface (i.e., epipelagic, upper 200 m), and demersal or benthic fish that live on or near the seabed. Several species of fish live in the Victorian nearshore reef habitat either as a permanent resident or as transients moving seasonally along the reef system. The most common reef fish are gummy shark, trevally, sand flathead, spiny gurnard, snapper, salmon and stringaree. The most commonly targeted fish species in Bass Strait include eastern school whiting (*Sillago flindersi*), flathead (*Neoplatycephalus spp.* & *Platycephalus spp.*), jackass morwong (*Nemadactylus marcopterus*), ling (*Genypterus blacodes*), spotted warehou (*Seriolella puncata*) and elephant fish (*Callorhinchus milii*) (Butler *et al*, 2002).

Bass Strait contains a wide variety of species of sharks, skates, rays and chimaeras, which are commonly targeted by commercial fishing operators. The species of shark that are commonly targeted include gummy shark (*Mustelus antarcticus*), school shark (*Galeorhinus galeus*), common saw shark (*Prostiophorus cirratus*), southern saw shark (*P. nudipinnis*), broadnose sevengill shark (*Notorynchus cepedianus*), bronze whaler (*Carcharhinus brachyurus*), and Australian angel shark (*Squatina Australis*). Last and Stevens (1994) recorded several species of skates that are mapped by the Atlas of Living Australia (2020) as occurring in Bass Strait including the peacock skate (*Pavoraja nitida*), longnose skate (*Raja sp. A*), white-spotted skate (*R. cerva*), thornback skate (*R. lemprieri*), southern fiddler ray (*Trygonorrhina fasciata*) and the black stingray (*Dasyatis brevicaudata*).

The EPBC PMST identified 40 fish species (30 of which are seahorses and pipefish) as potentially occurring in the survey area and spill EMBA (listed in Table 5.8). 26 of the identified species were recorded in the PMST results for the EMBA only and were not recorded in the PMST results for the survey area. The threatened and migratory species are described in this section.

In addition to the fish species identified using the PMST database, a search of the ALA database for the survey area identified 70 fish species including leatherjackets, perch, and warehou. These groups are described below. In addition, a search of the ALA database for the EMBA identified 121 species from the Chondrichthyes class (i.e., cartilaginous fish including sharks and rays) and 838 species from the Actinopterygii class (e.g., ray-finned fish). Commonly recorded groupings from this class include leatherjacket, bream, groper, eels, flounder, boarfish, cowfish, whiting, hatchetfish, salmon, pigfish, lanternfish, handfish, perch, whiptail, morwong, wrasse, weedfish, snapper, mackerel and trevally. The full list for fish species recorded in the survey area and the EMBA are presented in **Appendix 6**.

A search of the VBA database for the survey area did not identify any fish species. A search of the VBA database for the EMBA identified 80 fish species with leatherjackets, perch, morwong, wrasse, whiting, sharks and stingrays commonly recorded. The full list of VBA records for fish species recorded in the EMBA is presented in **Appendix 7**. The most abundantly recorded species include:

- Blue throated wrasse (*Notolabrus tetricus*) – 165 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.

- Purple wrasse (*Notolabrus fucicola*) – 135 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.
- Herring cale (*Olisthops cyanomelas*) – 133 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.
- Barber perch (*Caesioperca rasor*) – 131 records. This species is widely distributed on the continental shelf of Southern Australia from southern WA to eastern Victoria and around Tasmania. The species forms large schools on sheltered coastal reefs and feeds on zooplankton.
- Magpie perch (*Cheilodactylus nigripes*) – 93 records. Distributed across southern Australia from WA to NSW and around Tasmania. Inhabits nearshore coastal reefs and caves from 1-65 m water depths and feeds on benthic invertebrates.

Figure 5.19 presents the annual presence and absence of key fish species in the spill EMBA.

Table 5.8. Fish that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
PMST							
Freshwater							
Galaxiella pusilla	Eastern dwarf galaxia	V	-	-	Yes	-	RP
Prototroctes maraena	Australian grayling	V	-	-	Yes	-	RP
Oceanic							
Carcharodon carcharias	Great white shark	V	Yes	-	-	FFR	RP
Carcharius Taurus	Grey nurse shark, east coast population	CE	-	-	Yes	-	RP
Epinephelus daemelii	Black rockcod	V	-	`-	Yes	-	CA
Isurus oxyrinchus	Shortfin mako	-	Yes	-	-	-	-
Lamna nasus	Porbeagle	-	Yes	-	-	-	-
Manta birostris	Giant manta ray	-	Yes	Yes	Yes	-	-
Rhincodon typus	Whale shark	V	Yes	-	Yes	-	RP
Thymichthys politus	Red handfish	CE	-	-	Yes	-	CA
Pipefish, seahorses and seadragons							

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Heraldia nocturna	Eastern upside-down pipefish	-	-	Yes	-	-	-
Hippocampus abdominalis	Big-bellied seahorse	-	-	Yes	-	-	-
Hippocampus breviceps	Short-head seahorse	-	-	Yes	Yes	-	-
Hippocampus minotaur	Bullneck seahorse	-	-	Yes	-	-	-
Histiogamphelus briggsii	Brigg's crested pipefish	-	-	Yes	Yes	-	-
Histiogamphelus cristatus	Rhino pipefish	-	-	Yes	Yes	-	-
Hypselognathus rostratus	Knifesnout pipefish	-	-	Yes	Yes	-	-
Kaupus costatus	Deepbody pipefish	-	-	Yes	Yes	-	-
Kimblaeus bassensis	Trawl pipefish	-	-	Yes	-	-	-
Leptoichthys fistularius	Brushtail pipefish	-	-	Yes	Yes	-	-
Lissocampus caudalis	Australian smooth pipefish	-	-	Yes	Yes	-	-
Lissocampus runa	Javelin pipefish	-	-	Yes	Yes	-	-
Maroubra perserrata	Sawtooth pipefish	-	-	Yes	-	-	-
Mitotichthys mollisoni	Mollison's pipefish	-	-	Yes	Yes	-	-
Mitotichthys semistriatus	Halfbanded pipefish	-	-	Yes	Yes	-	-
Mitotichthys tuckeri	Tucker's pipefish	-	-	Yes	Yes	-	-
Notiocampus ruber	Red pipefish	-	-	Yes	-	-	-
Physodurus eques	Leafy seadragon	-	-	Yes	-	-	-
Phyllopteryx taeniolatus	Common seadragon	-	-	Yes	-	-	-

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Pugnaso curtirostris	Pugnose pipefish	-	-	Yes	Yes	-	-
Solegnathus robustus	Robust pipehorse	-	-	Yes	-	-	-
Solegnathus spinosissimus	Spiny pipehorse	-	-	Yes	-	-	-
Stigmatopora argus	Spotted pipefish	-	-	Yes	Yes	-	-
Stigmatopora nigra	Widebody pipefish	-	-	Yes	Yes	-	-
Stipecampus cristatus	Ringback pipefish	-	-	Yes	Yes	-	-
Syngnathoides biaculeatus	Double-end pipehorse	-	-	Yes	Yes	-	-
Urocampus carinirostris	Hairy pipefish	-	-	Yes	Yes	-	-
Vanacampus margaritifer	Mother-of-pearl pipefish	-	-	Yes	Yes	-	-
Vanacampus phillipi	Port Phillip pipefish	-	-	Yes	-	-	-
Vanacampus poecilolaemus	Longsnout pipefish	-	-	Yes	Yes	-	-
ALA							
Brachionichthys hirsutus	Spotted handfish	CE	-	-	Yes	-	CA
Brachiopsilus ziebelli	Ziebell's handfish	V	-	-	Yes	-	RP
Centrophorus harrissoni	Harrisson's dogfish	CD	-	-	Yes	-	-
Centrophorus zeehaani	Southern dogfish	CD	-	-	Yes	-	-
Galeorhinus galeus	School shark	CD	-	-	-	-	-
Hoplostethus atlanticus	Orange roughy	CD	-	-	Yes	-	-
Seriolella brama	Blue warehou	CD	-	-	-	-	-
Sphyrna lewini	Scalloped hammer-head	CD	-	-	Yes	-	-

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
Thunnus maccoyii	Southern bluefin tuna	CD	-	-	Yes	-	-
VBA							
No additional species identified.							

Definitions and key as per Table 5.4.

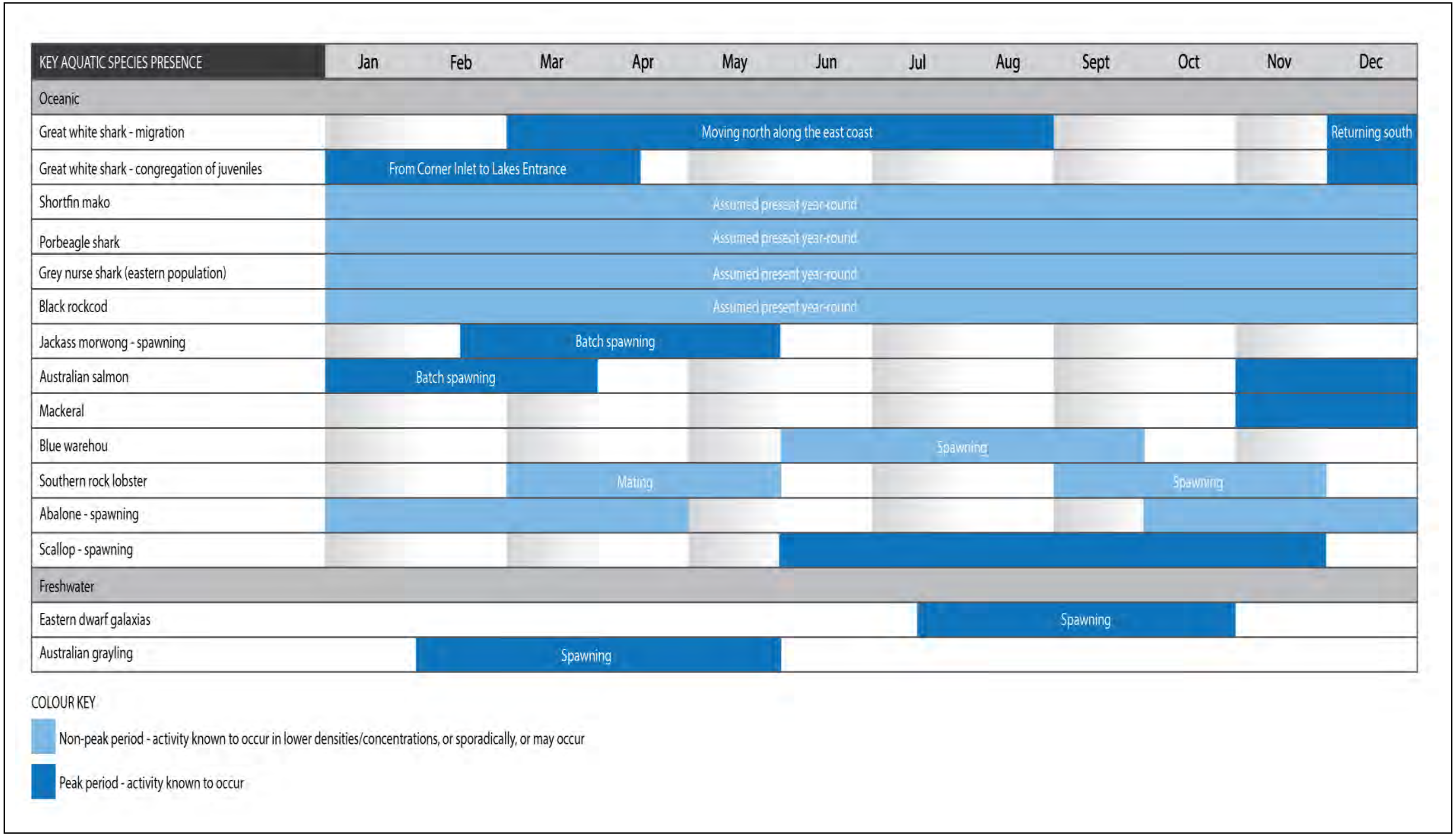


Figure 5.19. The annual presence and absence of key threatened fish species and fish species of fishing value in the survey area and spill EMBA

Eastern dwarf galaxias

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	No

Habitat suitable to the eastern dwarf galaxias (*Galaxiella pusilla*) is slow flowing and still, shallow, permanent and temporary freshwater habitats such as swamps, drains and the backwaters of streams and creeks, often containing dense aquatic macrophytes and emergent plants (Saddlier *et al*., 2010). Given the marine nature of the activity, it is not likely that eastern dwarf galaxias' will be encountered in the spill EMBA due to its preference for freshwater habitats.

Australian grayling

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	Yes

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 NSW, Victoria and Tasmania migrating between streams and the ocean (Backhouse *et al*., 2008; DELWP, 2015). The species spends most of its life in freshwater (DELWP, 2015) and migrates to lower reaches of rivers to spawn in autumn (Museums Victoria, 2020), though timing is dependent on many variables including latitude and varying temperature regimes (Backhouse *et al*., 2008), with increased stream flows also thought to initiate migration (Backhouse *et al*., 2008).

The Australian Grayling Action Statement (DELWP, 2015) lists Victorian rivers that flow into Bass Strait that are known habitat for this species and includes the Cann, Thurra and Wingan river mouths, which are intersected by the EMBA if they are open to Bass Strait. The Australian grayling is known to occur on King Island however its mapped habitat occurs on the western coast of the island which is not intersected by the EMBA. The National Recovery Plan for the Australian Grayling (Backhouse *et al*., 2008) lists the Arthur river in Tasmania as an important river for the species, which is intersected by the EMBA at its mouth. The Australian Grayling Action Statement (DELWP, 2015) list the threatening processes to this species as barriers to movement, river regulation, poor water quality, siltation, introduced fish, climate change, diseases and fishing. It is unlikely that the Australian grayling is present in the spill EMBA due to its preference for freshwater stream and river habitats though it may be present in estuarine environments during spawning.

Black rockcod

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	No	No

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 (425 km northeast of the survey area and outside the EMBA), and rarely west of this point (DSEWPC, 2012c). 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, 2012c). 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, 2012c). Given their known distribution, the black rockcod may occur in suitable habitat within the far-eastern area of the EMBA north of Mallacoota.

Grey nurse shark (east coast population)

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	No

The grey nurse shark (*Carcharius Taurus)* (eastern population) is a large robust species that has become critically endangered due to commercial fishing, spearfishing and protective beach meshing (TSSC, 2001). 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 (TSSC, 2001). Only one record of the species occurs from Gippsland, at Mallacoota Inlet in the early 1970s.

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, 2014b). The east coast population extends from central Queensland to southern NSW, occasionally as far south as the NSW/Victoria border (DoE, 2014b), which coincides with the BIA for their distribution and breeding (October to November).

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, 2014b). There are no aggregation sites located off the Victorian coast (DoE, 2014b). Given the current distribution of the grey nurse shark, it is unlikely to occur within the spill EMBA.

Red handfish

A comparison of presence and absence for the red handfish between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	No	No

The red handfish is a small, slow moving benthic fish that is known to inhabit a small geographic area in the coastal waters of southeast Tasmania. It appears that the red handfish has undergone a recent marked decline in both distribution and abundance (DSEWPC, 2012d). No specimens were recorded at Primrose Sands (25 km east of Hobart) during surveys in 2005 and efforts to locate red handfish at sites where they were previously known in southeast Tasmania to exist are reported to have failed (DSEWPC, 2012d). The most recent sightings of the species were made in Primrose Sands in 2010 (DSEWPC, 2012d).

The main identified threat to the red handfish is habitat degradation resulting from one or a combination of impacts including introduced species, pollution and siltation, increasing water temperatures and the proliferation of other native species as a result of human activities (DSEWPC, 2012d). Given that the red handfish has not been recorded off the northeast coast of Tasmania and its preference for the benthos, it is unlikely that it will be present in the EMBA.

Syngnathids

There are 30 species of syngnathids (pipefish, seahorse and pipehorse) recorded in the PMST as potentially occurring in the EMBA (see Table 5.8). The majority of these fish species are associated with seagrass meadows, macroalgal seabed habitats, rocky reefs and sponge gardens located in shallow, inshore waters (e.g., protected coastal bays, harbours and jetties) less than 50 m deep (Museums Victoria, 2020). They are sometimes recorded in deeper offshore waters, where they depend on the protection of sponges and rafts of floating seaweed such as *Sargassum*.

The PMST species profile and threats profiles indicate that the sygnathiforme species listed for the EMBA are widely distributed throughout southern, south-eastern and south-western Australian waters (DAWE, 2020b). The diverse range of ecological niches afforded by the shallow waters shoreward of the EMBA would be expected to provide suitable habitat for these species. Considering the preferred depth range for these species, it is unlikely that there will be any suitable habitat in the area for these species around the survey area, but they are likely to be present within the shallow nearshore waters of the spill EMBA at all times of the year.

Great white shark

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

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	No

The great white shark (*Carcharodon carcharias*) is widely distributed and located throughout temperate and sub-tropical waters. The known range in Australian waters includes all coastal areas except the Northern Territory (DSEWPC, 2013b) (Figure 5.20).

Studies indicate that the great white shark is usually a solitary animal, largely transient in areas it inhabits for days to weeks (DSEWPC, 2013b). Individuals are known to return to feeding grounds on a seasonal basis (Klimley and Anderson, 1996). The species moves seasonally along the south and east Australian coasts, moving northerly along the coast during autumn and winter and returning to southern Australian waters by early summer. Observations of adult great white sharks in or near the spill EMBA area are more frequent around Australian fur seal colonies (see Figure 5.18) including Wilsons Promontory and Seal Rocks, Phillip Island. Juveniles are known to congregate along Ninety Mile Beach from Corner Inlet to Lakes Entrance. Museums Victoria (2020) indicates that Corner Inlet may be an important nursery area for the eastern population of great white sharks mostly from mid-summer through to autumn (DSEWPC, 2013b).

Key threats to the species as listed in the White Shark Recovery Plan (DSEWPC, 2013b) are mortality from targeted fishing, accidental fishing bycatch and illegal fishing and mortality from shark control activities such as beach meshing and drum-lining. Given the transitory nature of the great white shark and the separation of the spill EMBA from known great white shark breeding and foraging areas, it is likely that great white sharks will be present in the spill EMBA area only in a transitory manner.

Whale shark

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	Yes

The whale shark (*Rhincodon typus*) is the world's largest fish and one of only three filter feeding shark species (TSSC, 2015e). 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, 2015e). The species is not known to migrate through Bass Strait, and it is highly unlikely to occur within the spill EMBA.

Shortfin mako shark

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	No

The shortfin mako shark (*Isurus oxyrinchus*) is a pelagic species with a circum-global wide-ranging oceanic distribution in tropical and temperate seas (Mollet *et al*., 2000) It is widespread in Australian waters, commonly found in water with temperatures greater than 16°C (Museums Victoria, 2020). Populations of the shortfin mako shark are considered to have undergone a substantial decline globally. These sharks are common by-catch species of commercial fisheries (Mollet *et al*., 2000). Due to their widespread distribution in Australian waters, shortfin mako sharks may be present in the spill EMBA at all times of the year.

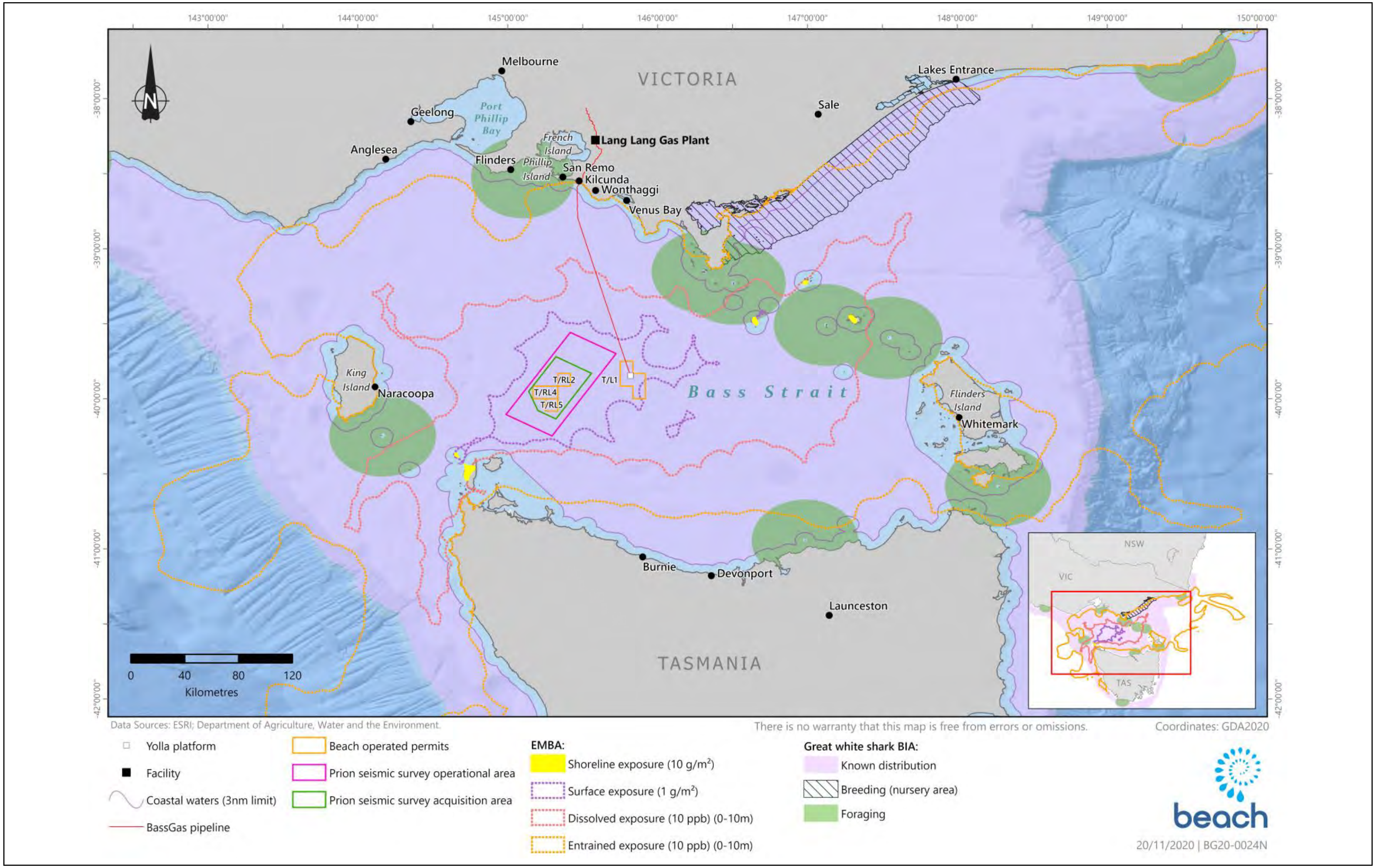


Figure 5.20. Great white shark BIA intersected by the survey area and the spill EMBA

Porbeagle shark

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

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	No	No

The porbeagle shark (*Lamna nasus*) is widespread in the southern waters of Australia (Museums Victoria, 2020). The species preys on bony fishes and cephalopods and is an opportunistic hunter that regularly moves up and down in the water column, catching prey in mid-water as well as at the seafloor. It is most commonly found over food-rich banks on the outer continental shelf and makes occasional forays close to shore or into the open ocean down to depths of approximately 1,300 m. It also conducts long distance seasonal migrations generally shifting between shallower and deeper water (Pade *et al*., 2009). Due to their widespread distribution in Australian waters, porbeagle sharks may be present in the spill EMBA at all times of the year.

Giant manta ray

A comparison of presence and absence for the giant manta ray between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	No	No

Giant manta rays (*Manta birostris*) are the largest species of ray in the world with a circumglobal distribution and are typically found in tropical and subtropical waters but can also be found in temperate waters. The giant manta ray is an ocean-going species and spends most of its life travelling with the currents and migrating to upwellings where nutrient-rich water increases the availability of zooplankton (Museums Victoria, 2020). Giant manta rays may travel through the furthest eastern extent of the EMBA and were not recorded in the PMST results for the survey area only.

Fish Species Recorded in the ALA and VBA Database Search Results

Unless otherwise referenced, this information is sourced from the Fishes of Australia online database (Museums Victoria, 2020).

Perch

Four species of perch (butterfly, reef ocean, bighead and orange-banded) are recorded in the ALA database for the survey area. Butterfly and reef ocean perch are widely distributed across southern Australia and vary in their feeding behaviours. Butterfly perch form large schools with other perch species that feed on plankton above high-profile rocky reefs, outcrops and dropoffs of 4-100 m water depth. They 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). Bighead gurnard perch are distributed across southern Australia and inhabits rocky reefs and sandy substrates in shallow (15 m) to deep waters (600 m).

Leatherjackets

Four species of leatherjacket (six-spine, mosaic, bearded and velvet,) are recorded in the ALA database for the survey area. The bearded leatherjacket inhabits sandy weedy areas of coastal reefs as well as open muddy substrates in estuaries and deep coastal bays. It is usually found lining up with ropes, seawhips and large stringy-type sponges, which enhance the camouflage ability of its long body. Six-spine leatherjackets are common throughout southern Australia and typically inhabit rocky reef and seagrass beds in 1-45 m water depths. The mosaic leatherjacket is endemic to the southern half of Australia from Queensland to Western Australia. Adults usually inhabit deep offshore reefs to 150 metres, while juveniles are found in estuaries and on sheltered coastal reefs. Juveniles are often seen around jetty piles and under jellyfishes. Velvet leatherjackets are similarly distributed to mosaic leatherjackets and the species feeds on benthic invertebrates and has also been observed feeding on zooplankton above the bottom. Each of these species is likely to be present in the survey area.

Warehou

Two species of warehou (blue and silver) are recorded in the ALA database search for the survey area. Blue warehou are a bentho-pelagic species found in southern Australia where it inhabits continental shelf and slope waters. Adults can be found at depths from 50-300 metres. Blue and silver warehou are schooling fish and usually aggregate close to the seabed and juveniles can sometimes be found schooling close to the surface in estuaries, often in association with jellyfish. Blue warehou is a commercially important species and formally managed under the Blue Warehou Stock Rebuilding Strategy (AFMA, 2020). Silver Warehou are a bottom-dwelling species that occurs on the continental shelf and slope. They can be found at depth of 50-600 metres. Adults are usually demersal, with juveniles occurring offshore. Older juveniles move inshore and are often found in bays and inlets. Once mature, fish move out into deeper water. Silver warehou are a schooling species that aggregates to feed and spawn. Blue and silver warehou possibly occur in the survey area.

School shark

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

	PMST	ALA	VBA
Survey area	No	Yes	No
EMBA	No	Yes	No

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 The species is listed as Conservation Dependent under the EPBC Act.. School shark are likely to be present in the survey area and EMBA.

Orange roughy

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

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 EMBA, it is highly unlikely that the survey area is a spawning aggregation site due to the lack of seamounts in the area.

Southern bluefin tuna

A comparison of presence and absence for southern bluefin tuna between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

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 (900 km northwest of the survey area), 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 Great Australian Bight (GAB) (DAWE, 2020b) and then slowly towed to Port Lincoln in South Australia and transferred to floating sea cages anchored to the sea floor. It is unlikely that southern bluefin tuna occur in the survey area or EMBA.

Spotted handfish

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

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 (DAWE, 2020b). 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 (DAWE, 2020b)). 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. Spotted handfish are unlikely to occur in the survey area, though may occur in the EMBA.

Ziebell's handfish

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

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). Ziebell's handfish is unlikely to occur in the survey area or the EMBA.

Southern dogfish

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

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

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 eastern extents of the EMBA but not in the survey area.

Harrisson's dogfish

A comparison of presence and absence for Harrisson's dogfish between the database searches of the survey area and EMBA is presented over page.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	No	Yes	No

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). The species prefers water depth ranges from 200 – 1050 m. 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. This species habitat preferences indicates that it is likely to occur in eastern extents of the EMBA but not in the survey area.

5.4.8 Reptiles

The EPBC PMST identified four species of marine turtle that potentially occur in the survey area and spill EMBA, as listed in Table 5.9. No BIAs for turtles occur within Bass Strait.

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). These species are not expected to be encountered within the spill EMBA.

A search of the VBA and ALA databases for the survey area did not identify any reptile species. In addition, a search of the VBA and ALA databases for the EMBA did not identify any additional reptile species to those presented in Table 5.9.

Table 5.9. Marine reptiles that may occur within the survey area and spill EMBA

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
PMST							
Caretta caretta	Loggerhead turtle	E	Yes	Yes	-	-	Generic RP in place for all marine turtle species, +
Chelonia mydas	Green turtle	V	Yes	Yes	-	-	
Dermochelys coriacea	Leatherback turtle	E	Yes	Yes	-	-	
Eretmochelys imbricate	Hawksbill turtle	V	Yes	Yes	Yes	-	
ALA							
No additional species identified.							
VBA							

Scientific name	Common name	EPBC Act Status			Recorded in EMBA only	BIA within the EMBA?	Recovery Plan in place?
		Listed threatened species	Listed migratory species	Listed marine species			
No additional species identified.							

Definitions and key as per Table 5.4.

Loggerhead turtle

A comparison of presence and absence for the loggerhead turtle between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	No

The loggerhead turtle (*Caretta caretta*) is globally distributed in sub-tropical waters (Limpus, 2008a) including eastern, northern and western Australia (DoEE, 2017), 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, and 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, 2017). No known loggerhead foraging areas have been identified in Victoria waters (DoEE, 2017). As such, it is unlikely to occur within the spill EMBA.

Green turtle

A comparison of presence and absence for the green turtle between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	No

The green turtle (*Chelonia mydas*) is distributed in sub-tropical and tropical waters around the world (Limpus, 2008b; DoEE, 2017). 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, 2017). There are no known nesting or foraging grounds for green turtles in Victoria and they occur only as rare vagrants (DoEE, 2017). The DoEE (2017) 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). As such, there is a low probability that this species may be encountered in the spill EMBA.

Leatherback turtle

A comparison of presence and absence for the leatherback turtle between the database searches of the survey area and EMBA is presented over page.

	PMST	ALA	VBA
Survey area	Yes	No	No
EMBA	Yes	Yes	Yes

The leatherback turtle (*Dermochelys coriacea*) is widely distributed throughout tropical, sub-tropical and temperate waters of Australia (DoEE, 2017) including oceanic waters and continental shelf waters along the coast of southern Australia (Limpus, 2009). Unlike other marine turtles the leatherback turtle utilises cold water foraging areas with reported foraging along the coastal waters of central Australia (southern Queensland to central New South Wales), southeast Australia (Tasmania, Victoria and eastern South Australia) and southern Western Australia (Limpus, 2009). This species feeds on soft-bodied invertebrates including jellyfish (Limpus, 2009). No major nesting has been recorded in Australia, with isolated nesting recorded in the Northern Territory, Queensland and northern New South Wales (DoEE, 2017). This species nests only in the tropics. The DoEE (2017) maps the leatherback turtles as having a known or likely range within Bass Strait and a migration pathway in southern waters with 36 sightings of the species recorded in the EMBA (CIE, 2020). The spill EMBA area is not a critical habitat for the species; it may occur in low numbers during migration.

Hawksbill turtle

A comparison of presence and absence for the leatherback turtle between the database searches of the survey area and EMBA is presented below.

	PMST	ALA	VBA
Survey area	No	No	No
EMBA	Yes	Yes	Yes

The Hawksbill turtle is widely distributed in the tropical and sub-tropical waters of Australia. Their eggs are laid on warm beaches with the most important nesting sites for the species located in northern Queensland, north-east Arnhem Land and Western Australia (DoEE, 2017). There has been one sighting of the species recorded in the EMBA (CIE, 2020). 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 (2017) maps the Hawksbill turtle as having a known or likely range in eastern Bass Strait. The spill EMBA area does not intersect any known nesting beaches of the Hawksbill turtle; the species may occur in the spill EMBA as a vagrant.

5.4.9 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; and
- Explicit transport of species for scientific research.

Marine pests known to occur in Bass Strait, according to Parks Victoria (2020):

- 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. fragile*) – 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.
- Cord grass (*Spartina anglica* and *Spartina x townsendii sp*) – found at the mouth of Bass River and in drain outlets near Tooradin in Western Port. Widespread in South Gippsland including Anderson's Inlet and Corner Inlet. Invades native saltmarsh, mangroves and mudflats, altering the mud habitat and excluding other species.

5.5 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 5.10 providing an outline of the conservation categories included.

Table 5.10. Conservation values in the EMBA

Category	Conservation classification	EP Section
MNES	Commonwealth marine areas (principally AMPs)	5.5.1
	World Heritage-listed properties	5.5.2
	National Heritage-listed places	5.5.3
	Wetlands of International Importance	5.5.4
	Nationally threatened species and threatened ecological communities	Throughout Sections 5.4 and 5.5.6.
	Migratory species	Throughout Section 5.4

	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	5.5.5
	Key Ecological Features (KEFs)	5.5.7
	Nationally important wetlands	5.5.8
Victorian protected areas	MNPs, marine parks and sanctuaries	5.5.9
	Coastal (onshore) conservation reserves	5.5.9
Tasmanian protected areas	MNPs, marine parks and sanctuaries	5.5.10
	Coastal (onshore) conservation reserves	5.5.10

5.5.1 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 14 AMPs in the South-east Commonwealth Marine Reserves Network – the spill EMBA intersects the following AMPs. Figure 5.21 illustrates the locations of the AMPs, which are described in this section:

- Apollo;
- Zeehan;
- Franklin;
- Boags;
- Beagle;
- Flinders; and
- East Gippsland

Appendix 1 presents the strategic objectives of the South-east Commonwealth Marine Reserves Network Management Plan 2013-2023 (DNP, 2013) against the routine and non-routine impacts of the survey.

<u>Apollo AMP</u>

The Apollo AMP is located off Apollo Bay on Victoria's west coast in waters 80 m to 120 m deep on the continental shelf, 115 km northwest of the survey area. The reserve covers 1,184 km^2 of Commonwealth ocean territory (DNP, 2013). The reserve encompasses the continental shelf ecosystem of the major biological zone that extends from South Australia to the west of Tasmania. The area includes the Otway Depression, an undersea valley that joins the Bass Basin to the open ocean (DNP, 2013). Apollo AMP features ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province. The area is an important foraging area for black-browed and shy albatross, Australasian gannet, short-tailed shearwater and crested tern. Apollo AMP contains the wreck of the *MV City of Rayville* (DNP, 2013).

<u>Zeehan AMP</u>

The Zeehan AMP is located 113 km west of the survey area and covers an area of 19,897 km^2 to the west and south-west of King Island in Commonwealth waters surrounding north-western Tasmania (DNP, 2013). It covers a broad depth range from the shallow continental shelf depth of 50 m to the abyssal plain which is over 3,000 m deep. The reserve spans the continental shelf, continental slope and deeper water ecosystems of the major biological zone that extends from South Australia to the west of Tasmania. Four submarine canyons incise the continental slope, extending from the shelf edge to the abyssal plains. A rich community made up of large sponges and other permanently attached or fixed invertebrates is present on the continental shelf, including giant crab (*Pseudocarcinus gigas*). Concentrations of larval blue warehou (*Seriolella brama*) and ocean perch (*Helicolenus spp*.) demonstrate the role of the area as a nursery ground. Rocky limestone banks provide important seabed habitats for a variety of commercial fish and crustacean species including the giant crab. The area is also a foraging area for a variety of seabirds such as fairy prion, shy albatross, silver gull, and short tail shearwater (DNP, 2013).

Franklin AMP

The Franklin AMP is located 70 km southwest from the survey 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 km^2. 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 group of islands. Great white sharks are also known to forage in the reserve (DNP, 2013).

Boags 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 Boags AMP covers 537 km^2 and is located off the northwest tip of Tasmania north of Three Hummock Island. Boags AMP is 13 km southwest of the acquisition area and is intersected by the operational area. 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 group of islands 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 blue whale 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, 2019).

Beagle AMP

The Beagle AMP is located 74 km east-northeast of the survey area in shallow water (50-70 m deep) and covers an area of 2,928 km^2 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, Australian gannet, common diving petrel and little penguins.

Flinders AMP

The Flinders AMP is located 275 km southeast of the survey area and covers a depth range from about 40 m on the shallow continental shelf to abyssal depths of 3000 m or more near the edge of Australia's exclusive economic zone (DNP, 2013). Flinders AMP covers continental shelf and a long section of steep continental slope incised by a series of deep submarine canyons. Sea bottom habitats include sheer rocky walls and large rocky outcrops that support a rich diversity of small seabed animals, such as lace corals and sponges. These and the large expanses of sandy and muddy sediments are habitats to a wide variety of fishes and to populations of the giant crab. Areas between 400 m and 600 m of the continental slope sea floor are habitat for dogfish and gulper sharks, and Harrison's dogfish has been recently recorded in the reserve (DNP, 2013). The biodiversity of the reserve is influenced by summer incursions of the warm East Australian Current and associated large-scale eddies. Flinders AMP also features offshore seamounts that are generally considered to be important centres of deep ocean biodiversity, although these far offshore extents are not intersected by the EMAB.

East Gippsland AMP

The East Gippsland AMP is located 380 km northeast of the survey area and contains an extensive network of canyons, continental slope and escarpment at water depths from 600 m to more than 4,000 m. The mix of both warm and temperate waters in the reserve create habitat for free-floating aquatic plants or phytoplankton. The East Australian Current combined with complex seasonality in oceanographic patterns creates large eddies of warm water with cooler, nutrient rich waters around the outside of the eddies (DNP, 2013). The mixing of these patterns creates conditions for highly productive phytoplankton growth, which support a rich abundance of marine life. Oceanic birds including albatrosses, petrels and shearwaters are known to forage in these waters. Humpback whales pass by the reserve during their migrations north and south (DNP, 2013).

5.5.2 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.

No properties on the World Heritage List occur within the spill EMBA. The nearest site is the Royal Exhibition Building and Carlton Gardens in Melbourne, an onshore property located 198 km north of the survey area.

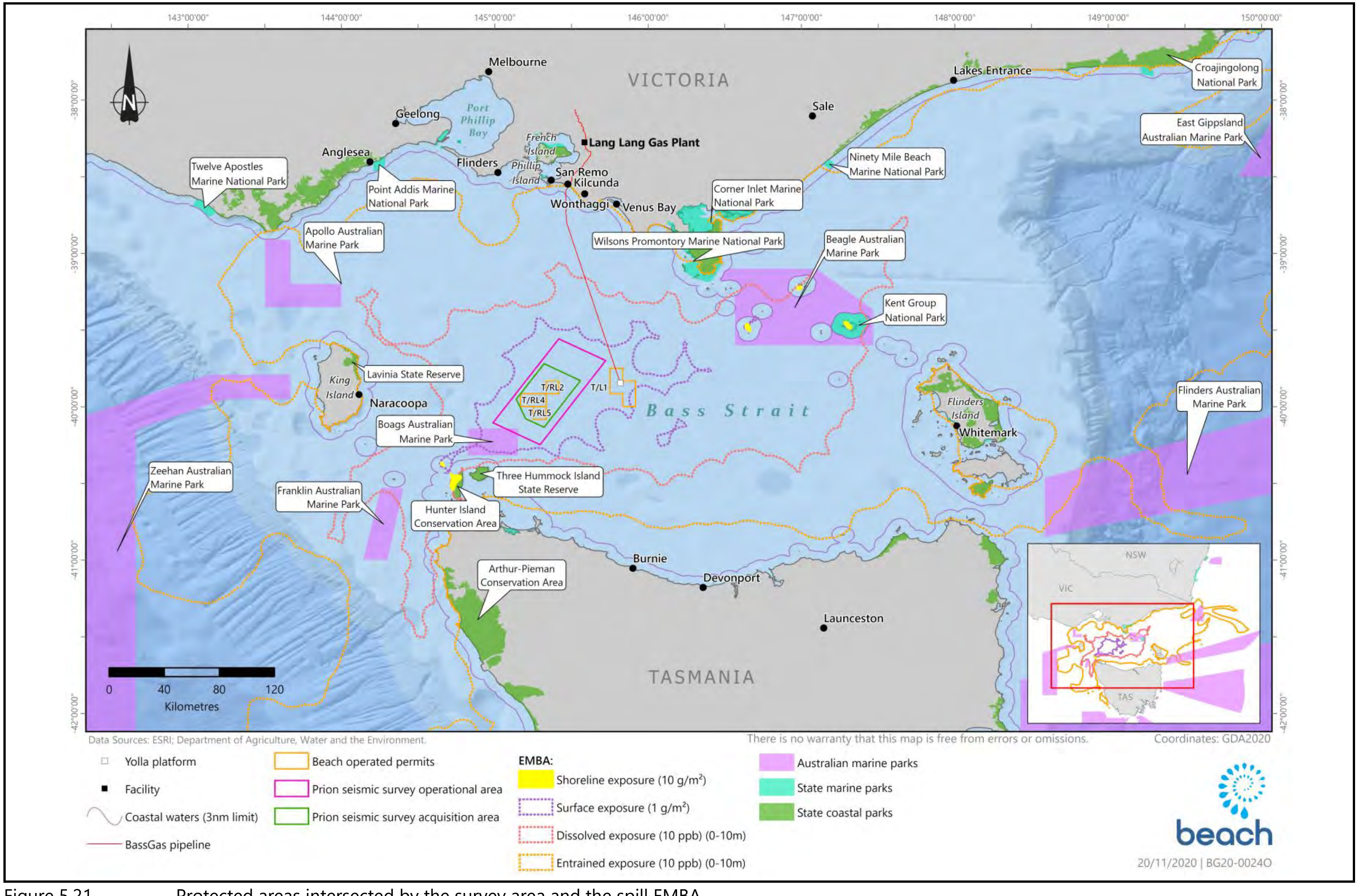


Figure 5.21. Protected areas intersected by the survey area and the spill EMBA

5.5.3 National Heritage-listed Places

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. The PMST Report states that the Western Tasmania Aboriginal Cultural Landscape is intersected by the spill EMBA. This national heritage-listed place is described below.

The Western Tasmania Aboriginal Cultural Landscape

During the late Holocene Aboriginal people on the west coast of Tasmania developed a specialised and more sedentary way of life 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 way of life 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.

5.5.4 Wetlands of International Importance

Australia has 66 wetlands of international importance ('Ramsar wetlands') that cover more than 8.3 million hectares (as of March 2020) (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.

The 'Lavinia' and 'Corner Inlet' Ramsar sites are intersected by the entrained hydrocarbons EMBA and are described here and presented in Figure 5.22.

Lavinia

The Lavinia Ramsar site is located on the northeast coast of King Island, Tasmania. 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 one of the few largely unaltered areas of the island and contains much of the remaining 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 (PWS, 2000).

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, these being:

- 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.

<u>Corner Inlet</u>

The Corner Inlet Ramsar Site is located 120 km northeast of the survey area and includes Corner Inlet and Nooramunga Marine and Coastal Park and the Corner Inlet MNP. It covers 67,192 ha and represents the most southerly marine embayment and intertidal system of mainland Australia (Parks Victoria, 2005a).

The major features of Corner Inlet that form its ecological character are its large geographical area, the wetland types present (particularly the extensive subtidal seagrass beds), diversity of aquatic and semi-aquatic habitats and abundant flora and fauna, including significant proportions of the total global population of a number of waterbird species (BMT WBM, 2011). The description below provides the values and baseline ecological character of the Corner Inlet Ramsar Site.

The Corner Inlet Ramsar Site Management Plan (WGCMA, 2014) identifies the key values of the site as:

- A substantially unmodified wetland that supports a range of estuarine habitats (seagrass, mud and sand flats, mangroves, saltmarsh and permanent marine shallow water);
- Presence of nationally threatened species including orange-bellied parrot, Australian grayling, fairy tern and growling grass frog;
- Non-breeding habitats for migratory shorebird species and breeding habitat for variety of waterbirds including several threatened species;
- Important habitats, feeding areas, dispersal and migratory pathways and spawning sites for numerous fish species of direct or indirect fisheries significance;
- Over 390 species of indigenous flora (15 listed species) and 160 species of indigenous terrestrial fauna (22 threatened species) and over 390 species of marine invertebrates;

- A wide variety of cetaceans and pinnipeds including bottlenose dolphins and Australian fur-seals, as well as occasional records of common dolphins, New Zealand fur-seals, leopard seals and SRW;
- Significant areas of mangrove and saltmarsh that are listed nationally as vulnerable ecological communities and provide foraging, nesting and nursery habitat for many species;
- Sand and mudflats, when exposed at low tide, that provide important feeding grounds for migratory and resident birds and at high tide provide food for aquatic organisms including commercial fish species;
- Ports and harbours – the four main ports (Port Albert, Port Franklin, Port Welshpool and Barry's Beach) service the commercial fishing industry, minor coastal trade, offshore oil and gas production and boating visitors;
- Fishing – the area supports the third largest commercial bay and inlet fishery in Victoria, including 18 licensed commercial fishermen, within an economic value of between $5 and $8 million annually;
- Recreation and tourism – Corner Inlet provides important terrestrial and aquatic environments for tourism and recreational activities such as fishing, boating, sightseeing, horse riding, scuba diving, bird watching and bushwalking;
- Cultural significance to the Gunaikurnai people, with the Corner Inlet and Nooramunga area located on the traditional lands of the Brataualung people who form part of the Gunaikurnai Nation. The area has a large number of cultural heritage sites that provide significant information for the Gunaikurnai people of today about their history. The Bunurong and the Boon Wurrung peoples also have areas of cultural significance in this region;
- Thirty-one shipwrecks are present in the site; and
- Research and education – the wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation within the Corner Inlet Ramsar Site provide a range of opportunities for education and interpretation.

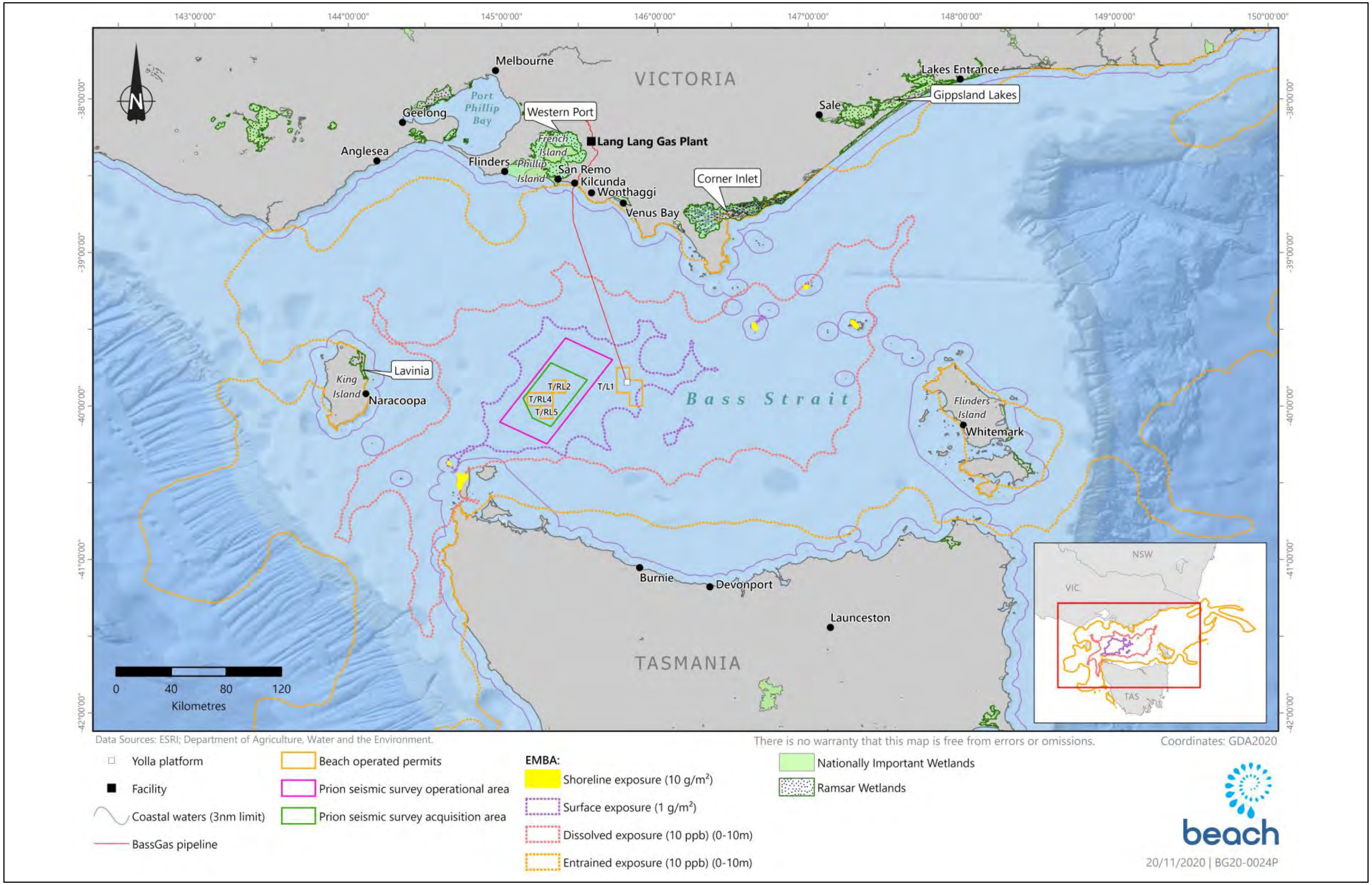


Figure 5.22. Ramsar and Nationally Important Wetlands intersected by the survey area and the EMBA

5.5.5 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 spill EMBA. Though the PMST Report lists the Gabo Island Lighthouse, Goose Island Lighthouse, Cape Lighthouse and Wilsons Promontory Lighthouse, each of these are located high above the high-water mark and the lighthouses themselves are not considered part of the EMBA. The nearest place is the Cape Wickham Lighthouse (106 km west of the survey area), which occurs on a prominent rocky headland (DAWE, 2020f).

5.5.6 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). The following TECs have been identified as potentially occurring in the EMBA:

- Alpine Sphagnum Bogs and Associated Fens
- Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria;
- Giant Kelp Marine Forests of South East Australia;
- Lowland Native Grasslands of Tasmania;
- Natural Damp Grasslands of the Victorian Coastal Plains
- Subtropical and Temperate Coastal Saltmarsh; and
- Tasmanian Forests and Woodland dominated by black gum or Brookers gum (*Eucalyptus ovata/E. brookeriana*).

Only assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria, Giant Kelp Marine Forests of South East Australia and Subtropical and Temperate Coastal Saltmarsh TECs are described here as the remaining TECs are terrestrial and not present in the spill EMBA. TECs mapped in relation to the EMBA are presented in Figure 5.23.

<u>Giant Kelp Marine Forests of South East Australia</u>

The Giant Kelp Marine Forests of South East Australia TEC is mapped as potentially occurring among islands of the Furneaux Group, the northwest and west coast of Tasmania, around Erith, Dover and Deal Islands in the Beagle AMP, and small areas southwest and east of Mallacoota.

According to the Approved Conservation Advice for Giant Kelp Marine Forests of South East Australia (DSEWPC, 2012a), giant kelp (*Macrocystis pyrifera*) is a 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. 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, 2012a).

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 sp*), urchins, sponges, blacklip abalone (*Tosia spp*) and SRL.

The large biomass and productivity of the giant kelp plants also provides 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, 2012a).

Giant kelp requires clear, shallow water no deeper than approximately 35 m below sea level (DSEWPC, 2012a). They are photoautotrophic 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 located in Tasmanian coastal waters.

Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria

According to the Approved Conservation Advice for the assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria, this ecological community is the assemblage of native plants, animals and micro-organisms associated with the dynamic salt-wedge estuary systems that occur within the temperate climate, microtidal regime (< 2 m), high wave energy coastline of western and central Victoria (TSSC, 2018). The ecological community currently encompasses 25 estuaries in the region defined by the border between South Australia and Victoria and the most southerly point of Wilsons Promontory (TSSC, 2018).

Salt-wedge estuaries are usually highly stratified, with saline bottom waters forming a 'salt-wedge' below the inflowing freshwater layer of riverine waters. The dynamic nature of salt-wedge estuaries has important implications for their inherent physical and chemical parameters, and ultimately for their biological structure and ecological functioning. Some assemblages of biota are dependent on the dynamics of these salt-wedge estuaries for their existence, refuge, increased productivity and reproductive success. The ecological community is characterised by a core component of obligate estuarine taxa, with associated components of coastal, estuarine, brackish and freshwater taxa that may reside in the estuary for periods of time and/or utilise the estuary for specific purposes (e.g., reproduction, feeding, refuge, migration) (TSSC, 2018).

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 Western Australia (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.

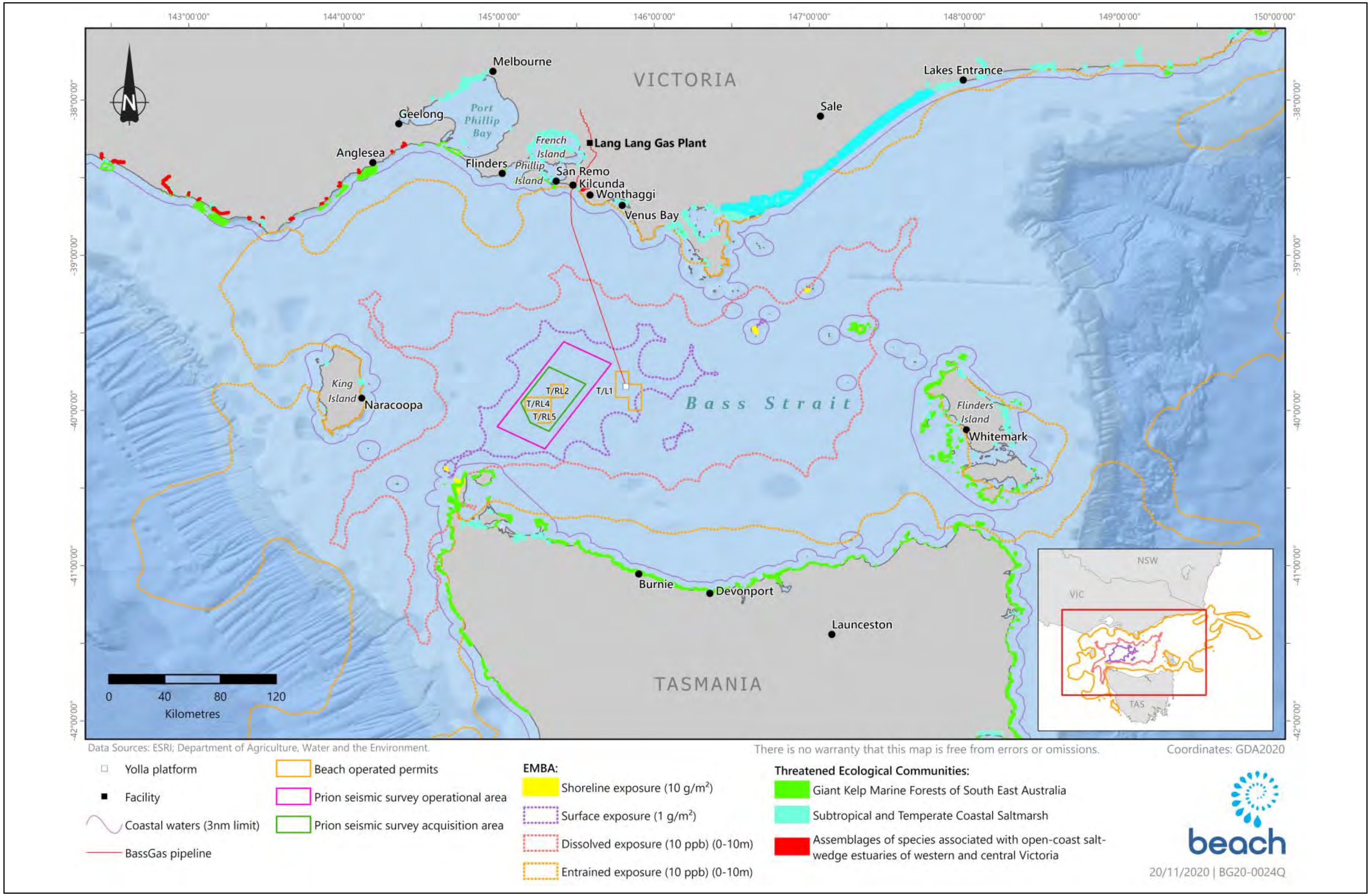


Figure 5.23. TECs intersected by the survey area and the EMBA

5.5.7 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 three KEFs (Figure 5.24), these being the West Tasmanian Canyons (136 km to the west of the survey area), the Upwelling East of Eden, (266 km to the northeast) and Big Horseshoe Canyon (351 km to the northeast). Each KEF is described below.

Upwelling East of Eden

Dynamic eddies of the EAC 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 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).

West Tasmania Canyons

The West Tasmania Canyons are 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 (outside the EMBA) 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.

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 and ocean perch), foraging seabirds (albatross and petrels), white shark and foraging blue and humpback whales.

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).

5.5.8 Nationally Important Wetlands

Nationally Important Wetlands (NIW) are considered important for a variety of reasons, including their importance for maintaining ecological and hydrological roles in wetland systems, providing important habitat for animals at a vulnerable stage in their life cycle, supporting 1% or more of the national population of a native plant or animal taxa or for its outstanding historical or cultural significance (DAWE, 2020g).

Ten NIWs have been identified to occur along the coast that is intersected by the spill EMBA (Figure 5.22). 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):

- Unnamed Wetland (TAS081) – This wetland is located on the northwest coast of Tasmania 6 km northwest of the Arthur River township and covers 3 ha. The site is an important representative wetland for the region and supports communities which are poorly reserved in Tasmania such as *Hydrocotyle muscosa* herbfields.
- Lavinia Nature Reserve (TAS075) – the eastern part of this NIW intersects the EMBA. Lavinia is also a wetland of international significance and is described in Section 5.5.4. 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) – the EMBA intersects the section of Western Port that is designated as a NIW but does not intersect the section recognised as a Ramsar wetland. 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.
- Powlett River Mouth (VIC078) - The Powlett River Mouth supports saltmarsh vegetation which in turn provides valuable habitat for the endangered orange-bellied parrot by supporting saltmarsh vegetation.
- Corner Inlet (VIC066) – this site is listed as a Ramsar site and supports 22 waterbirds species listed under the JAMBA and 17 waterbird species under the CAMBA agreements. The site is an internationally important wetland and is described in detail in Section 5.5.4.
- Jack Smith Lake State Game Reserve (VIC069) – Jack Smith Lake was once likely a bay that has now been isolated from the sea by the development of a sandy barrier. The wetland features thickets of swamp paperbark (*Melaleuca ericifolia*), which are subject to regular wetting and drying cycles. There is an artificial ocean outlet that controls water levels within the site. Over 100 bird species including 45 waterbird species have been recorded on the reserve including the threatened orange-bellied parrot (*Neophema chrysogaster*).
- Lower Snowy River Wetlands System (VIC087) – This wetland is located towards the mouth of the Snowy River in east Gippsland. The site is of high value for its ecological, recreational, scientific, educational and scenic values. The wetlands are an excellent example of a floodplain system with a diverse range of habitats and extensive areas of swamp papersbark (*Melaleuca ericifolia*), reed beds, saltmarsh and mud flats.
- Tamboon Inlet (VIC135) – 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) – 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.
- Benedore River (VIC154) – This wetland occurs in east Gippsland in the Croajingolong National Park. The Benedore River has no introduced fish species and a natural assemblage of native species, which indicates pristine conditions. There are 16 threatened flora species recorded in the wetland. There are 25 threatened fauna species including the little tern (*Sterna albifrons*). The Benedore River is contained behind Ninety Mile Beach dunes, which may be open during times of high flow.

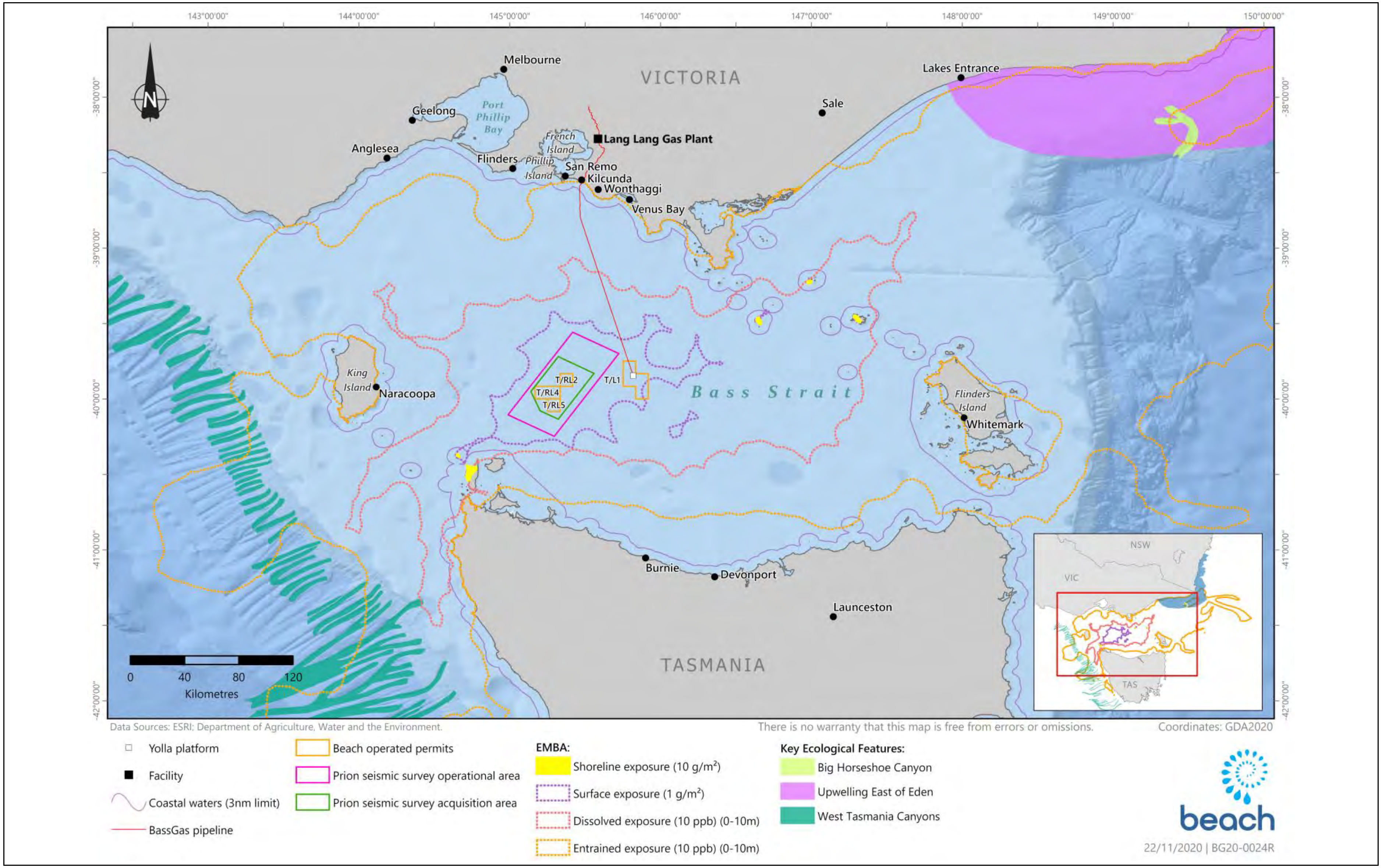


Figure 5.24. KEFs intersected by the survey area and the spill EMBA

5.5.9 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. Offshore, there are 24 Victorian marine national parks and sanctuaries.

The six marine protected areas and ten onshore protected areas (i.e., reserves that extend to the low-water mark) intersected by the EMBA are shown in Figure 5.21 and described in Table 5.11, moving west to east along the EMBA.

5.5.10 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. Offshore, there are seven marine reserves and 14 marine conservation areas (with the latter restricted to waters around Hobart in southern Tasmania).

The two marine protected areas and 59 onshore protected areas intersected by the EMBA are shown in Figure 5.21 and described in Table 5.12, moving anti-clockwise through the spill EMBA beginning at King Island.

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

Table 5.11. Victorian marine and coastal protected areas in the spill EMBA

Name	Distance from the survey area	Description
Marine protected areas		
Bunurong MNP	98 km northeast. Extends over 5 km of coastline 2.5 km east of Cape Patterson in south Gippsland and reaches offshore for 3 nm to the limit of Victorian waters.	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 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	99 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.
Wilsons Promontory MNP	86 km northeast. Extends along 70 km of coastline on the southern tip of Wilsons Promontory National Park including Victorian state waters.	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, 2006b). 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 southernmost tip of mainland Australia, it's one of the country's best examples of marine biodiversity protection (Parks Victoria, 2006b).
Wilsons Promontory Marine Park	86 km northeast.	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, 2006b). 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, 2006b).

Name	Distance from the survey area	Description
Point Hicks MNP	371 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, 2006c). 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*).
Cape Howe MNP	440 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, 2006d). 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;

Name	Distance from the survey area	Description
		• 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 SRW, 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)		
Great Otway National Park	177 km northwest.	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

Name	Distance from the survey area	Description
		• The majority of the Aire Heritage River corridor.
Phillip Island Nature Park	110 km north.	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).
Kilcunda Harmers Haven Coastal Reserve	101 km north. 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	85 km 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	85 km northeast.	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).
Nooramunga Marine and Coastal Park	129 km northeast.	Nooramunga Marine and Coastal Park covers an area of 30,170 ha in Corner Inlet. The park is also protected as a Ramsar wetland (see Section 5.5.4). The park consists of shallow marine waters, intertidal mudflats and a series of over forty sand islands. The Park, along with the Corner Inlet Marine and Coastal Park to its west, contain the largest stands of white mangrove and saltmarsh areas in Victoria (BMT WBM, 2011). The saltmarshes are dominated by beaded and shrubby glassworts. Seagrass meadows also occur throughout the park. Seaward of the mangroves are extensive areas of intertidal mud and sand flats. An immense range of marine plants and invertebrates can be found here that provide food for the thousands of migratory wading birds that arrive each year from their northern hemisphere breeding grounds. The seagrass meadows provide habitat to over 300 marine invertebrates, including a range of large crabs, seastars, sea snails, iridescent squid and many fish including pipefish, stingarees, flathead, whiting and flounder. Finfish such as snapper, King George whiting, flathead, garfish and salmon are caught by recreational fishers. Thirty-two (32) migratory wader species have been recorded in the park, including the largest concentrations of bar tailed godwit (*Limosa lapponica*) and great knot (*Calidris tenuirostris*) in south-eastern Australia. In summer the ocean beaches and sand provide nesting habitat for pied oystercatchers, crested terns, Caspian terns, fairy terns and hooded plovers.

Name	Distance from the survey area	Description
McLoughlins Beach – Seaspray Coastal Reserve	166 km northeast.	This park encompasses the foreshore between McLoughlins Beach and Seaspray, including a narrow portion of the sea. There is no management plan for this coastal reserve and a paucity of information about the reserve's values. It was known to be an area of importance for hooded plover nesting, and is popular with recreational fishers (with salmon, flathead, snapper and tailor being the main catch species).
Marlo Coastal Reserve	323 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.
Cape Conran Coastal Park	343 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, 2005b). 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, 2005b).
Croajingolong National Park	376 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).

Name	Distance from the survey area	Description
		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 5.12.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 the survey area	Description
Marine Protected Areas		
Kent Group Marine Reserve and Kent Group National Park	Located 138 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 strong-hold 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).
Arthur Bay Conservation Area	195 km southeast.	Arthur Bay Conservation Area covers 7.5 km^2 and includes the coastline and marine areas south of Blue Rocks and north of Whitemark on the west coast of Flinders Island. There is no management plan in place.
Onshore Protected Areas (where the EMBA intersects shorelines)		
Councillor Island Nature Reserve	87 km west.	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	92 km west.	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	91 km west.	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	101 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	114 km west.	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.

Name	Distance from the survey area	Description
City of Melbourne Bay Conservation Area	85 km west.	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.
Albatross Island Nature Reserve	41 km southwest.	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	50 km southwest.	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	60 km southwest.	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	30 km southwest.	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	37 km southwest.	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	62 km southwest.	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	62 km southwest.	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	61 km southwest.	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	61 km southwest.	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.
Stack Island Game Reserve	59 km southwest.	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.

Name	Distance from the survey area	Description
The Doughboys Nature Reserve	70 km southwest.	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	80 km southwest.	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	93 km southwest.	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 southwest.	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	128 km southwest.	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).
Boxen Island Conservation Area	208 km southeast.	Boxen Island is a flat dolerite island with an area of 7 ha in eastern Bass Strait's Furneaux Group. The reserve is considered part of an IBA Area because it supports hundreds of breeding pairs of black-faced cormorants. The area is designated IUCN Category V. There is no management plan in place.
Goose Island Conservation Area	199 km southeast.	Goose Island, part of the Badger Group within the Furneaux Group, is a 109-ha unpopulated granite island. The Conservation Area hosts breeding pairs of seabird and shorebird species including short-tiled shearwaters, pacific gulls and sooty oystercatchers. Goose Island Conservation Area is designated IUCN Category VI and does not have a management plan in place.
Badger Island Indigenous Protection Area	201 km southeast.	The Badger Island Indigenous Protected Area covers an area of 12.43 km^2 and is located on an unpopulated low-lying granite and limestone island in eastern Bass Strait. The island and its surrounds previously supported a community of Tasmanian Aboriginal people but is no longer inhabited. The area is designated IUCN Category V and does not have a management plan in place.
Mount Chappell Island Indigenous Protected Area	209 km southeast.	Mount Chappell Island Indigenous Protected Area is found in Bass Strait and forms parts of the Furneaux Group of islands. The island has long been regarded by Aboriginal people as an important part of the seasonal food-gathering cycle, and the Tasmanian Government handed it back to the Aboriginal community in 1995. The small island is now managed as an Indigenous Protected Area by the Tasmanian Aboriginal Centre. There is no management plan in place.
Fotheringate Bay Conservation Area	215 km southeast.	Fotheringate Bay Conservation Area covers 1.24 km^2 and is located on the west coast of Flinders Island in Bass Strait. The Conservation Area is adjacent to the Strzelecki National Park and contains a popular beach and camping ground among locals. There is no management plan for the Fotheringate Bay Conservation Area.
Big Green Island Nature Reserve	208 km southeast.	Big Green Island is located 3 km off the west coast of Flinders Island and is part of the Furneaux Group. The reserve covers the entire 122 ha granite island and is a recorded breeding site for seabird and wader species. There is no management plan for the reserve.

Name	Distance from the survey area	Description
East Kangaroo Island Nature Reserve	199 km southeast.	East Kangaroo Island is located 8.5 km off the west coast of Flinders Island and is part of the Furneaux Group. The reserve covers the entire 157 ha limestone island and is a recorded breeding site for seabird and wader species. The reserve is part of the Chalky, Big Green and Badger Island Groups IBA. There is no management plan for this reserve.
Chalky Island Conservation Area	203 km east from.	Chalky Island is located 5 km off the west coast of Flinders Island and is part of the Furneaux Group. The area covers the entire 41 ha unpopulated granite island and is a recorded breeding site for seabird and wader species. The conservation area is part of the Chalky, Big Green and Badger Island Groups IBA. There is no management plan for this reserve.
Isabella Island Nature Reserve	209 km southeast.	Isabella Island is located 3.5 km off the west coast of Flinders Island and is part of the larger Furneaux Group. The nature reserve covers the entire 11.5 ha unpopulated granite island and is a recorded breeding site for seabird and wader species. The Nature Reserve is part of the Chalky, Big Green and Badger Island Groups IBA. There is no management plan for this reserve.
Prime Seal Island Conservation Area	188 km southeast.	Prime Seal Island is located 6.5 km off the west coast of Flinders Island and is part of the Furneaux Group. The conservation area covers the entire 1,220 ha limestone and granite island and is a recorded breeding site for seabird and wader species. There is no management plan in place for this area.
Settlement Point Conservation Area	197 km southeast.	Settlement Point Conservation Area covers an area of 0.63 km^2 and is located on the west coast of Flinders Island. The coastline of this area is primarily rocky shore, cliff face and intermittent stretches of beach. There is no management plan for this area.
Emita Nature Recreation Area	200 km east.	The Emita Nature Recreation Reserve covers an area of 1.34 km^2 is located on the west coast of Flinders Island adjacent the township of Emita. The coastline of the reserve is predominantly sandy beach with intermittent rocky shore. There is no management plan for this area.
Marshall Beach Conservation Area	200 km east.	Marshall Beach Conservation Area covers 1.9 km^2 of the coast on the western coast of Flinders Island. The conservation area primarily encompasses a long stretch of sandy beach and extends only 100-200 m inland. There is no management plan for this conservation area.
Marriott Reef Conservation Area	201 km east.	The Marriott Reef Conservation Area covers an area of 0.16 km^2 of the marine environment and begins 500 m off the west coast of Flinders Island. The Area is designated IUCN Category V and there is no management plan in place.
Mount Tanner Nature Recreation Area	190 km east.	Mount Tanner Nature Recreation Area covers an area of 42.25 km^2 and is located on the northwest coast of Flinders Island. The area protects inland remnant vegetation and its coastal areas are a combination of sandy beach and rocky shores. Mount Tanner Nature Recreation Area is designated IUCN Category VI and does not have a management plan.
Bun Beetons Point Conservation Area	184 km east.	Bun Beetons Point Conservation Area covers an area of 1.01 km^2 and is located on the northwest coast of Flinders Island. It protects a coastline of rocky shores and sandy beaches and stretches 100-150 m inland. There is no management plan in place.
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.
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.

Name	Distance from the survey area	Description
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.
Blyth Point Conservation Area	176 km east.	Blyth Point Conservation Area covers an area of 1.1 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 and stretches 100-150 m inland. Blyth Point Conservation Area is designated IUCN Category V and there is no management plan in place.
Palana Beach Nature Recreation Area	178 km east.	Palana Beach Nature Recreation Area covers an area of 0.6 km^2 and is located on the north coast of Flinders Island. The coastline of this Nature Recreation Area is predominantly sandy beach. Palana Beach Nature Recreation Area is designated IUCN Category V and there is no management plan in place.
Jacksons Cove Conservation Area	180 km east.	Jacksons Cove Conservation Area covers an area of 2.4 km^2 and is located on the north coast of Flinders Island. The coastline of this conservation area is a mix of rocky shores and stretches of sandy beach. Jacksons Cove Conservation Area is designated IUCN Category VI and there is no management plan in place.
Sister Islands Conservation Area	182 km northeast.	The Sister Islands Conservation Area covers an area of 13.8 km^2 over two main granite and dolerite islands located 2 and 7 km off the north coast of Flinders Island. The conservation area is a recorded breeding site for seabird and wader species and is designated IUCN Category VI with no management plan in place.
North East River Game Reserve	215 km east.	The North east River Game Reserve covers an area of 25.59 km^2 and is located on the northeast coast of Flinders Island. The coast of the conservation area is an extensive stretch of sandy beach with the land further inland dominated by coastal scrub and woodland. The conservation area includes an estuarine lagoon that is intermittently open to the ocean and is IUCN designated Category VI. There is no management plan in place.
Foochow Conservation Area	220 km east.	The Foochow Conservation Area covers an area of 59 km^2 and is located on the east coast of Flinders Island. The coast of the conservation area is an extensive sandy beach with semi-permanent waterbodies further inland. The conservation area is designated IUCN Category VI and there is no management plan in place.
Patriarchs Conservation Area	248 km east.	Patriarchs Conservation Area is located on the east coast of Flinders Island and covers an area of 40.53 km^2. The conservation area extends 7 km inland and along 13 km of sandy beach. The conservation area is designated IUCN Category VI and there is no management plan in place.
Craggy Island Conservation Area	168 km east.	Craggy Island Conservation Area is located 15 km off the northwest coast of Flinders Island and covers an area of 0.36 km^2 of the rugged granite island. The conservation area hosts breeding pairs of seabird and shorebird species including short-tiled shearwaters, little penguins, fairy prions and sooty oystercatchers. Craggy Island Conservation Area is designated IUCN Category V and does not have a management plan.

Name	Distance from the survey area	Description
Curtis Island Nature Reserve	83 km northeast. 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).
Devils Tower Nature Reserve	94 km northeast.	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	122 km northeast.	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.
North East Islet Nature Reserve	124 km northeast.	North East Islet (or Boundary Islet) Nature Reserve covers an area of 0.01 km^2 and is part of the Hogan Island Group. It is a haul-out site for the Australia fur-seal (Carlyon *et al.*, 2011). It is designated IUCN 1a, which is a strict nature reserve. There is no management plan for the reserve.
East Moncoeur Island Conservation Area	87 km northeast.	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	86 km northeast.	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	83 km northeast.	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	84 km northeast.	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	82 km northeast.	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.

5.6 Cultural Heritage

Cultural heritage can be broadly defined as the legacy of physical science artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations. Cultural heritage includes tangible culture such as buildings, monuments, landscapes, books, works of art, and artefacts, as well as intangible culture such as folklore, traditions, language, and knowledge, and natural heritage including culturally significant landscapes.

This section describes the cultural heritage values broadly categorised as Aboriginal and European heritage within the spill EMBA. The boundary of the spill EMBA includes the coastline up to the high-water mark.

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, 2018). The Victorian Aboriginal Heritage Register contains details of Aboriginal cultural heritage places and objects areas along the coastline and is not publicly accessible in order to maintain 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., rock lobster, crab) and shellfish formed an important part of the diet of Aboriginals 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 (AHR) 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 5.5.3). It must be assumed that sites will be scattered along the coast of King Island, Flinders Island and the broader area of the spill EMBA.

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 metres of sea country offshore. The determination of native title under the *Native Title Act* 1993 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.

<u>Tasmania</u>

There are no registered native title claims in Tasmania.

5.6.3 Maritime Archaeological Heritage

<u>Shipwrecks</u>

Shipwrecks over 75 years old are protected within Commonwealth waters under the *Historic Shipwrecks Act* 1976 (Cth), in Victorian waters under the *Victorian Heritage Act* 1995 (Vic), and in Tasmanian waters under the *Historic Cultural Heritage Act* 1995 (Tas).

There are 235 shipwrecks mapped within the spill EMBA using a search of the Australian National Shipwreck Database (DAWE, 2020h) (Figure 5.25).

The *Albert* (1850) (*shipwreck ID: 6844*) shipwreck is located within the survey area. *Albert* was a schooner of 44 tons and was built at the Albert River, Victoria, by John McKenzie in 1849. The schooner sailed from Circular Head in Tasmania for Melbourne on 9 September 1850 under the command of George Brush but failed to arrive. The vessel had previously loaded a cargo of potatoes at the Forth River and had hit the bar while outward bound for Circular Head to obtain a customs clearance, but the master elected to wait till he reached Melbourne before having the schooner surveyed. The damage may well have been more serious than he suspected (DAWE, 2020h).

<u>Shipwreck Protection Zones</u>

Of the 650 shipwrecks in Victoria, nine have been placed within protected zones (a no-entry zone of 500-m radius [78.5 ha] around a particularly significant and/or fragile shipwreck) (DAWE, 2020h). Five of these are located within Port Phillip Bay, and two along the west Gippsland coast, these being the *PS Clonmel* (135 km northeast of the survey area) and the *SS Glenelg* (181 km northeast of the survey area). Both shipwrecks are intersected by the spill EMBA and are described below.

SS Glenelg (1900) is one of the worst maritime disasters in Victorian history with the deaths of 38 people and only three survivors. After the wreck was discovered, it was subject to heavy looting and was placed in a protected zone to help prevent further theft. Maritime archaeologists also want to study the remains of the hull as the may provide unknown technical details of iron ship building, details of the refit the vessel underwent in 1898 and information pertaining to life on board a typical cargo/passenger vessel at the turn of the century (DAWE, 2020h).

The paddle steamer *PS Clonmel* (1841) was one of the first steam-powered vessels on the Australian coast. However, its career was short, being wrecked on its third voyage on what is now known as Clonmel Island at the Port Albert entrance. All on board reached safety, but much of the cargo was lost. The wreck of the Clonmel was instrumental in the settlement of Gippsland and the establishment of the towns of Port Albert, Tarraville and

Alberton. Although the wreck of the Clonmel was a disaster at the time, it is now one of the most significant archaeological sites in Victoria (DAWE, 2020h).

Lighthouses

There are numerous lighthouses in central Bass Strait (Figure 5.26), with the nearest lighthouse being that on Three Hummock Island, 30 km southwest of the survey area.

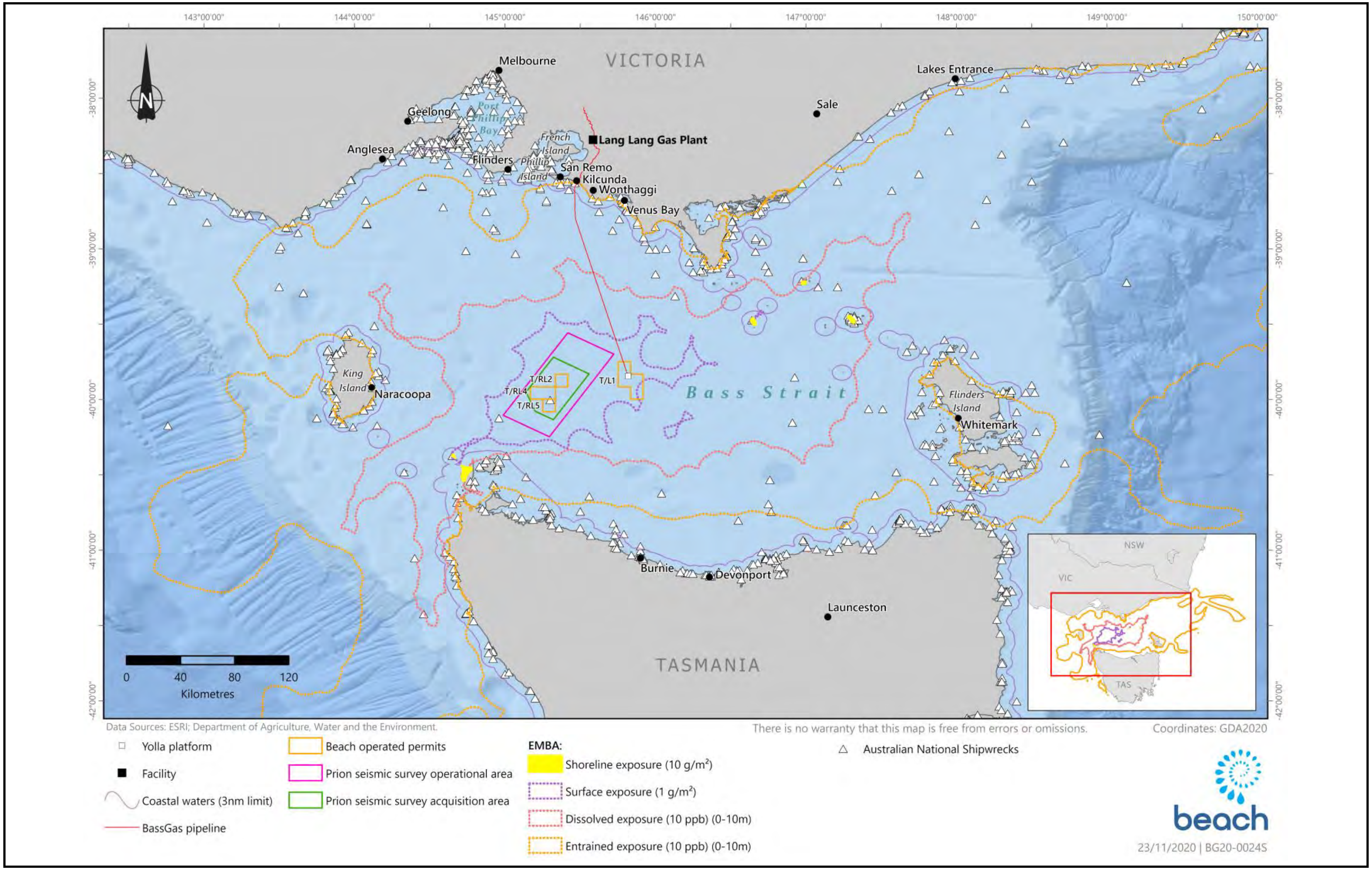


Figure 5.25. Known shipwrecks intersected by the survey area and the spill EMBA

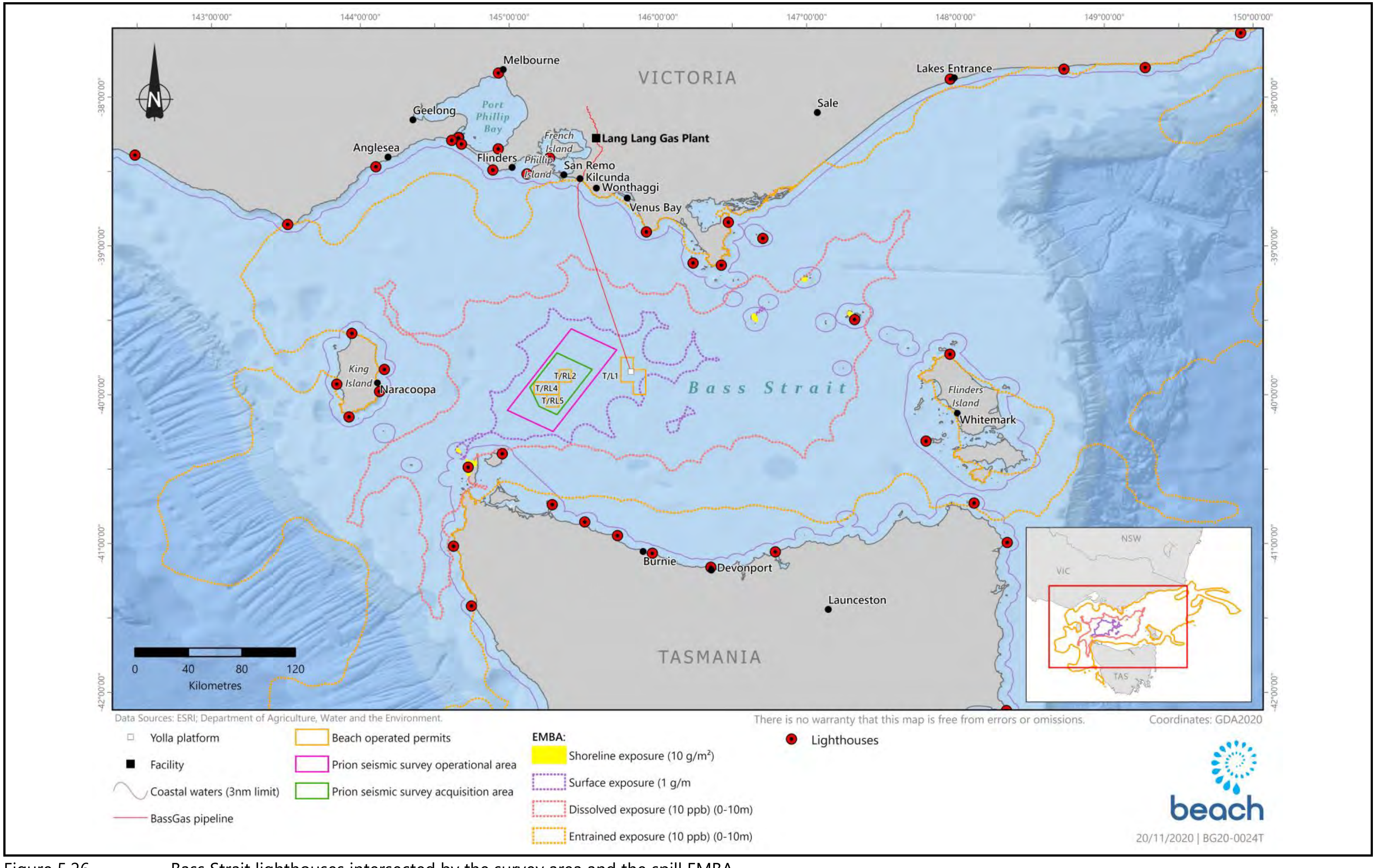


Figure 5.26. Bass Strait lighthouses intersected by the survey area and the spill EMBA

5.7 Socio-economic Environment

This section describes the social and economic environment of the spill EMBA using data from the Australian Bureau of Statistics (ABS) (ABS, 2020). Note, no settlements are predicted to be exposed to shoreline loading. As such, only representative settlements intersected by the EMBA are described here briefly. There are no settlements within the survey area.

5.7.1 Coastal Settlements

Victoria

The Bass Coast Shire is located in south-eastern Victoria, about 130 kilometres south-east of the Melbourne CBD and is a popular holiday destination. Bass Coast Shire is bounded by Western Port Bay in the north and west, Cardinia Shire in the north-east, South Gippsland Shire in the east, and Bass Strait in the south.

ABS data from the 2016 census for the Bass Coast Shire indicates that it has a population of 34,804 with a median age of 50 and with Aboriginal people making up 0.9% of the population. The Shire covers an area of 864 km^2, 88% of which is used for primary production.

Coastal towns along the coast of the EMBA within the Bass Coast Shire are briefly described below based on ABS 2016 census data:

- Kilcunda has a population of 396 people and a median age of 51. Of those in the labour force, 51.7% worked full-time and 37.8% worked part-time. Professionals, managers and technicians and trade workers made up 52.4% of the population’s occupations.
- 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.
- Cape Woolamai (Phillip Island) has a population of 1,549 and a median age of 38. It has 1,629 private dwellings, of which only 35.1% are permanently occupied, reflecting its popularity as a holiday home destination.
- 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.

ABS data from the 2016 census for the South Gippsland Shire indicates that it has a population of 28,703 with a median age of 47 and with Aboriginal people making up 1% of the population. The Shire covers an area of 3,296 km^2.

Coastal towns along the coast of the EMBA within the South Gippsland Shire are briefly described below based on ABS 2016 census data:

- Venus Bay has a population of 944 people and a median age of 58. Of those in the labour force, 42.6% worked full-time and 39.8% worked part-time. Technicians and trade workers made up 20% of the population’s occupations.
- Waratah Bay has a population of 56 people and a median age of 50. Due to the small population for this area, limited information is available.
- Sandy Point has a population of 209 people and a median age of 58. Of those in the labour force, 38.4% worked full-time and 49.3% worked part-time. Professionals and clerical and administrative workers made up 46.9% of the population’s occupations.

Tasmania

- Whitemark (Flinders Island) has a population of 301 people and a median age of 53. Of those in the labour force, 57% worked full-time and 34.2% worked part-time. Technicians and trade workers, managers and labourers made up 54.9% of the population's occupations.
- Naracoopa (King Island) has a population of 62 people and a median age of 53. Due to the small population for this area, limited information is available.
- Woolnorth has a population of 112 people and a median age of 27. Due to the small population for this area, limited information is available.
- Arthur River has a population of 57 people and a median age of 46. Due to the small population for this area, limited information is available.

5.7.2 Offshore energy exploration and production

In 2018, Victoria accounted for 11% of Australia's crude oil production, 11% of Australia's condensate production, 49% of Australia's LPG production and 10% of Australia's conventional gas production (APPEA, 2019). Production has been trending down since it peaked in 2000.

The spill EMBA intersects the Gippsland oil and gas production province, which contains numerous offshore platforms, subsea wells and pipelines. Petroleum production from the offshore Gippsland Basin is centred on the Esso Australia Resources Pty Ltd (EARPL) operations for the Gippsland Basin Joint Venture. EARPL produces oil and gas from 23 platforms and subsea developments, hundreds of wells and some 880 km of associated pipelines, tied back to the Longford Gas Plant and Long Island Point. Production first commenced in 1969 from the Barracouta field. The latest fields to come into production were the Kipper-Tuna-Turrum oil and gas fields in 2013.

The spill EMBA overlaps the Tasmanian Gas Pipeline, which connects the Victorian and Tasmanian gas networks (Figure 5.27). The subsea section of this pipeline is 301 km long and has a capacity of 47 PJ/annum (TGP, 2020).

The spill EMBA intersects the investigation area of the Star of the South Wind Farm (125 km northeast of the survey 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 currently being undertaken.

5.7.3 Other Infrastructure

The Victorian Desalination Plant, located at Wonthaggi, is located 111 km north of the survey area and is intersected by the EMBA. 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).

There are two Telstra telecommunications cables located in central Bass Strait (Figure 5.27). Installed in 2003, a 19.6 km long section of the Bass Strait 'telephone cable 2' dissects the northeast part of the acquisition area.

The Indigo communications cable, which connects Perth and Sydney, is located 22 km north of the acquisition area and 4 km north of the operational area at its closest point.

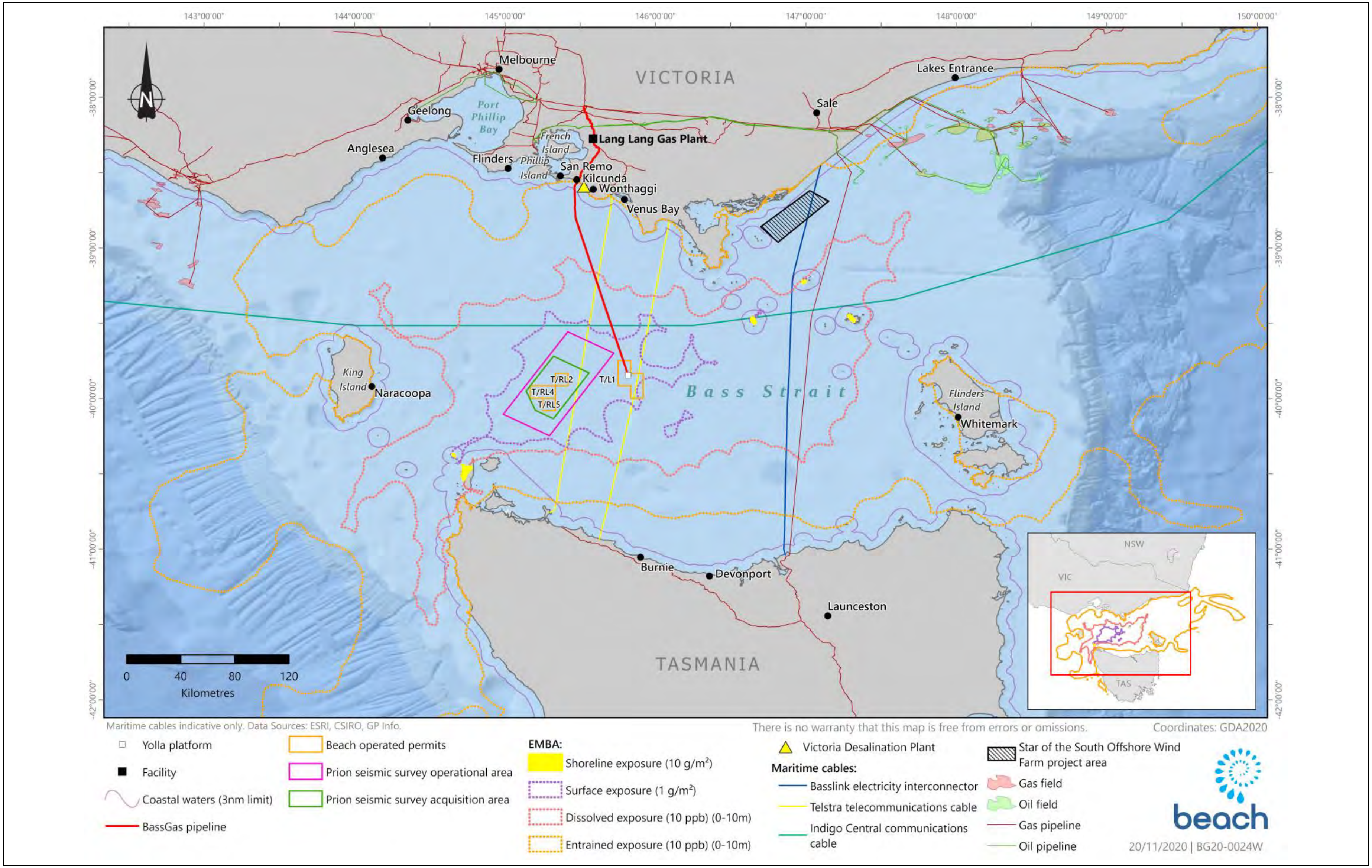


Figure 5.27. Bass Strait subsea infrastructure intersected by the survey area and the spill EMBA

5.7.4 Tourism

Marine-based tourism and recreation in Bass Strait is primarily associated with recreational fishing, boating and ecotourism. Seaside towns are the primary destinations that attract tourists and holidaymakers to the south coast of Victoria and northwest coast of Tasmania. These coastal communities are popular tourist towns for their boating and fishing activities, along with bushwalking, bird watching and other nature-focused activities. Towns including Inverloch, Venus Bay, Cape Paterson and Cape Woolamai in Victoria are especially popular in summer as well. The George Bass Coastal Walk is one such nature-focused activity that stretches from the outskirts of San Remo to Kilcunda and features a cliff-top trail that follows the route of explorer George Bass and offers spectacular views of the coastline. It is estimated that the tourism industry in Bass Coast has generated approximately $245 million and supports approximately 1,426 jobs in the region (Remplan, 2019).

5.7.5 Recreation

Recreational fishing along the Bass, Gippsland typically targets snapper, King George whiting, flathead, bream, sharks, tuna, calamari, and Australian salmon. Along the Tasmanian north coast, a range of recreational species are targeted including salmon, bream, tuna and rock lobster using gear including rods, nets and pots.

The Kilcunda Lobster Festival is held annually in late January in the town of Kilcunda as a fundraising event. The festival draws nearly 7,000 people each year and celebrates all things lobster. As Bass Strait is relatively shallow, the water currents through the Bass Strait can create unpredictable seas, reducing the numbers of small recreational boats from venturing long distances from shore. Larger game fishing boats are likely to fish further out to sea and use boat ramps and marinas along the Victorian coast of the spill EMBA.

Recreational diving and snorkelling is a popular activity with a diverse range of sites in around the Victorian and Tasmanian coast. Open water dives to shipwrecks off the coast of Wilsons Promontory, such as the wreck of the *SS Cambridge* and the *SS Gulf of Carpentaria* are also common spots for recreational divers.

5.7.6 Commercial Fisheries

The spill EMBA intersects several Commonwealth-, Victorian- and Tasmanian-managed commercial fisheries. These are described here.

<u>Commonwealth-managed fisheries</u>

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) (68% overlap with the spill EMBA);
- Eastern Tuna and Billfish Fishery (5.2% overlap with the spill EMBA);
- Eastern Skipjack Tuna Fishery (5.2% overlap with the spill EMBA);
- Southern Bluefin Tuna Fishery (2.5% overlap with the spill EMBA);
- Small Pelagic Fishery (eastern sub-area) (6.0% overlap with the spill EMBA);
- Southern Squid Jig Fishery (SSJF) (6.7% overlap with the spill EMBA); and
- Southern and Eastern Scalefish and Shark Fishery (SESSF), incorporating.
  - Gillnet and Shark Hook sector (11.9% overlap with the spill EMBA).
  - Commonwealth Trawl sector (14.5% overlap with the spill EMBA).

- Scalefish Hook sector (7.1% overlap with the spill EMBA).

Table 5.13 summarises the jurisdiction and recent fishing activities relevant to the survey. Though certain fisheries have 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 fished within the survey area and/or the EMBA.

Table 5.13. 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**	**Yes**	**Yes**
Eastern Tuna and Billfish Fishery	**Yes**	**No**	**Yes**
Southern Bluefin Tuna Fishery	**Yes**	**No**	**No**
Small Pelagic Fishery (eastern sub-area)	**Yes**	**No**	**No**
SSJF	**Yes**	**Yes**	**Yes**
SESSF (Gillnet and Shark Hook sector)	**Yes**	**Yes**	**Yes**
SESSF (Commonwealth Trawl sector (CTS))	**Yes**	**No**	**Yes**
SESSF (Scalefish Hook sector)	**Yes**	**Yes**	**Yes**

Table 5.14 summarises information for each of the fisheries identified with jurisdiction to fish within the EMBA, including target species, the geographic extent of the fishery, the nature of the overlap with the survey area and spill EMBA, the fishing season, fishing methods, catch volumes and value.

Table 5.14. Commonwealth-managed commercial fisheries in the EMBA

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA or survey area?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area)
Bass Strait Central Zone Scallop Fishery (Figure 5.28a, b, c, d, e and f)	Commercial scallop (*Pecten fumatus*)	Central Bass Strait area that lies beyond 20 nm of the Victorian and Tasmanian coasts. Fishery does not operate in state waters. Fishing effort is concentrated east of King Island, off Apollo Bay and north of Flinders Island. Primary landing ports of the fishery are Devonport, Stanley, Apollo Bay, Melbourne, Queenscliff and San Remo.	**Survey area?** **Yes.** There is overlap between the survey area and recent fishing effort. The survey area intersects 3.6% of the total fishery area. **EMBA?** **Yes.** There is overlap between the EMBA and the King Island scallop fishing grounds. The spill EMBA intersects 77.6% of the fishery.	1st April to 31st December. Most catch occurs from September-December.	Towed scallop dredges that target dense aggregations ('beds') of scallops. 65 fishing permits are in place. 12 vessels were active in the fishery in 2018, a decrease from 26 active vessels in 2009, reflecting the 'boom or bust' nature of the fishery.	• 2019 – 2,931 tonnes worth $6.3 million. • 2018 – 3,253 tonnes worth $6.7 million. • 2017 – 2,929 tonnes worth $6.7 million. • 2016 – 2,885 tonnes worth $4.6 million. • 2015 – 2,260 tonnes worth $2.8 million. • 2014 – 1,418 tonnes worth $0.5 million. Scallop spawning occurs from winter to spring (June to November), with timing dependent on environmental conditions such as wind and water temperature. Catch is primarily taken during September-December.	As reported by SETFIA and Fishwell Consulting (2020), fishery activity in the survey area for 2009-2018 includes: • Average annual catch of 9.3 tonnes valued at $22,671. • Five vessels known to operate within the survey area. • There are four license holders within the survey area. • There has been a total of 12 days fished. Industry targets sandy substrate in water depths of 50-55 m. Industry confident that scallops extend southeast from the KI-BDSE bed for approximate 14 nm.
Eastern Tuna and Billfish Fishery (Figure 5.29)	Albacore tuna (*Thunnus alulunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*), broadbill swordfish (*Xiphias gladius*), striped marlin	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 recent fishing effort. **EMBA?**	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 40 in 2018 (down	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.	There has been no recorded catch data in the survey area for the last five years.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA or survey area?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area)
	(*Tetrapturus audux*)	Primary landing ports of the fishery are Bermagui, Coffs Harbour, Ulladulla, Cairns, Mooloolaba and Southport.	**Yes.** The spill EMBA intersects 5.2% of the fishery, but in an area of low fishing intensity.		from about 150 in 2002). No Victorian or Tasmanian ports are used to land catches.	• 2016 – 5,139 tonnes worth $47.1 million. • 2015 – 5,408 tonnes worth $33 million. • 2014 – 4,368 tonnes worth $30.7 million. Spawning occurs through most of the year in water temperatures greater than 26°C (Wild Fisheries Research Program, 2012).	
Eastern skipjack Tuna Fishery (Figure 5.30)	Skipjack tuna (*Katsuwonus pelamis*)	Extends from the border of Victoria and South Australia to Cape York, Queensland. Primary landing port was Port Lincoln.	**Survey area?** **No.** There is no overlap between the survey area and recent fishing effort. **EMBA?** **No.** The spill EMBA intersects 5.2% of the fishery, but in an area that is not fished.	Not currently active.	Purse seine fishing gear is used in this fishery. There are 19 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.
Southern Bluefin Tuna (Figure 5.31)	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	**Survey area?** **No.** There is no overlap between the survey area and recent fishing effort. **EMBA?**	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 (five to eight vessels consistently fish this area). Port	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.	There has been no recorded catch data in the survey area for the last five years.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA or survey area?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area)
		within the OCS (DEH, 2004). The nearest fishing effort is concentrated along the NSW south coast around the 200 m depth contour. Primary landing port is Port Lincoln.	**Yes.** The spill EMBA intersects 2.5% of the fishery, but in an area of low fishing intensity.		Lincoln is the primary landing port. On the east coast, pelagic longline fishing is the key fishing method. 2017-18 – 38 active vessels. 2016-17 – 22 active vessels. 2015-16 - 25 active vessels. 2014-15 - 24 active vessels.	• 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. • 2013-14 – 5,420 tonnes worth $39.5 million.	
Small Pelagic Fishery (Figure 5.32)	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. Primary landing ports are Iluka and Ulladulla.	**Survey area?** **No.** There is no overlap between the survey area and fishing effort. The survey area intersects 0.14% of the fishery (western sub-area). **EMBA?** **No.** The spill EMBA intersects 6.0% of the eastern sub-area and 4.2% of the western sub-area of the fishery,	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 2018-19 using four active vessels.	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.	There has been no recorded catch data for the survey area in the last five years.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA or survey area?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area)
			but in an area that is not fished.				
Southern Squid Jig Fishery (Figure 5.33)	Arrow squid (*Nototodarus gouldi*)	The fishery extends from the SA/WA border east to southern Queensland. AFMA does not control squid fishing in Victorian or Tasmanian state waters. Primary landing ports of the fishery are Hobart, Portland and Queenscliff.	**Survey area?** **Yes.** There is overlap between the survey area and low fishing intensity. The survey area intersects 0.1% of the total fishery. **EMBA?** **Yes.** The spill EMBA intersects 6.7% of the fishery, but in an area of low fishing intensity.	12-month season begins 1st January and ends 31 December.	Squid jigging is the fishing method used, mainly at night time and in water depths of 60 to 120 m. High-powered lamps are used to attract squid. In 2018 there were 9 active vessels.	The species' short life span, fast growth and sensitivity to environmental conditions result in strongly fluctuating stock sizes. • 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.	As reported by SETFIA and Fishwell Consulting (2020), fishery activity in the survey area for 2009-2018 includes: • Average annual catch of 0.59 tonnes valued at $1,200. • Five vessels are known to operate within the survey area. • Six days have been fished for 2009-2018 inclusive.
Southern and Eastern Scalefish and Shark Fishery (SESSF)							
Shark Gillnet (Figure 5.34) and Shark Hook (Figure 5.35) 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.	**Survey area?** **Yes.** There is overlap between the survey area and low and medium fishing intensity. Survey area intersects 0.17% of the total fishery area. **EMBA?**	12-month season begins 1st May. Fishery catch is distributed across the year, with no defined peak periods of catch.	Demersal gillnet and a variety of line methods. Landing ports in Victoria are Lakes Entrance, San Remo and Port Welshpool. 2018-19 – 74 permits and 78 active vessels. 2017-18 – 74 permits and 76 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.	There are nine current SESSF license holders that potentially fish the survey area. For 2009-2018 inclusive: • Average annual catch of 20.94 tonnes valued at $129,509. • Thirty-two (32) different vessels have operated in the survey area.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA or survey area?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area)
		Primary landing ports include Adelaide, Port Lincoln, Robe, Devonport, Hobart, Lakes Entrance, Sen Remo and Port Welshpool.	**Yes.** Based on 2018-19 fishing intensity data, the spill EMBA overlaps areas of low, medium and high intensity fishing. The spill EMBA intersects 11.9% of the fishery.		2016-17 – 74 permits and 62 active vessels. 2015-16 – 74 permits and 61 active vessels.	• 2015-16 – 2,233 tonnes worth $18.4 million.	• Main species caught includes gummy shark (74%) and school shark (11%).
Commonwealth Trawl Sector (CTS) (Figure 5.36)	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 New South Wales, Victorian and Tasmanian coastlines to Cape Jervis in South Australia. Primary landing ports of the fishery are Eden, Sydney, Ulladulla, Hobart, Lakes Entrance and Portland.	**Survey area?** **No.** Based on 2018-19 fishing intensity data, there is no overlap between the survey area and recent fishing intensity. Survey area intersects 0.21% of the total fishery area. **EMBA?** **Yes.** Based on 2018-19, fishing intensity data, the spill EMBA overlaps areas of low, medium, and high fishing intensity.	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.	Logbook catches have been gradually declining since 2001. • 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.	SETFIA and Fishwell Consulting (2020) advise that catch and effort data for the survey area is deemed confidential due to the low number (< 5) of fishing vessels that utilise the survey area.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA or survey area?	Fishing season	Fishing methods, vessels and licences	Catch data and other information (whole of fishery)	Catch data and other information (survey area)
			The spill EMBA intersects 14.52% of the fishery.				
Scalefish Hook Sector (SHS) (Figure 5.37)	Key species targeted are gummy shark (*Mustelus antarcticus*), elephantfish (*Callorhinchus milii*) and draughtboard shark (*Cephaloscyllium laticeps*).	Includes all waters off South Australia, Victoria and Tasmania from 3 nm to the extent of the AFZ. Primary landing ports of the fishery are Eden, Sydney, Ulladulla, Hobart, Lakes Entrance and Portland.	**Survey area?** **No.** Based on 2018-19, fishing intensity data that shows no SHS intensity recorded in the survey area. The spill EMBA intersects 0.10% of the fishery. **EMBA?** **Yes.** Based on 2018-19 fishing intensity data, the spill EMBA overlaps areas of low and medium fishing intensity. The spill EMBA intersects 7.1% of the fishery.	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 demersal gillnets. For 2017-18, there were 37 fishing rights 29 active vessels.	Logbook catches have been gradually declining since 2006 and are now <2,000 t/year. Catch data is combined with that for the CTS.	The data provided by AFMA includes the gillnet, hook and trap sectors.

Sources: Patterson et al (2020, 2019, 2018; 2017; 2016), Status of Australian Fish Stocks reports (2019) and SETFIA and Fishwell Consulting (2020).

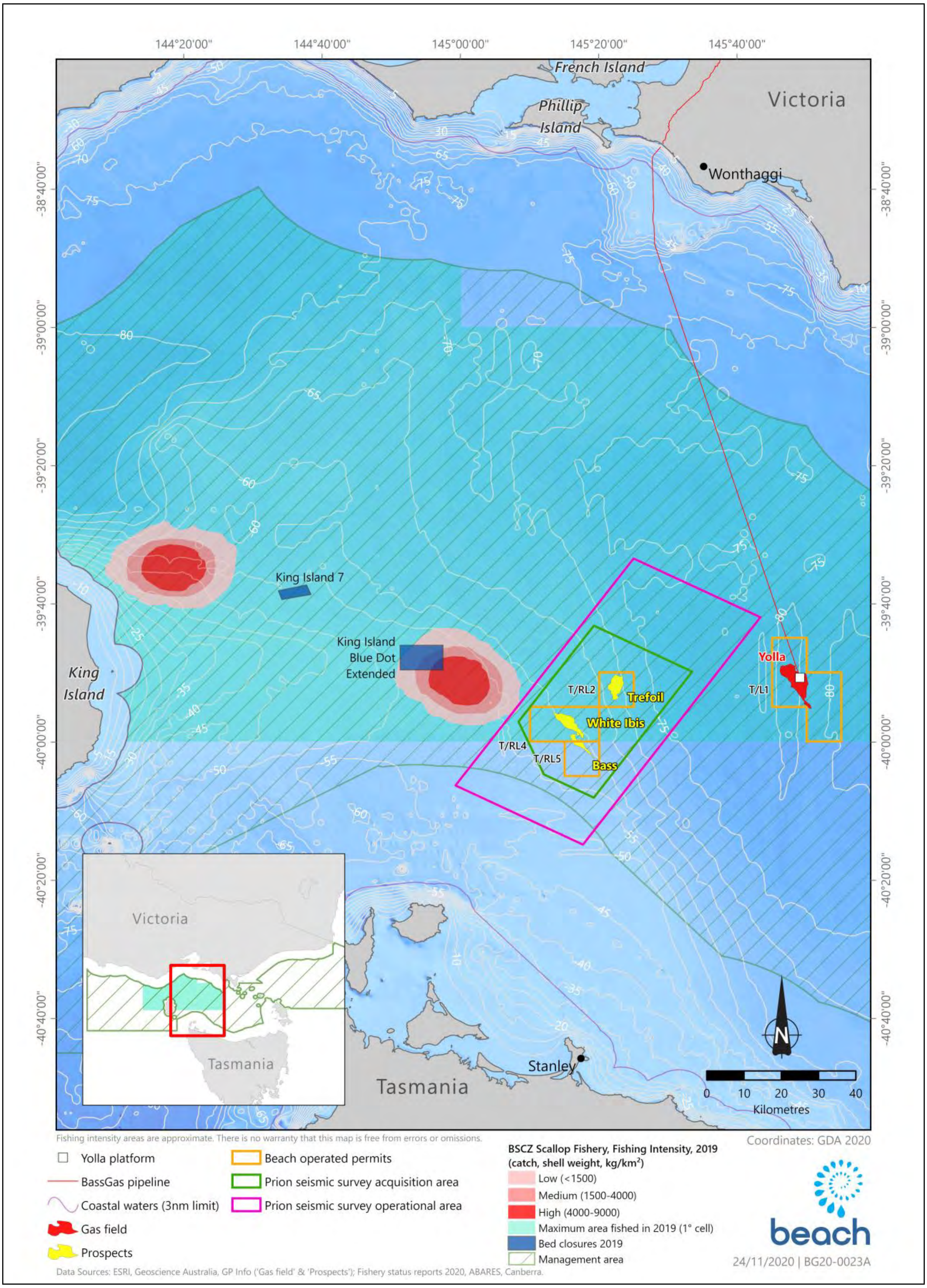


Figure 5.28a. Jurisdiction and fishing intensity in the BSCZSF 2019

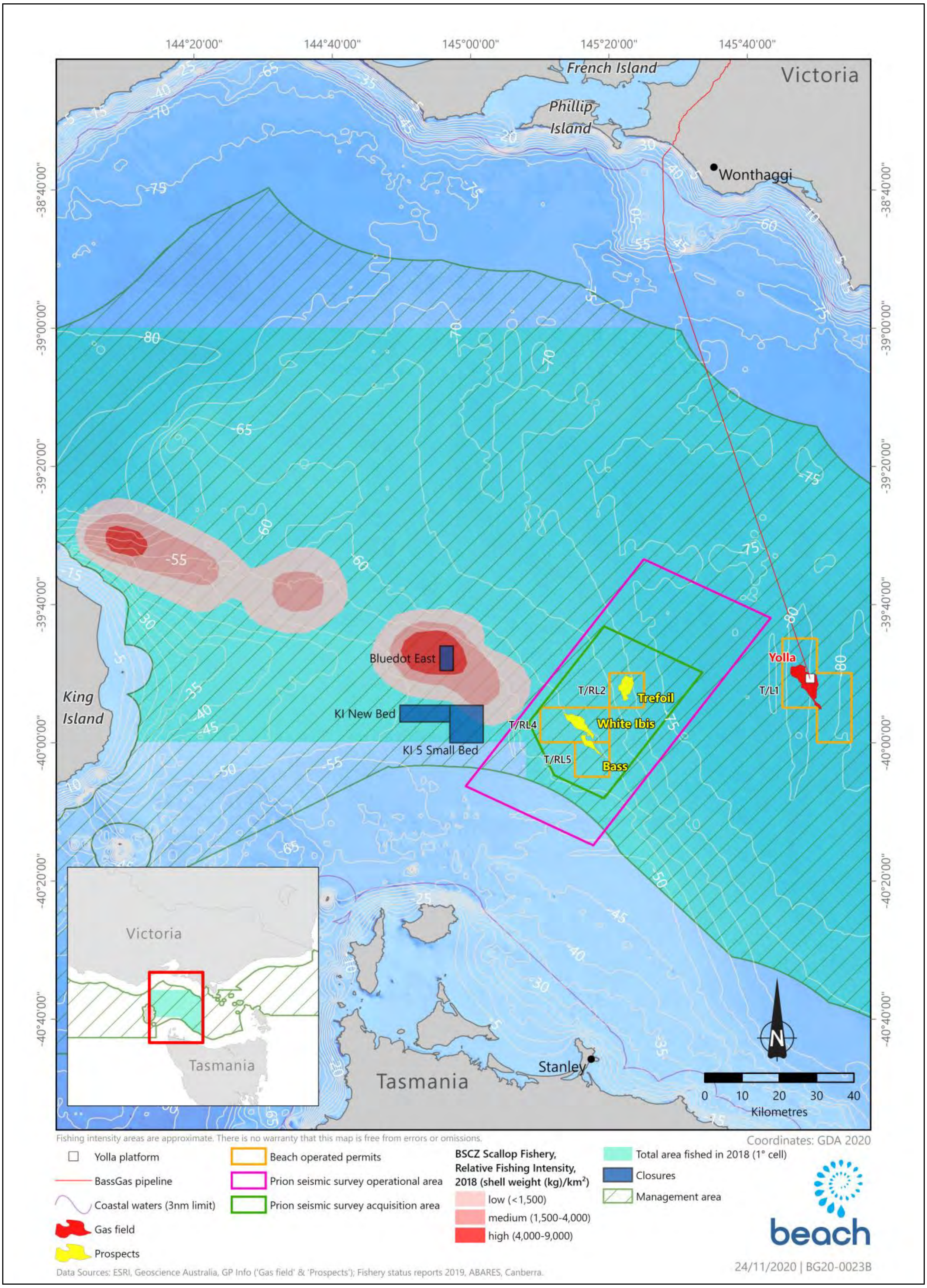


Figure 5.28b. Jurisdiction and fishing intensity in the BSCZSF 2018

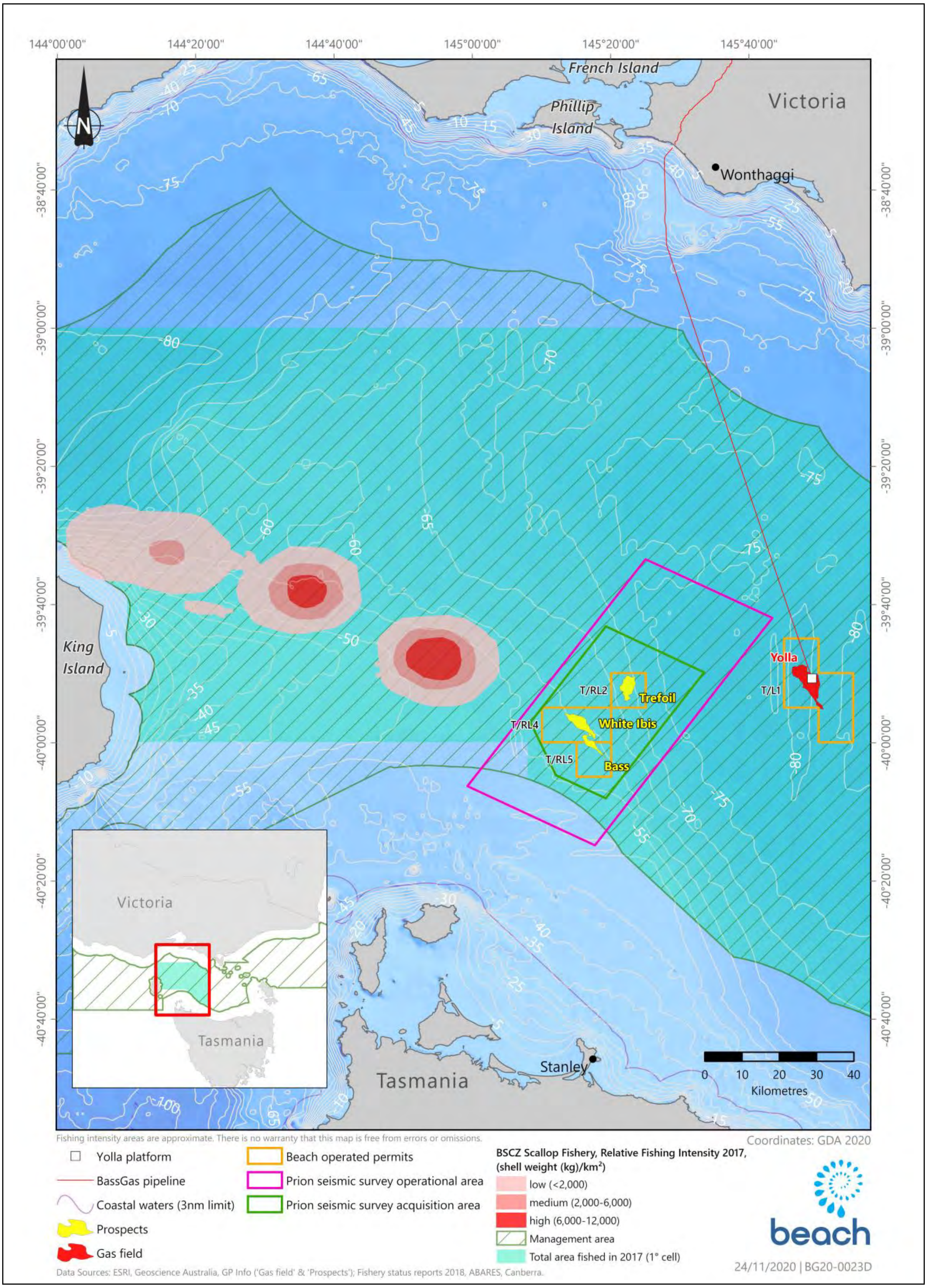


Figure 5.28c. Jurisdiction and fishing intensity in the BSCZSF 2017

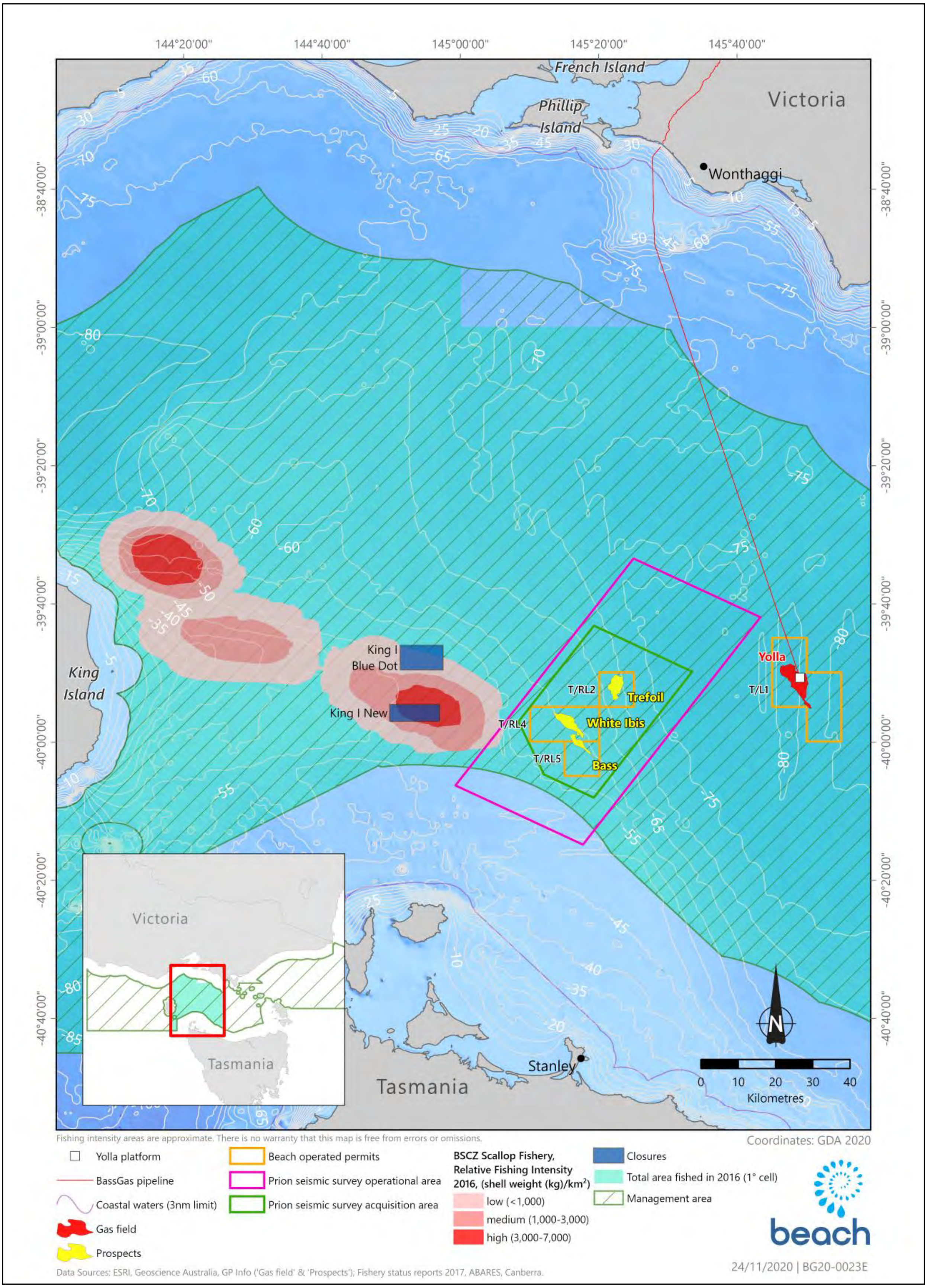


Figure 5.28d. Jurisdiction and fishing intensity in the BSCZSF 2016

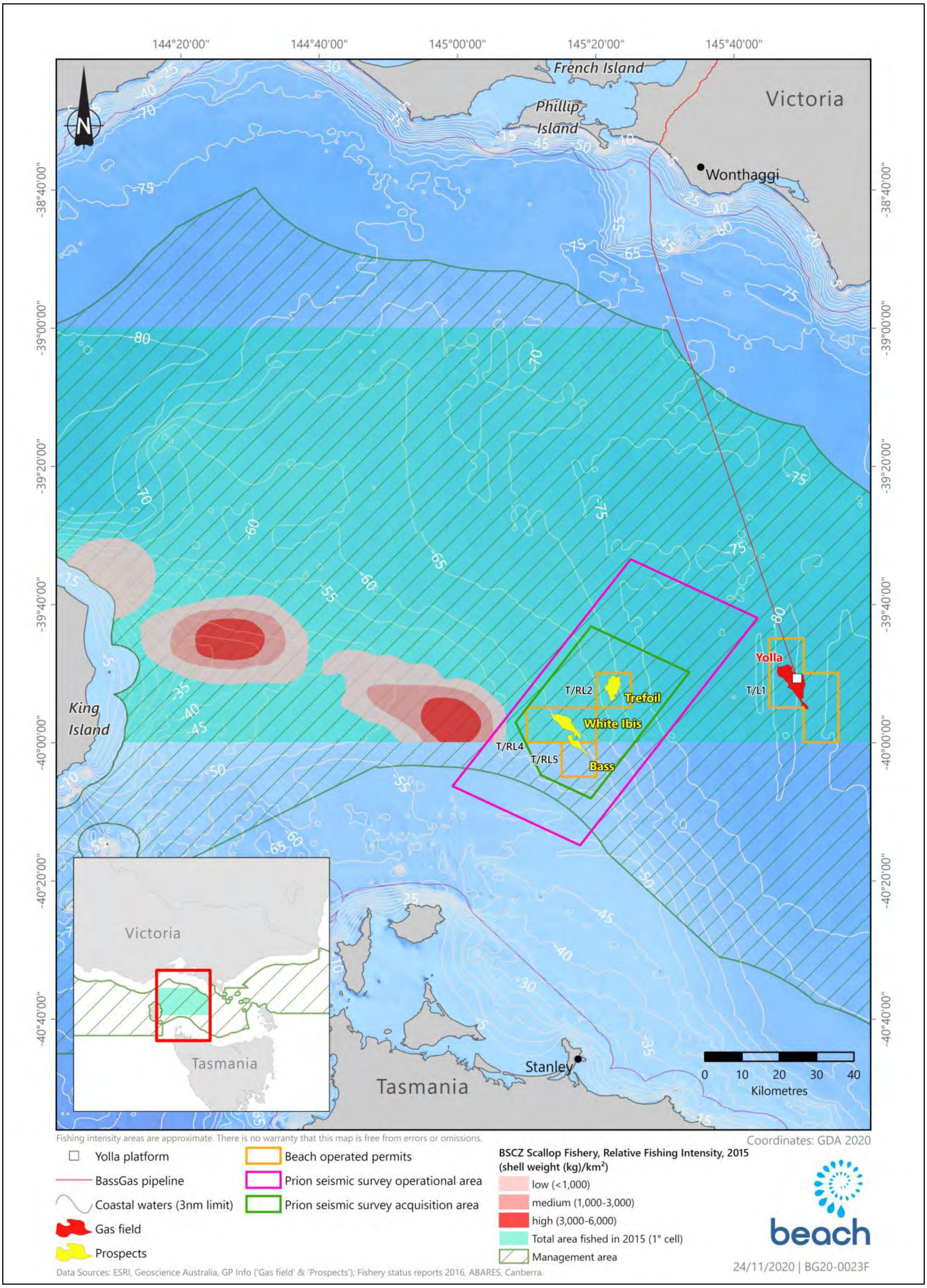


Figure 5.28e. Jurisdiction and fishing intensity in the BSCZSF 2015

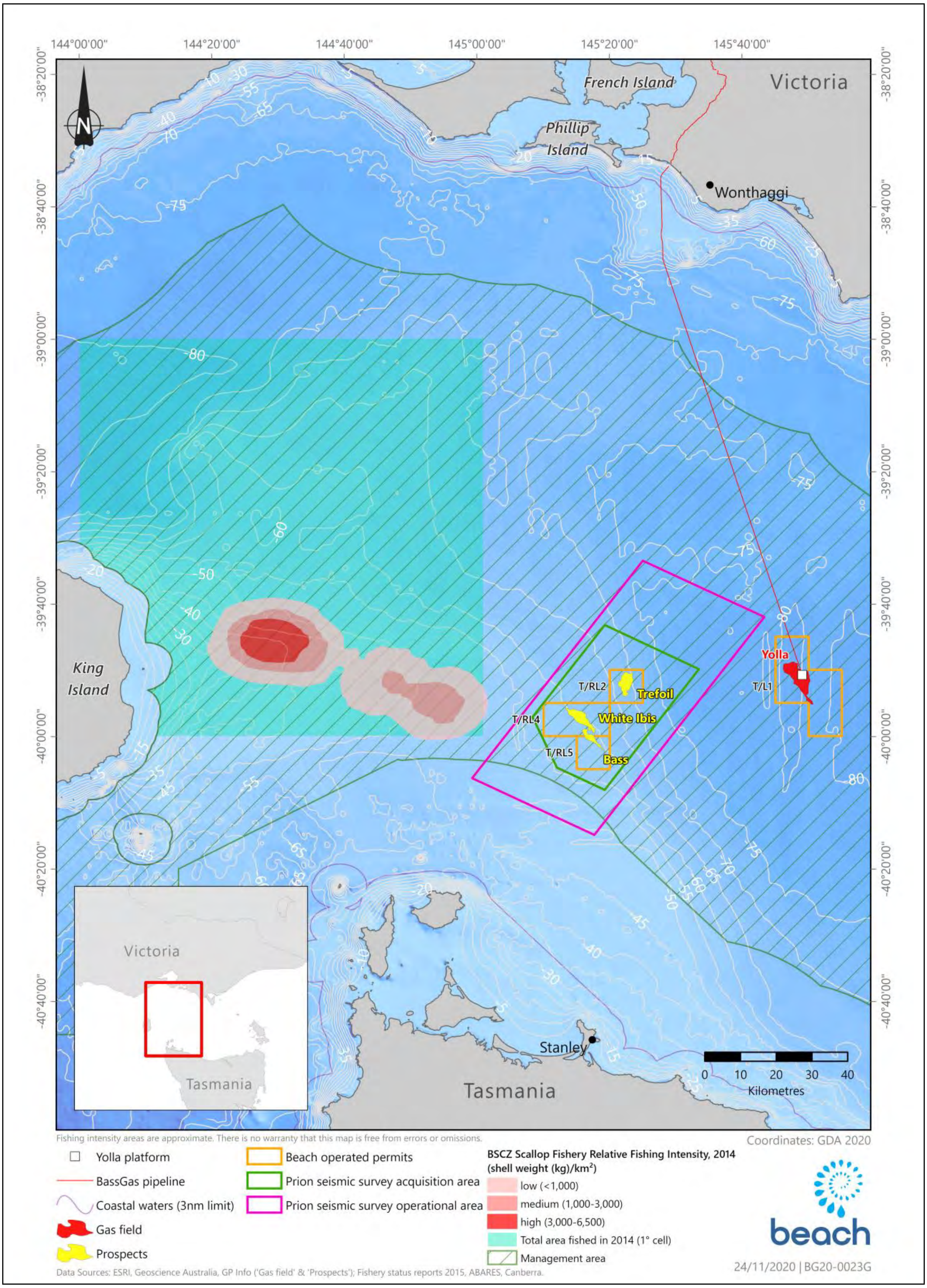
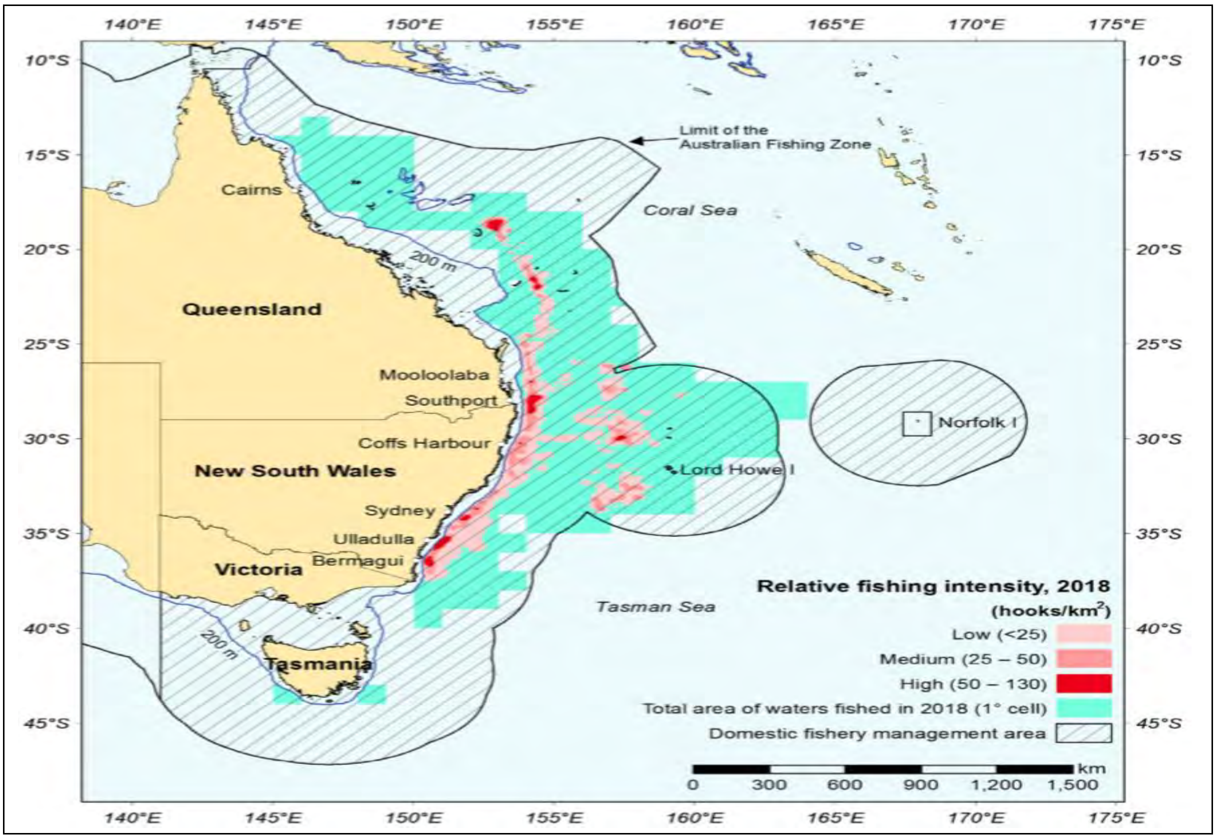
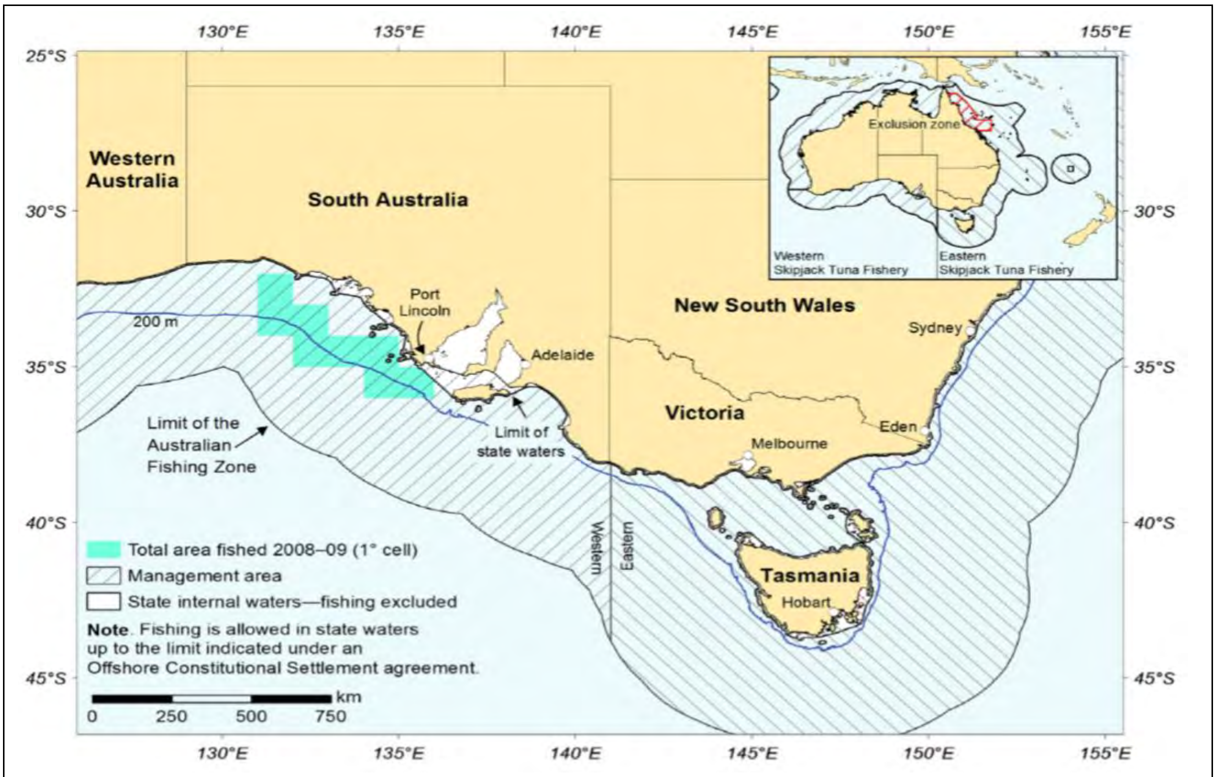


Figure 5.28f. Jurisdiction and fishing intensity in the BSCZSF 2014



Source: Patterson et al (2019).

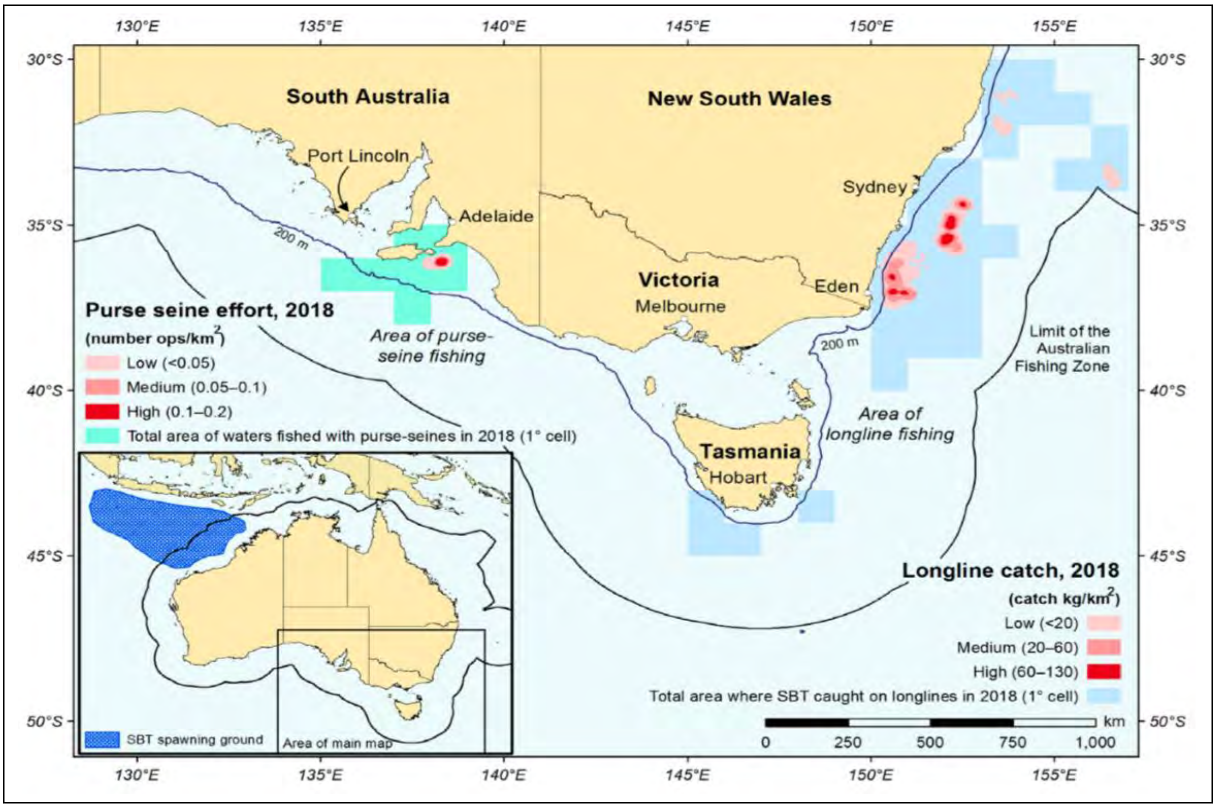
Figure 5.29. Jurisdiction and fishing intensity in the Eastern Tuna and Billfish Fishery 2018



Last fishing effort occurred in 2008-09.

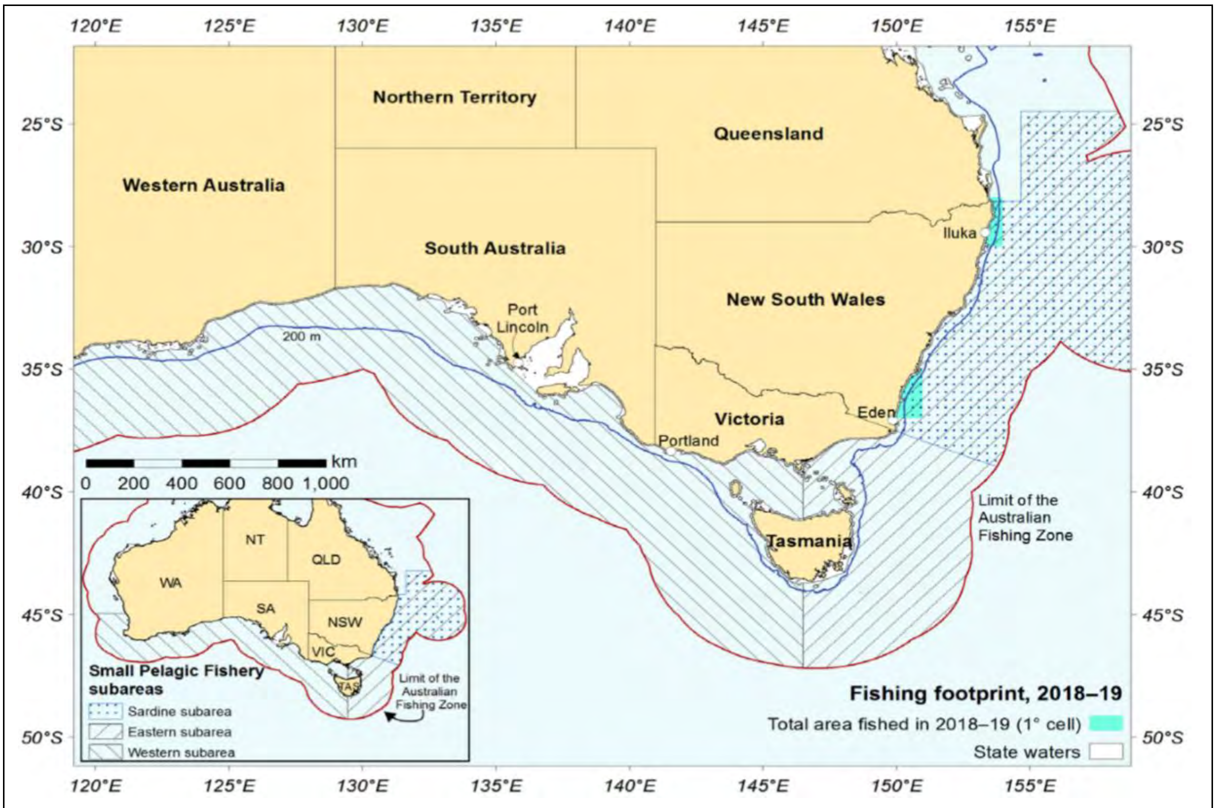
Source: Patterson et al (2019).

Figure 5.30. Jurisdiction and fishing intensity in the Eastern Skipjack Tuna Fishery 2008-09



Source: Patterson et al (2019).

Figure 5.31. Jurisdiction and fishing intensity in the Southern Bluefin Tuna Fishery 2018



Some effort data not shown for confidentiality reasons.

Source: Patterson et al (2019).

Figure 5.32. Jurisdiction and fishing intensity in the Small Pelagic Fishery 2018-19

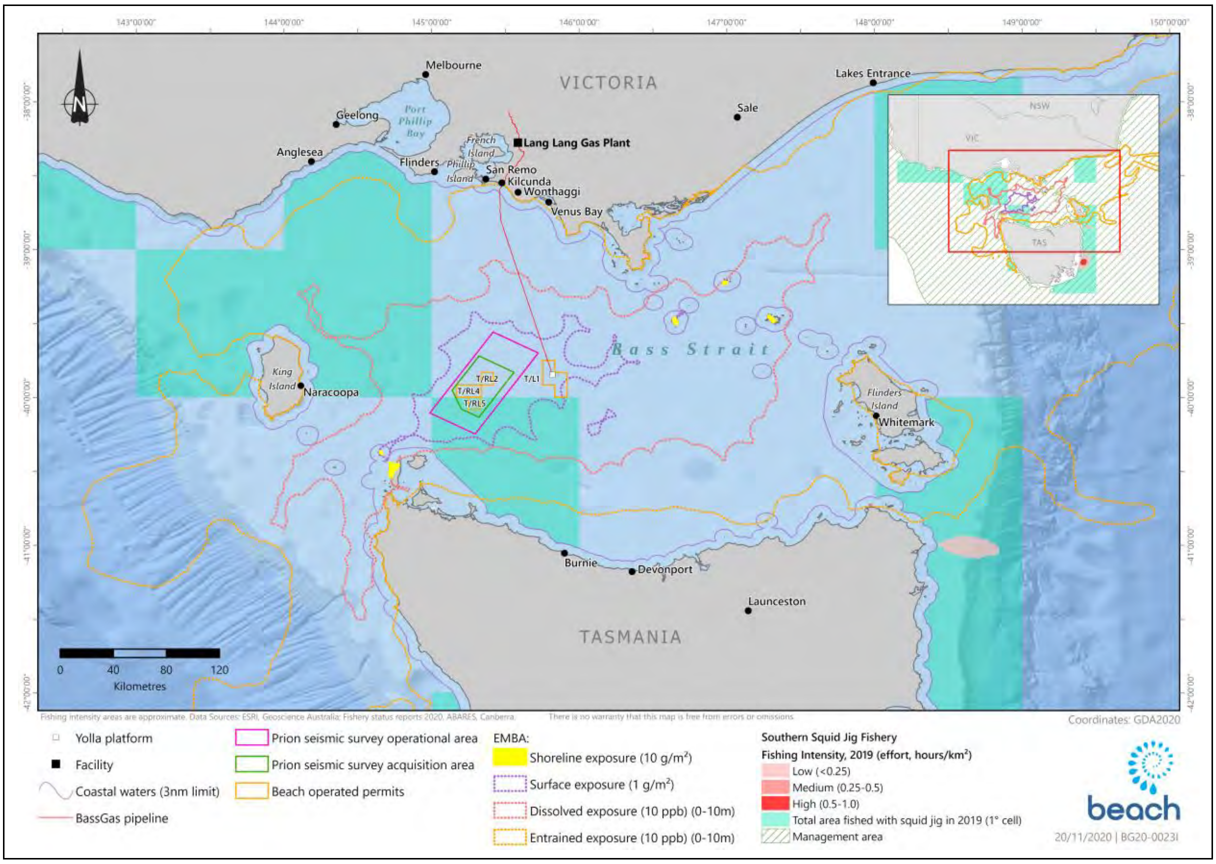


Figure 5.33. Jurisdiction and fishing intensity in the SSJF 2019

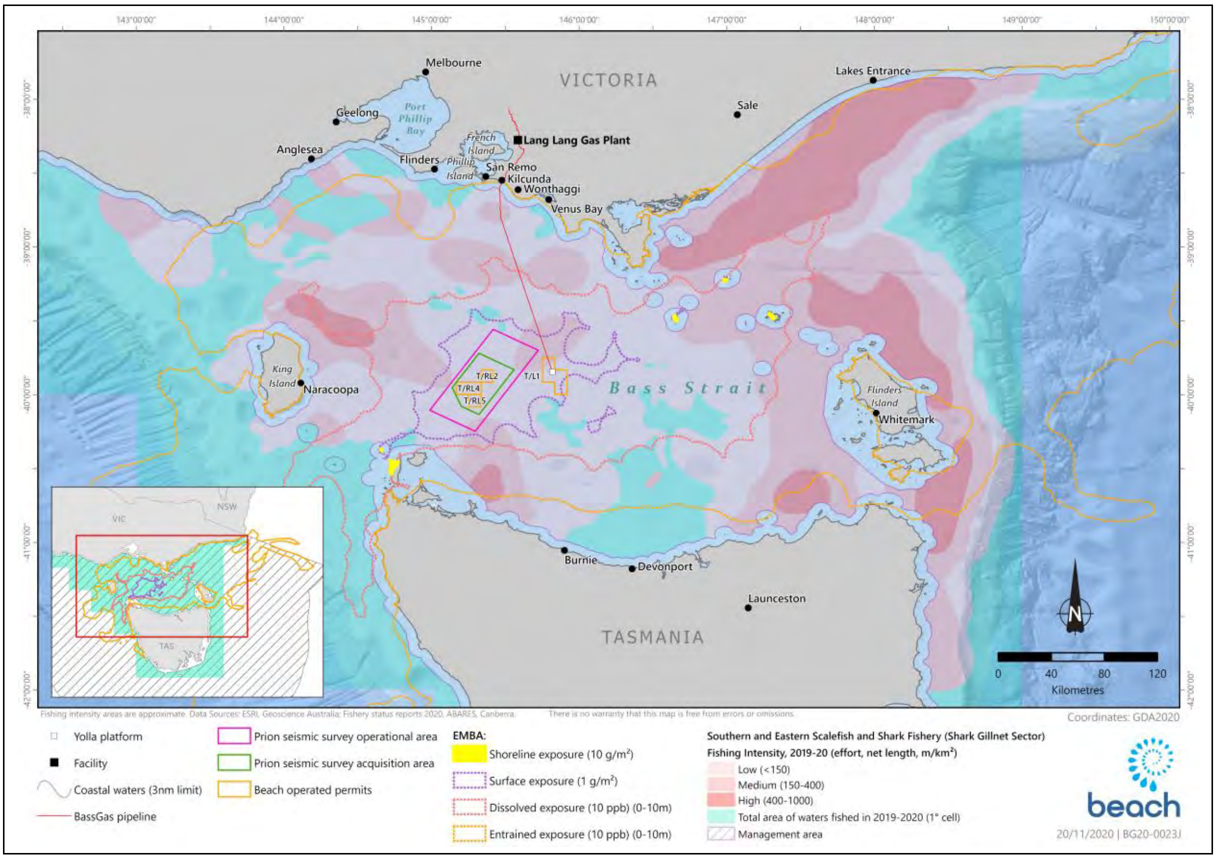


Figure 5.34. Jurisdiction and fishing intensity in the SESSF – Shark Gillnet Sector 2019-20

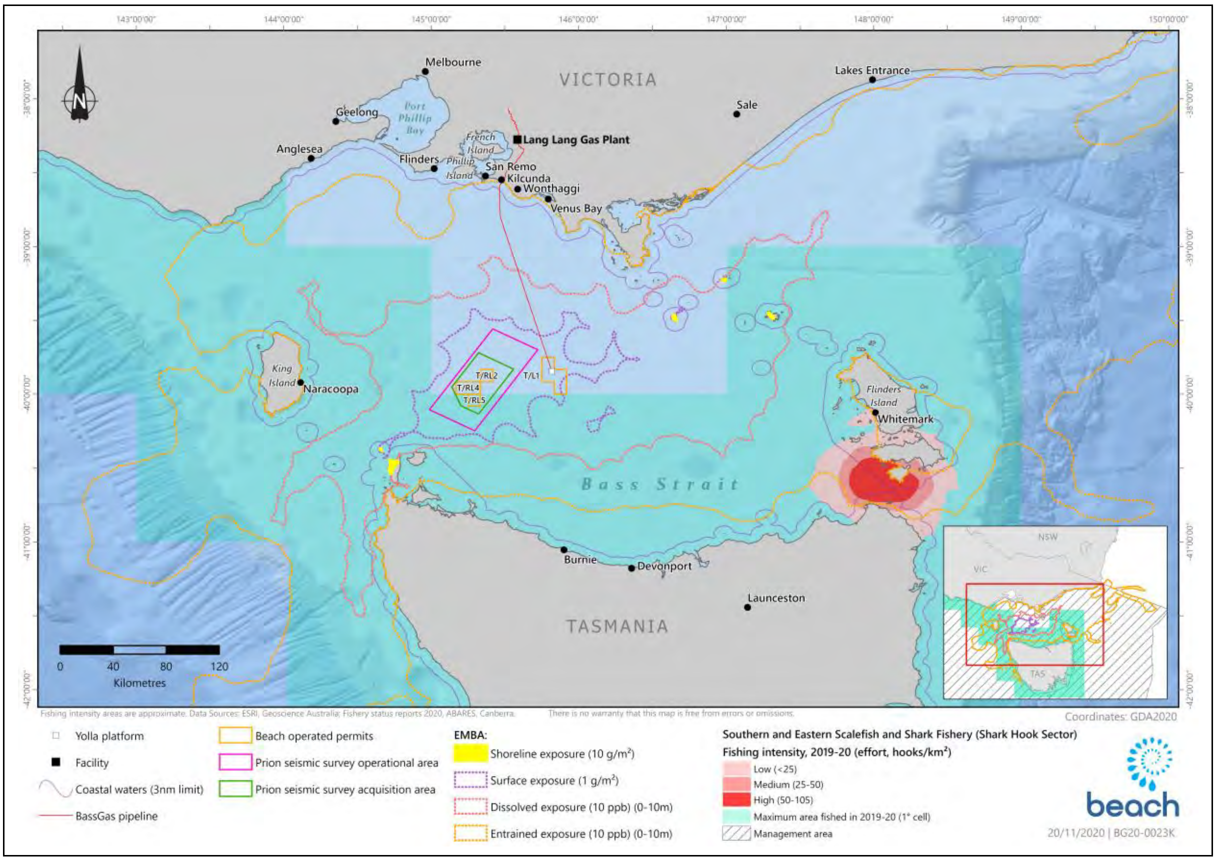


Figure 5.35. Jurisdiction and fishing intensity in the SESSF – Shark Hook Sector 2019-20

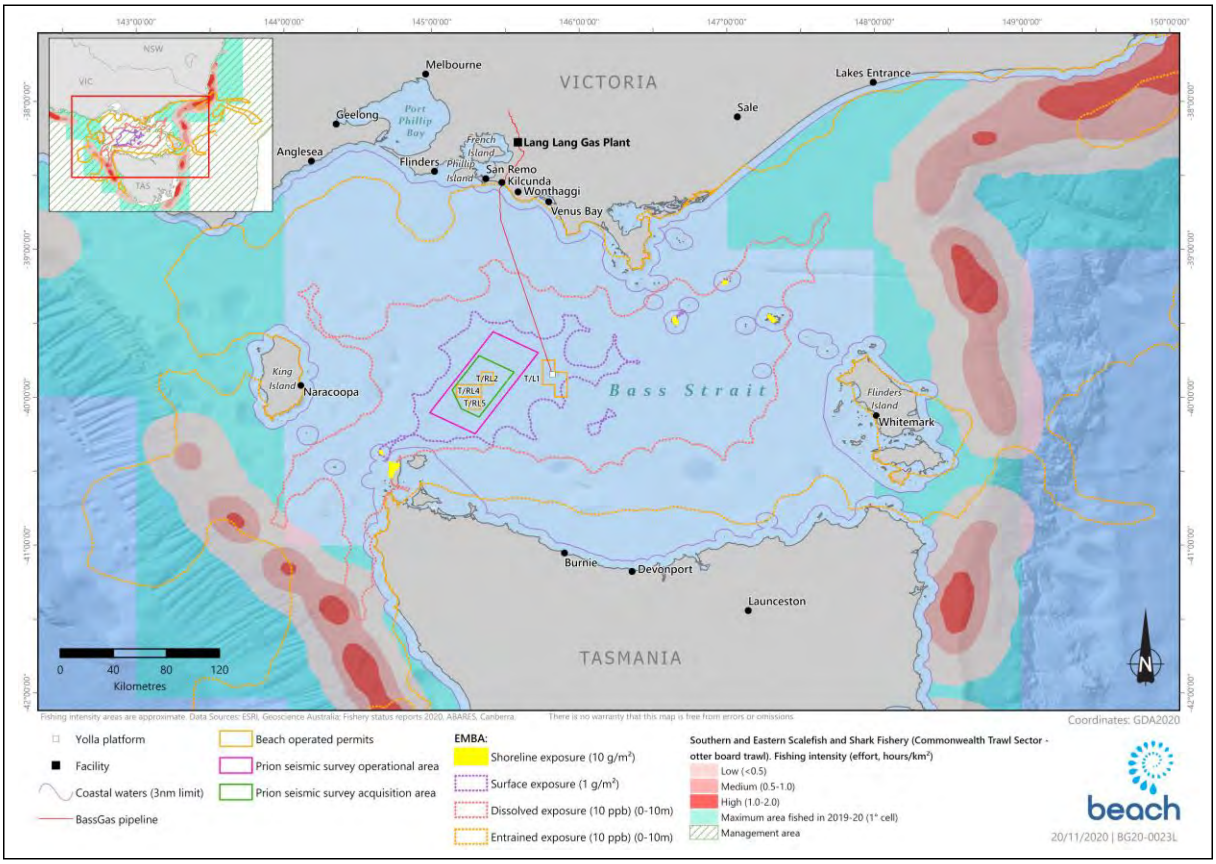


Figure 5.36a. Jurisdiction and fishing intensity in the SESSF – CTS 2019-20

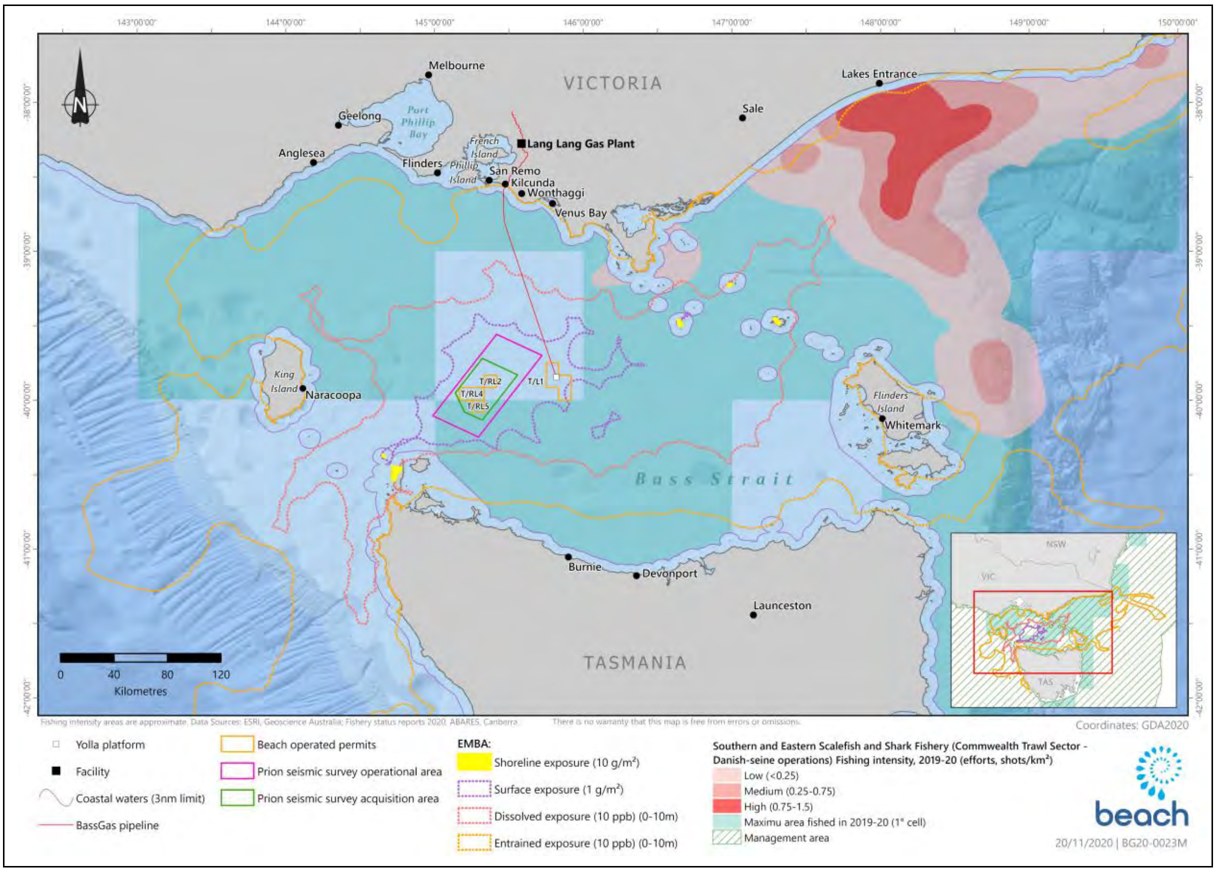


Figure 5.36b. Jurisdiction and fishing intensity in the SESSF – CTS (Danish seine operations) 2019-20

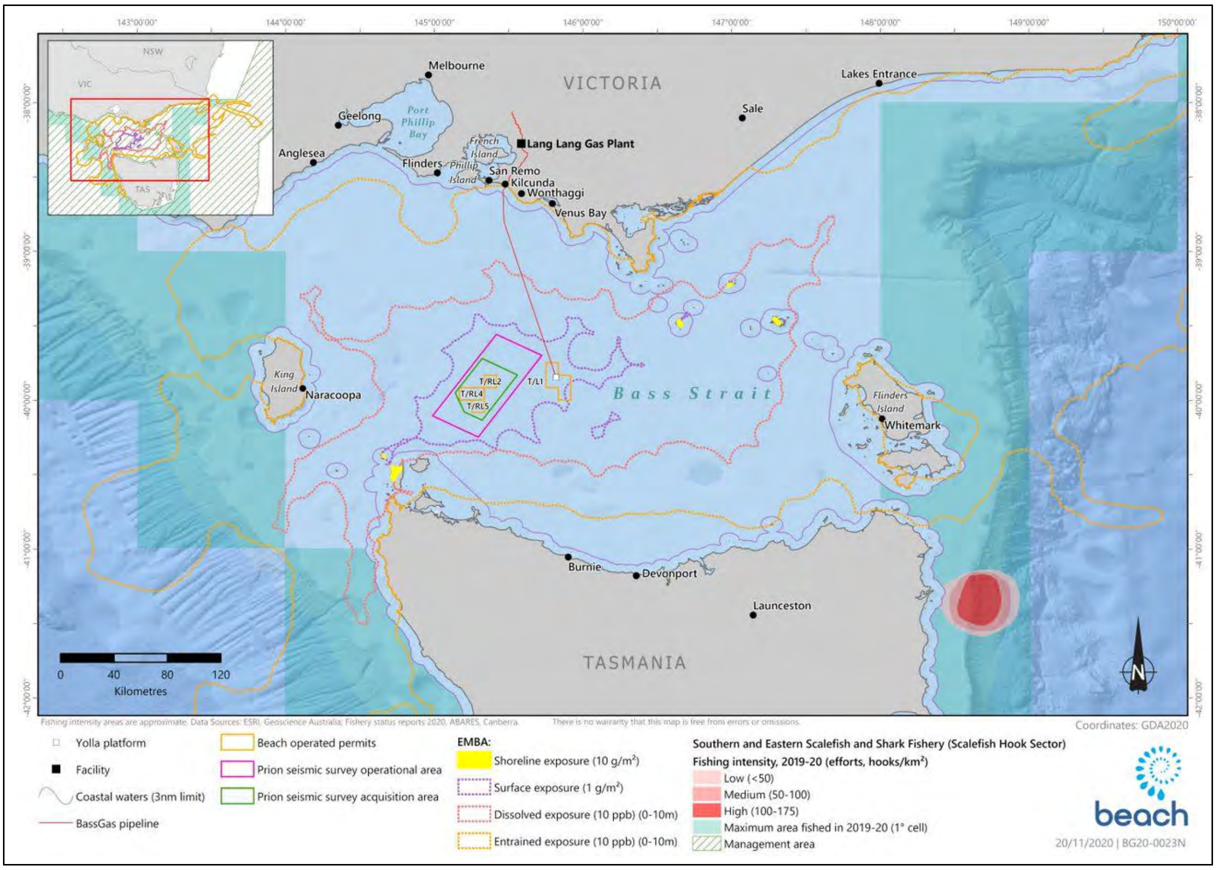


Figure 5.37. Jurisdiction and fishing intensity in the SESSF – Scalefish Hook Sector 2019-20

Through data analysis and consultation with fishing industry associations, representatives and government agencies, Beach has determined that the Commonwealth-managed fisheries most relevant to the Prion MSS are the BSCZSF and SESSF (Shark Gillnet and Shark Hook Sectors). Beach commissioned the South East Trawl Fishing Industry Association (SETFIA) and Fishwell Consulting (2020) to identify commercial fisheries that actively fish in the survey area and to report on catch and revenue taken by these fisheries from the survey area. The findings of the SETFIA and Fishwell Consulting report (2020) were used to determine the extent of fishery catch from 2009-2018 in the survey area and to guide consultation discussions. A summary of the report findings is presented in Table 5.15.

Table 5.15. Fishery effort, catch, value and main species caught from 2009-2018 within the survey area

Fishery	**Vessels**	**Total shots**	**Total catch (tonnes)**	**Total value**	**Main species caught**	**Fishing methods**
SESS (CTS)	<5	Confidential	Confidential	Confidential	Confidential	Danish seine
SESS (Shark Gillnet and Shark Hook Sector)	32	769	209.4	$1,295,091	Gummy shark	Gillnet, demersal longline
SSJF	5	6 (days fished)	5.9	$12,000	Gould's squid	Jigs
BSCZSF	5	12 (days fished)	93	$226,719	Commercial scallop	Scallop dredge

Source: SETFIA and Fishwell Consulting (2020)

SESSF Shark Gillnet and Shark Hook Sectors

SETFIA and Fishwell Consulting (2020) identified the SESSF (Shark Gillnet and Shark Hook Sectors) as having recent catch from the survey area. From 2009-2018, the fishery recorded an average annual catch of 20.94 tonnes valued at $129,509 from the survey area. Catch was generally well distributed across the year with minor fluctuations between individual months and no predictable periods of high or low catch. This likely reflects the diverse, mobile and widely distributed nature of the main target species, which includes elephant fish, gummy shark, saw sharks and school sharks. As presented in Figure 5.34, areas of high fishing intensity from 2018-19 are concentrated outside the survey area north of Flinders Island and King Island. The survey area overlaps areas of mostly low fishing intensity and a small area of medium intensity in its eastern extent. Almost the entirety of Bass Strait is utilised by the fishery. Beach has consulted with members of this fishery, with no material concerns arising about potential conflicts between their activities and the survey.

BSCZSF

SETFIA and Fishwell Consulting (2020) identified the BSCZSF as having recent catch from the survey area. From 2009-2018, the fishery recorded an average annual catch of 9.3 tonnes valued at $22,671 from the survey area. Catch was generally constrained to the months of September to December and has been concentrated east of King Island since 2014 (see Figure 5.28), with the most recent catches in water depths of 50-55 m. Given that these high intensity scallop fishing grounds are concentrated close to the survey area, Beach has undertaken extensive consultation with the scallop fishing industry to ascertain the location of mature and juvenile scallop beds. Resulting from discussions in July 2020 with industry representatives, Beach excised part of the southwest part of the acquisition area. This area was identified by the scallop industry as containing suitable substrate for scallops at the targeted water depth layer (50-55 m) and, though there is no recent fishing effort in the area, is a site of considerable interest to the industry.

At the start of each BSCZSF fishing season, AFMA provides a 150 t research catch allowance to enable fishers to search for commercially viable scallop beds, which are defined as "*an area or scallop bed containing no greater than 20 per cent of scallops of a size less than 85 mm*" (Koopman *et al.,* 2019). During May 2019, four commercial fishing vessels were used to conduct stratified random surveys of one bed off Flinders Island (FI), nine beds off

King Island (KI) and two beds off Apollo Bay (AB). Choice and prioritisation of these beds was made based on previous surveys and commercial catches from 2018, and with input from the Scallop Resource Assessment Group (Scallop RAG). For Beach's assessment, the Kind Island beds are the most relevant due to their proximity to the survey area.

The beds surveyed in 2019 were in part re-surveys from 2018 with the addition of three areas of high commercial catches recorded in 2018 also included. One of these new beds surveyed is known as KI-BDSE and occurs (at its closest point) 800 m west of the survey area (refer to Figure 5.38). KI-BDSE is the closest scallop assessment site undertaken during the 2019 survey and there were no assessment sites located within the Prion survey area. In 2018, commercial catch from KI-BDSE was 366 t from five vessels, which contributed to its inclusion as a site for the 2019 assessment. A comparison of the commercial catch from KI-BDSE with other 2019 survey areas is presented in Table 5.16. The estimated biomass of the KI-BDSE assessment area is 19,592 t with 3.088 individuals per square metre, which are the highest results of any of the 2019 survey sites in those categories. It is estimated that over 95% of the individuals in KI-BDSE are of a size greater than 85 mm, thereby classifying the area as a commercial scallop bed. The 2019 survey results for KI-BDSE and the eight other King Island assessment areas are presented in Table 5.17. Due to a combination of commercial reasons and the COVID-19 pandemic, the BSCZSF 2020 survey was not undertaken.

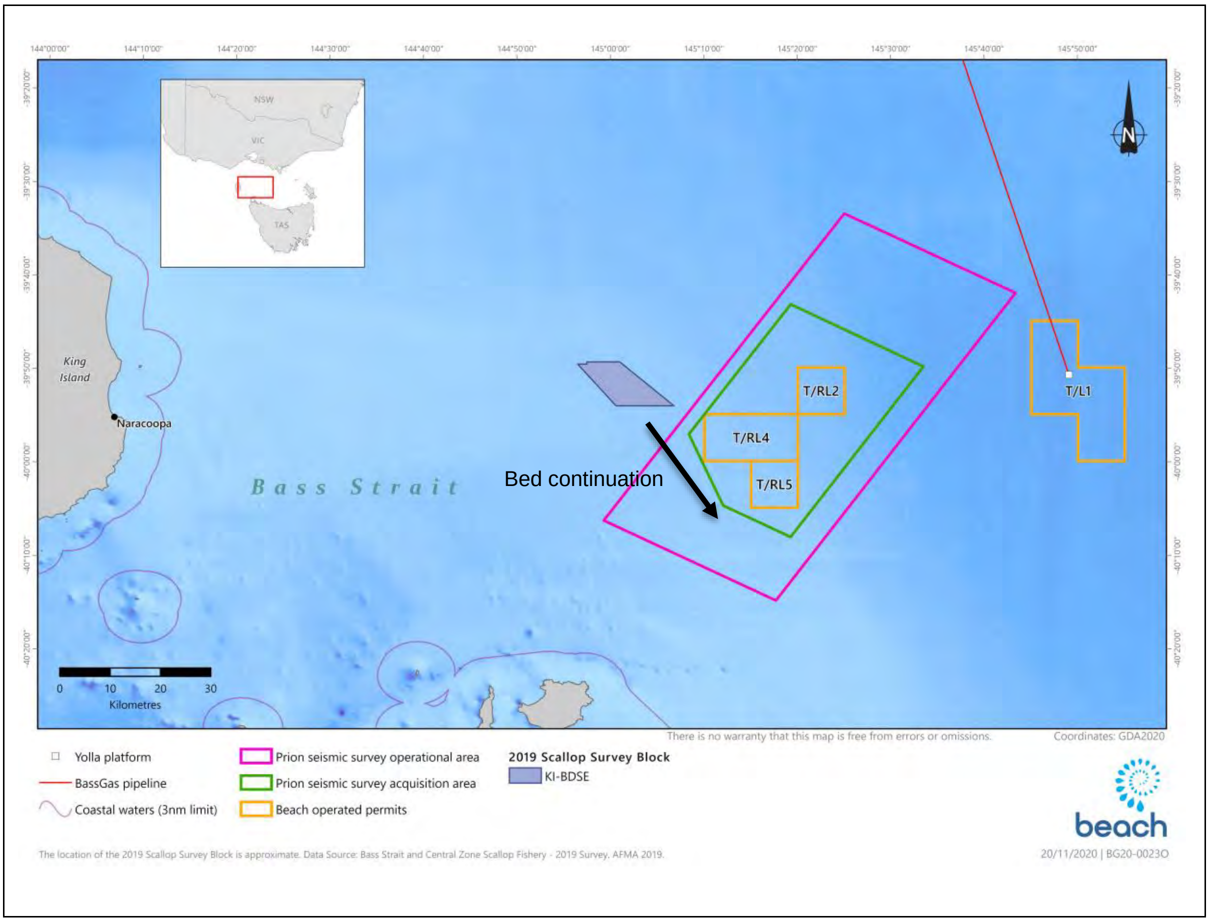


Figure 5.38. Location of KI-BDSE and the survey area

Table 5.16. 2018 commercial catch from 2019 survey sites.

Bed	2018 Commercial catch (t)	Number of Vessels
FI	0	0
KI-5S	Confidential – included in all other areas	1
KI-New	0	0
KI-BDE	575	10
KI-BDSE	**366**	**5**
KI-6	217	7
KI-7	99	7
KI-8	679	9
KI-9	157	9
AB-1	Confidential – included in all other areas	1
AB-2	183	5
All other areas	960	11

Source: Koopman et al (2019).

Table 5.17. 2019 survey results for KI-BDSE

Bed	No. of tows	Estimated biomass (t)	% weight > 85 mm	Estimated biomass (t) > 85 mm	Density (individual / m^2)	Mean size (mm)	Meats / kg
KI-5S	25	1,612.1	99.8	1,608.6	0.170	107.8	62
KI-BDE	25	8,353.4	85.4	7,135.3	1.597	90.6	80
KI-BDSE	**25**	**19,591.5**	**95.5**	**18,713.8**	**3.088**	**92.8**	**88**
KI-New	25	1,181.9	100.0	1,181.8	0.173	110.6	54
KI-6	25	1,960.1	98.6	1,932.4	1.458	100.5	71
KI-7	25	837.2	97.5	816.0	0.599	97.4	157
KI-8a	15	795.4	98.3	782.1	2.156	101.8	72
KI-8b	12	362.7	98.5	357.1	1.230	101.0	66
KI-9	25	9,616.2	97.7	9,398.4	2.867	95.7	84

Source: Koopman et al (2019).

Victorian-managed Fisheries

Victorian-managed commercial fisheries with access licences that authorise harvest in the waters of the spill EMBA include the following:

- Scallop;
- Abalone;
- Rock Lobster;
- Wrasse;
- Ocean Access (General);
- Pipis (the entire Victorian coastline);
- Ocean Purse Seine;
- Inshore trawl; and
- Giant crab.

There are no Victorian-managed fisheries that operate within the survey area. 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). The acquisition area intersects catch and effort cells P26, P27, P28, Q25, Q26, Q27 and Q28 (Figure 5.39).

Table 5.18 summarises the key information for each of these fisheries and indicates that all the above-listed fisheries, are actively fishing in the spill EMBA.

As detailed in Table 4.3, Beach's consultation with Victorian fishery industry representatives indicates they have no material concerns about potential conflicts between their activities and the survey. The VFA advised Beach that there is no Victorian-managed fishing activity in the survey area (see Chapter 4).

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 5.19 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.

As detailed in Table 4.3, the Tasmanian Department of Primary Industries, Parks, Water and the Environment (DPIPWE) confirmed that there is very little Tasmanian-managed fishing activity with disclosable catch from the survey area. Following consultation with DPIPWE fishery managers, a non-disclosable amount of catch in an area represents less than 50 kg for any fishery reported from the survey area. DPIPWE advised that given the catch was so low (<50 kg) the fisheries operating within the survey area could not officially be disclosed. Therefore, from the continued consultation and desktop research undertaken by Beach, it is interpreted that a very low level of fishing activity may occur in the survey area that is not considered significant to the industry.

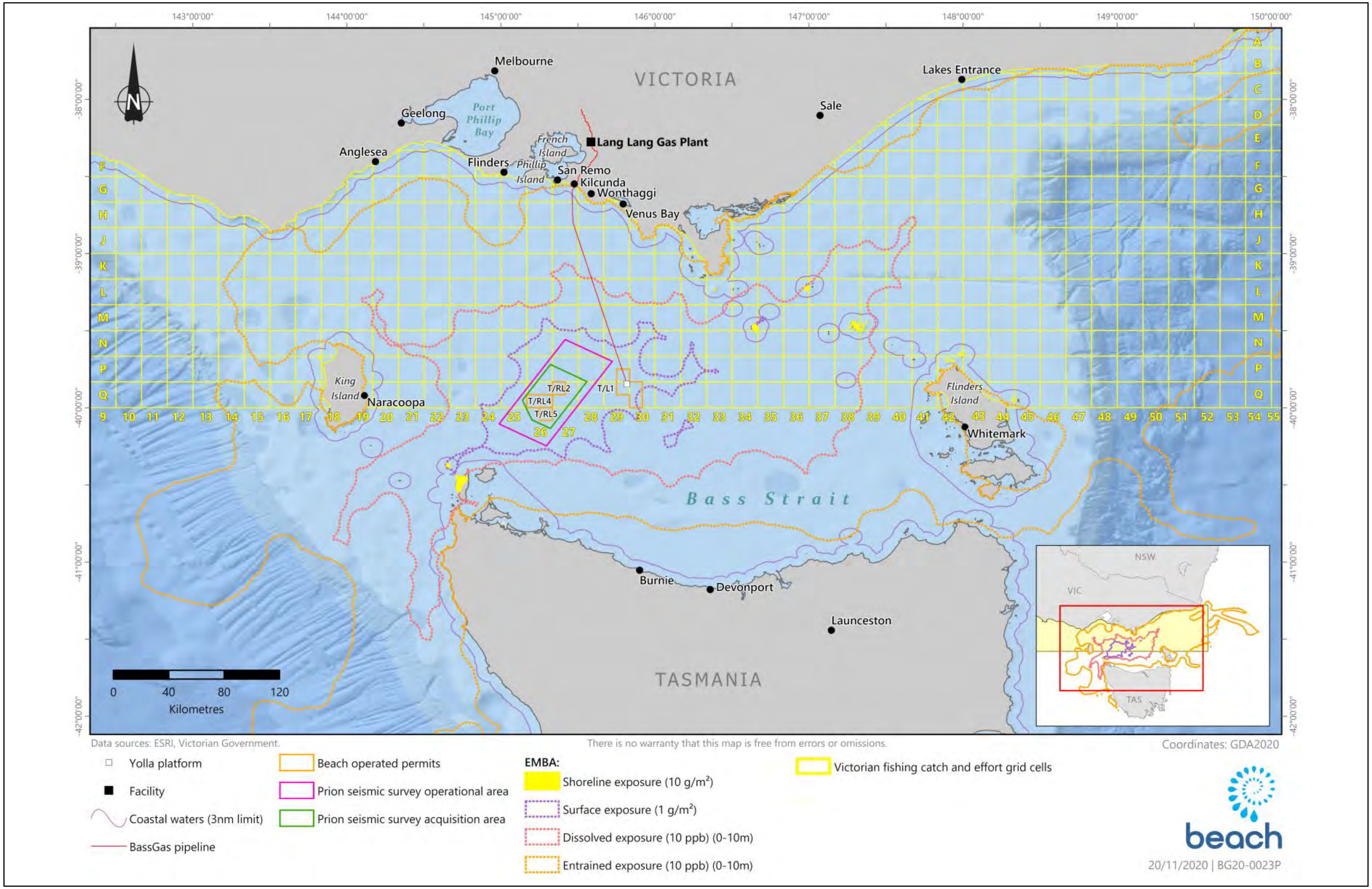


Figure 5.39. VFA fishing catch and effort grid cells overlapped by the survey area and the EMBA

Table 5.18. Victorian-managed commercial fisheries in the EMBA

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Bass Strait Scallop Fishery (Victorian zone) (Figure 5.40)	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. The spill EMBA intersects 57% of the fishery.	**Yes.** Highest fishing effort is concentrated in the eastern waters of the state, with most vessels launching from Lakes Entrance and Port Welshpool.	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 management arrangements designed to increase fishing activity in the area.	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 12 and 20). 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 SESS fishery and the southern squid jig fishery (see Table 5.14).	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 for the 2013-14, 2014-15, 2015-16, 2016-17 and 2017-18 fishing seasons, 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.
Abalone Fishery (Figure 5.41)	Blacklip abalone (*Haliotis rubra*) is the primary target, with greenlip abalone (*H. laevigata*) taken as a bycatch.	Victorian Central Abalone Zone is located between Lakes Entrance and the mouth of the Hopkins River. Most abalone live on rocky reefs from the shore out to depths of 30 m. The spill EMBA intersects 56% of the entire Victorian fishery.	**Yes.** Based on catch distributed along the Victorian coast. Waters of the survey area are too deep for this fishery.	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.	In the central zone, catches for the last five seasons were: • 2018/19 – 274 tonnes. • 2017/18 – 277 tonnes. • 2016/17 – 280 tonnes. • 2015/16 – 306 tonnes. • 2014/15 – 310 tonnes.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
					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.	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.
Rock Lobster Fishery (Figure 5.42)	SRL (*Jasus edwardsii*). Very small bycatch of species including southern rock cod (*Lotella* and *Pseudophycis spp*), hermit crab (family *Paguroidea*), leatherjacket (*Monacanthidae spp*) and octopus (*Octopus spp*).	The eastern zone stretches from Apollo Bay in southwest Victoria to the Victorian/NSW 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. The spill EMBA intersects 56% of the entire Victorian fishery.	**Yes.** EMBA intersects all regions of the fishery except the Warrnambool region.	Closed season for: • Female lobsters – 1 June to 15 November to 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.	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. As of June 2020, there were 33 fishery access licences in the eastern zone.	The Rock Lobster Fishery is Victoria's most valuable fishery. In the eastern zone, catches for the last five seasons with available data were: • 2018/19 – 45 tonnes values at $4.04 million. • 2017/18 – 57 tonnes valued at $4.67 million. • 2016/17 – 52 tonnes valued at $4.28 million. • 2015/16 – 58 tonnes valued at $5.1 million. • 2014/15 – 59 tonnes valued at $5 million.
Wrasse Fishery (Figure 5.43)	Blue-throat wrasse (*Notolabrus tetricus*), saddled wrasse (*N. fucicola*), orange-spotted	Entire Victorian coastline out to 20 nm (excluding marine reserves, bays and inlets). The spill EMBA intersects 57% of the fishery.	**Yes.** In recent years, catches have been highest off the central coast (Port Phillip Heads, Western	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	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.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
	wrasse (*N. parilus*).		Port and Wilson's Promontory) and the west coast. The EMBA intersects all three assessment areas of the fishery.		saddled wrasse prefer depths of 10-30 m. As of June 2020, there were 22 fishery access licences.	• 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 5.44)	Pipi (*Donax deltoids*)	Covers the entire Victorian coastline, with pipis found in the intertidal zone of high-energy sandy beaches.	**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.
Giant crab fishery	Giant crab (*Pseudocarcinus gigas*)	The boundaries of the fishery mimic those of the Rock Lobster Fishery, with the majority of fishing intensity based in the Western Zone. The spill EMBA intersects 56% of the entire Victorian fishery.	**Yes.** However, fishing is concentrated west of Apollo Bay, the western most extent of the EMBA intersects this area.	Closed season from: • Female crabs – 1 June to 15 November to protect females in berry during spawning period. • Male crabs – 15 September to 15 November to protect males during their moulting period when soft shells increase their vulnerability.	Fishers target giant crabs using baited rock lobster pots. As of June 2020, there were 11 fishery access licenses.	Catches of giant crab for the last five seasons were: 2018/19 – not available. 2017/18 – 9.8 tonnes. 2016/17 – 10.0 tonnes. 2015/16 – 10.0 tonnes. 2014/15 – 10.5 tonnes.
Multi-species ocean fishery						

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
Ocean Purse Seine Fishery	Australian sardine (*Sardinops sagax*), Australian salmon (*Arripis trutta*) and sandy sprat (*Hyperlophus vittatus*) are the main species. Southern anchovy (*Engraulis australis*) caught in some years.	Entire Victorian coastline, excluding marine reserves, bays and inlets.	**Yes.** An assumption, based on limited data availability.	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. 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.	Confidential data (due to low number of operations).
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.	**Yes.** 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	Entire Victorian coastline, excluding marine reserves, bays and inlets.	**Yes.** Based out of Lakes Entrance with catch	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.	The catch of eastern school prawn in 2015 was 75 t, the largest for the previous 10 years.

Fishery	Target species	Geographic extent of fishery	Does fishing occur in the EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
	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*).	Most operators are based at Lakes Entrance.	locations being distant from the spill EMBA.		As of June 2020, there were 54 fishery access licences, with only about 15 active to various degrees.	

Source: VFA (2020).

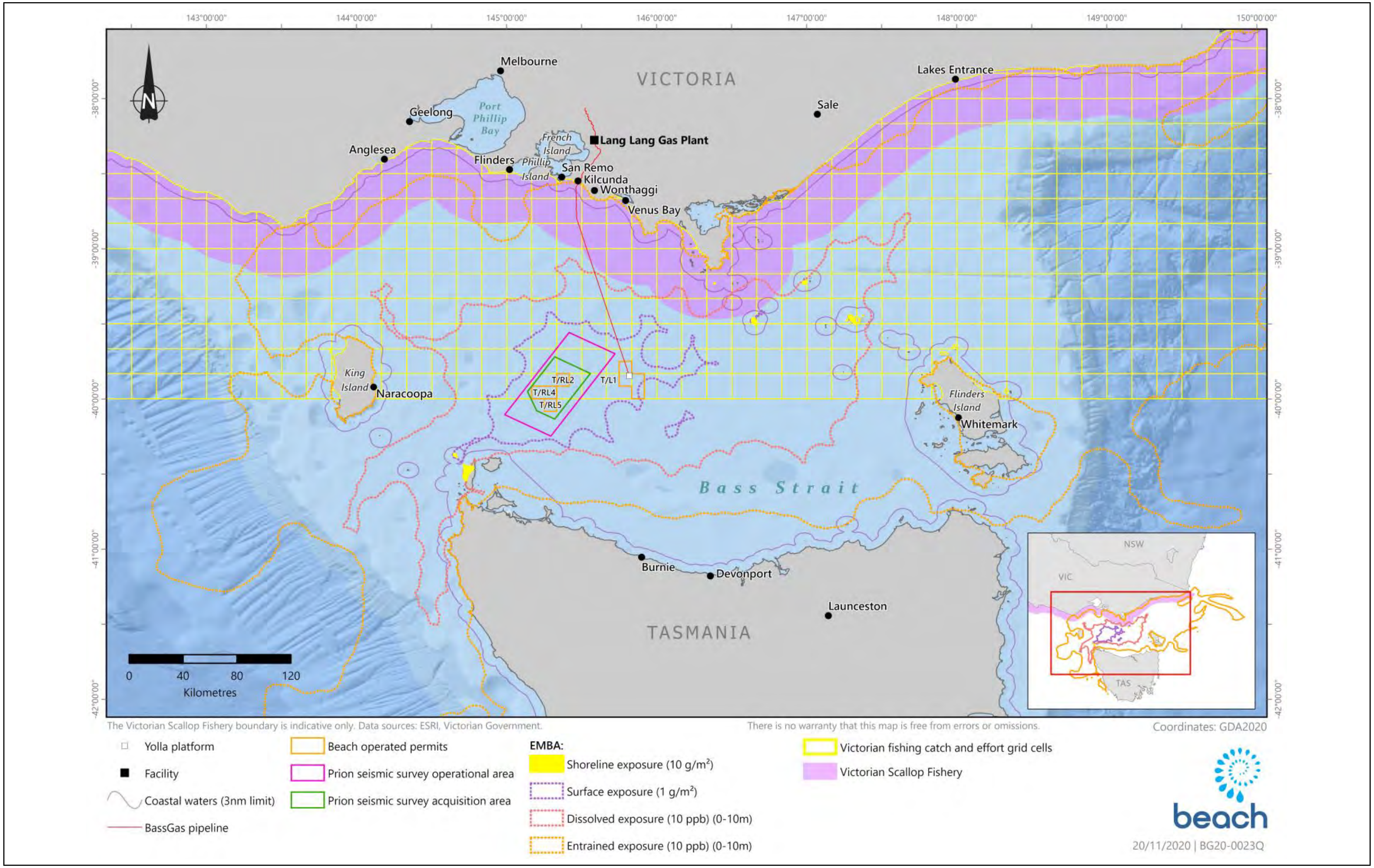


Figure 5.40. Jurisdiction of the Victorian scallop fishery and its intersection with the EMBA

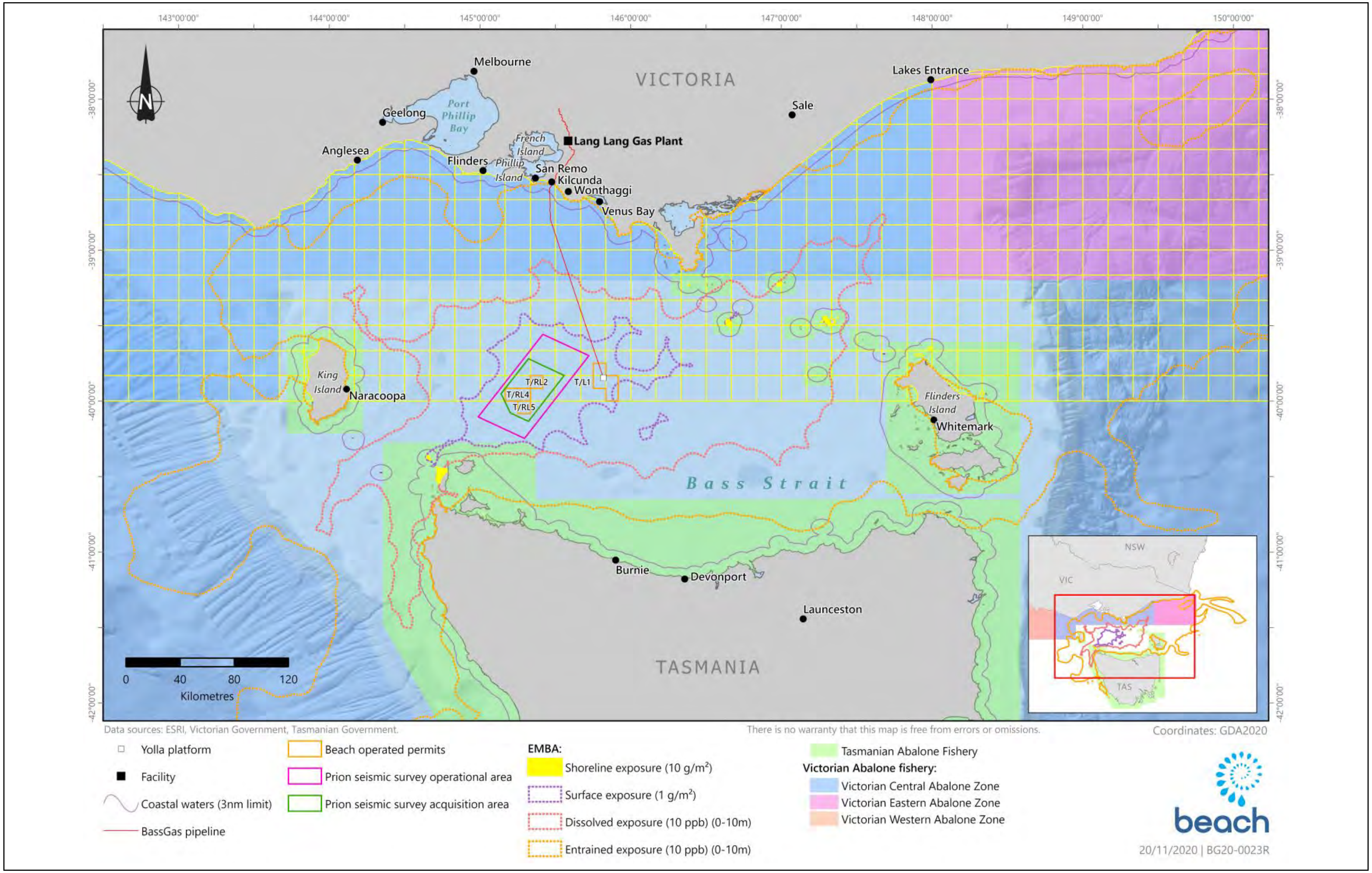


Figure 5.41. Jurisdiction of the Victorian (and Tasmanian) abalone fishery and its intersection with the EMBA

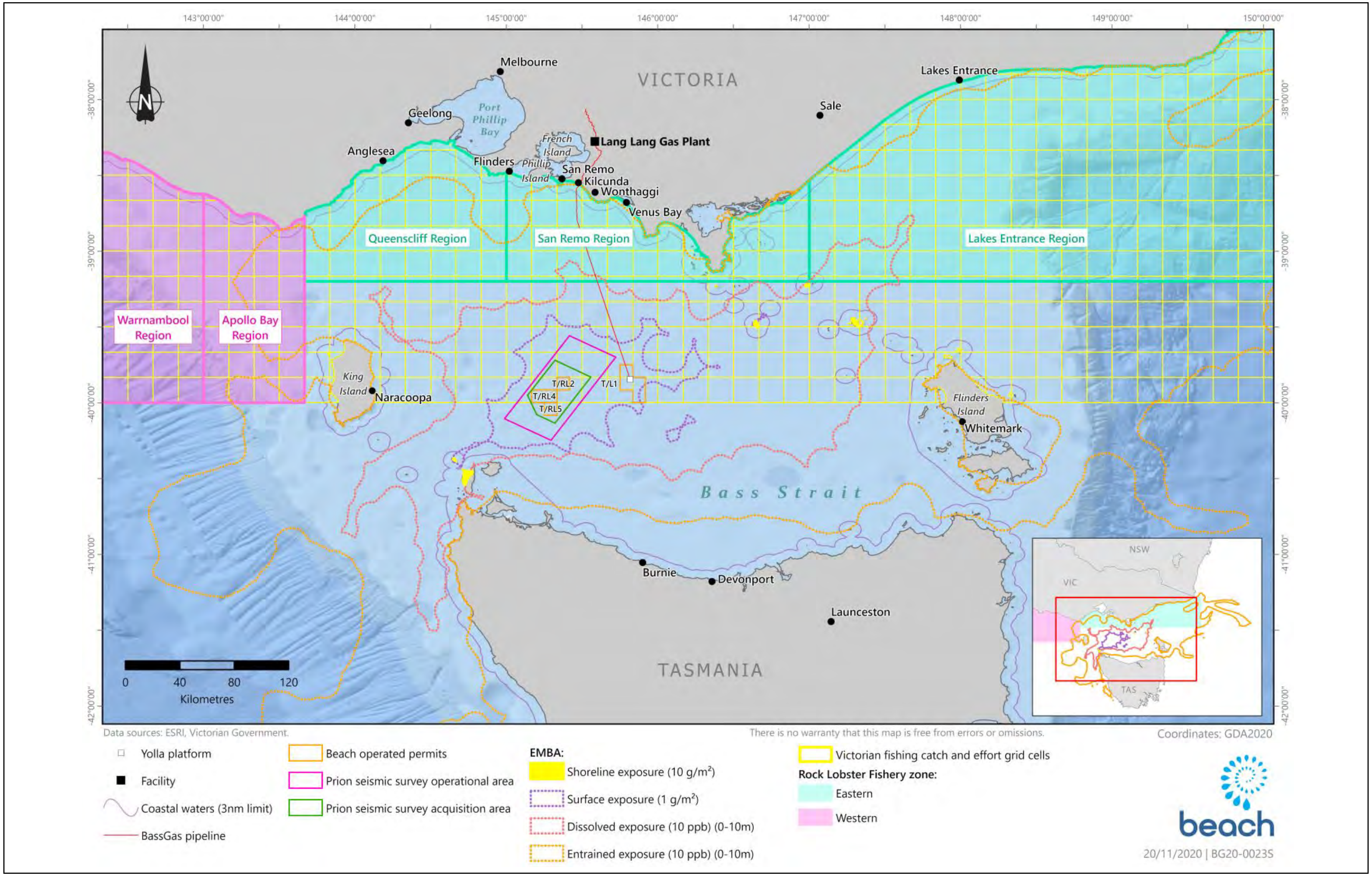


Figure 5.42. Jurisdiction of the Victorian SRL fishery and its intersection with the EMBA

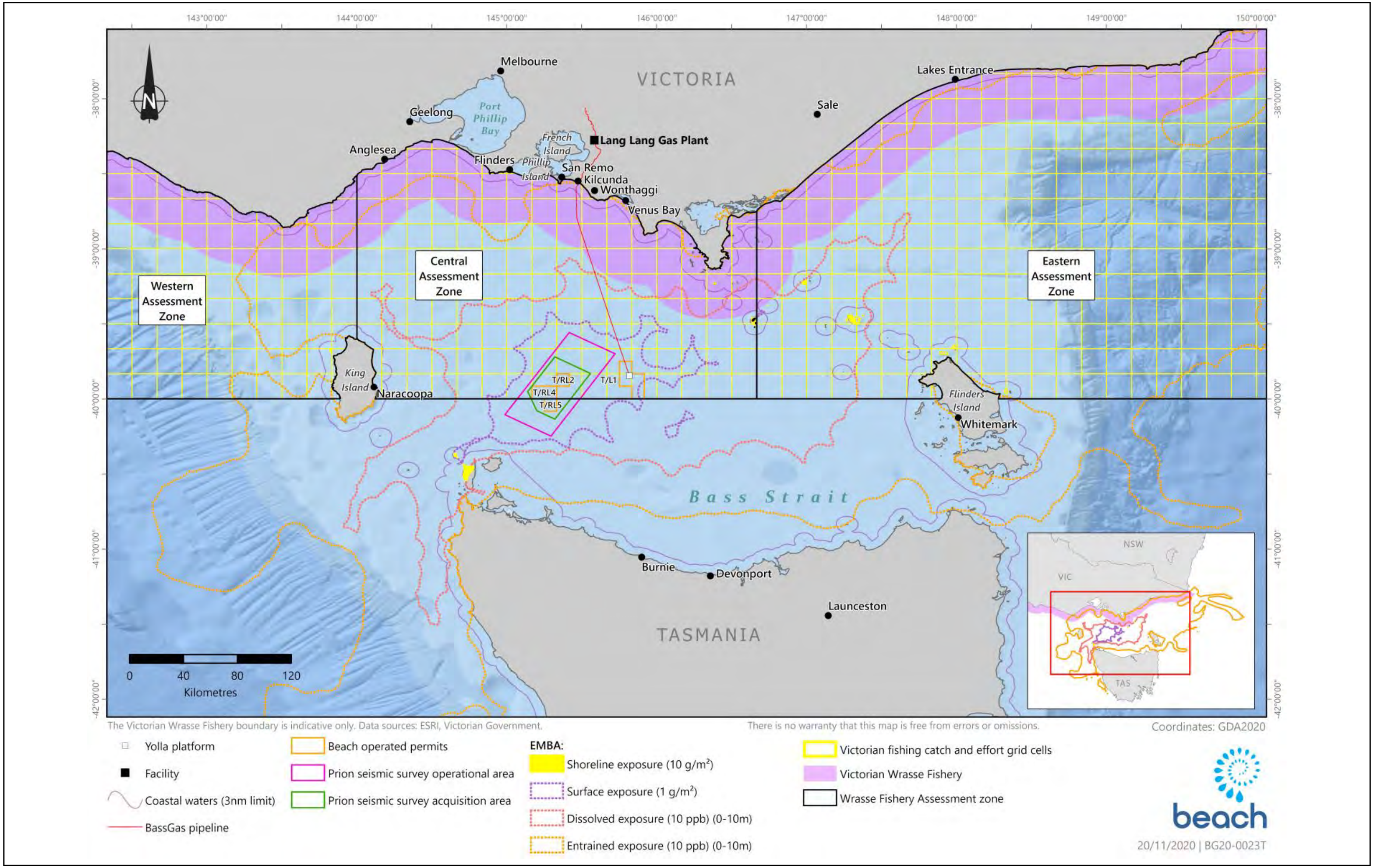
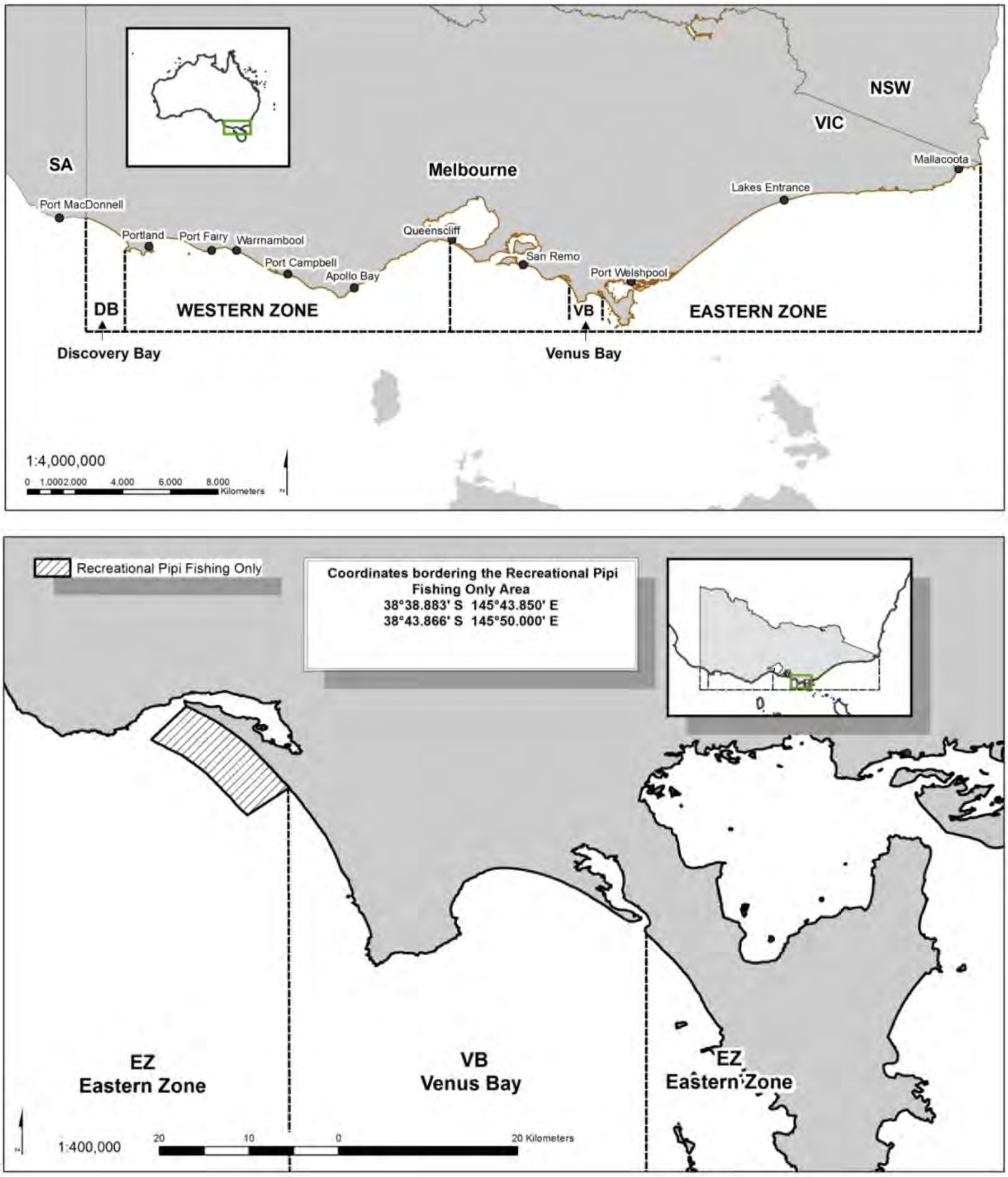


Figure 5.43. Jurisdiction of the Victorian wrasse fishery and its intersection with the EMBA



Source: VFA (2020).

Figure 5.44. Jurisdiction of the Victorian pipi fishery (top), and the 'recreational only' area (bottom)

Table 5.19. Tasmanian-managed commercial fisheries in the spill 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
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.
Abalone Fishery (Figure 5.41)	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 overlap between the survey area and the fishery. **EMBA? Yes.** The EMBA intersects 39% of the fishery in the north west, west and north east zones.	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 vessel). Commercial divers do not use SCUBA gear. Divers use an iron bar to prise abalone from rocks.	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. • 2014 – 1,932 t.
Rock Lobster Fishery (Figure 5.45)	SRL (*Jasus edwardsii*).	All Tasmanian waters. East Coast Stock Rebuilding Zone subject to temporary closures.	**Survey area? No.** Consultation with the DPIPWE fishery manager did not indicate that fishing occurs in the survey area. The survey area intersects 0.90% of the fishery. **EMBA? Yes.** The EMBA intersects 44.5% of the fishery in the eastern and western zones.	12-month season, from March to February. • Female - 1 May 2018 for all State waters. • Male - 1 September 2018 for all waters south of St Helens	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 (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. Consultation with the fishery manager indicated that majority of catch is taken from the

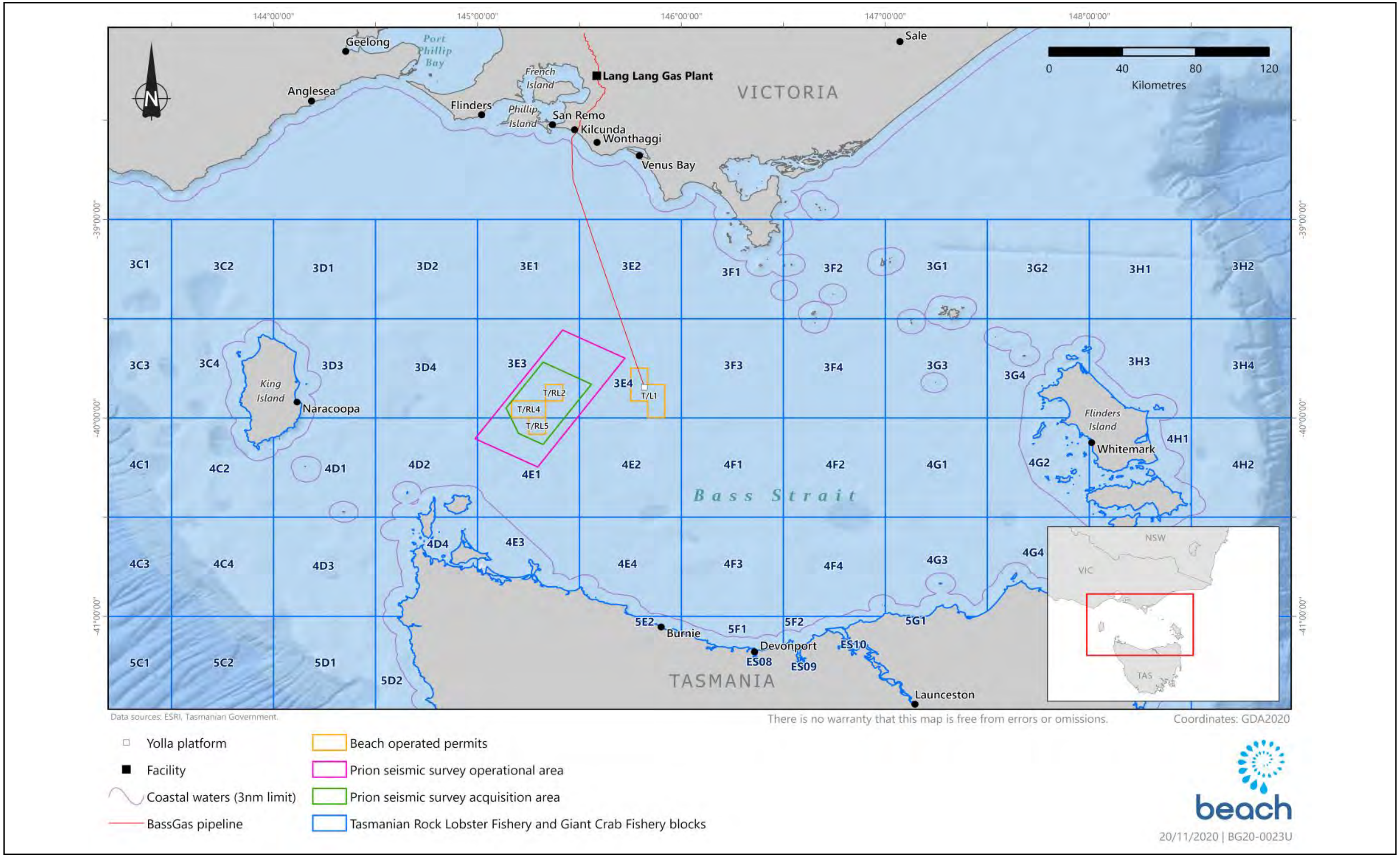
Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
				around to Sandy Cape. • Male - 1 October 2018 all other State waters.		southwest and northeast coasts of Tasmania, around King Island and around Flinders Island.
Shellfish Fishery (Figure 5.46)	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 5.46).	**Survey area? No.** The designated zones occur off the east coast of Tasmania. **EMBA? No.** The designated zones occur off the east coast of Tasmania.	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.	**Survey area? No.** Seaweed is harvested as it washes ashore. **EMBA? No.** The primary sites of the fishery occur off the east coast of Tasmania and west coast of King Island. There is no known seaweed collection that occurs at sites that may be exposed to shoreline loading of hydrocarbons.	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.	No catch data available.
Scalefish Fishery (Figure 5.47)	Multi-species fishery including banded morwong (*Cheilodactylus spectabilis*), tiger flathead (*Neoplatycephalus richardsoni*), southern	Entire Tasmanian coastline.	**Survey area? Yes.** Catch of Gould's squid has been reported from the survey area under the Tasmanian scalefish fishery, however this includes data	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.	Catches of key scalefish species for the last five seasons were: • 2017/18 – 318 t. • 2016/17 – 312 t. • 2015/16 – 348 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
	school whiting (*Sillago flindersi*) Australian salmon (*Arripis trutta*), barracouta (*Thyrsites atun*), bastard trumpeter (*Latridopsis forsteri*) and blue warehou (*Seriolella brama*).		from the Commonwealth-managed SSJF. If catch is taken from the survey area, it is of very low (<50 kg/annually) quantity. The survey area intersects 1.23% of the fishery. **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 EMBA intersects 51.94% of the fishery.		There were 259 vessels operating in 2017/18 across the fishery.	• 2014/15 – 273 t. • 2013/14 – 320 t.
Giant Crab Fishery (Figure 5.45)	Tasmanian giant crab (*Pseudocarcinus gigas*).	Entire Tasmanian coastline, the fishery shares the same reporting grid as the rock lobster fishery (see Figure 5.45).	**Survey area? No.** Consultation with the DPIPWE fishery manager indicated that catch is not taken from the survey area. The survey area intersects 0.9% of the fishery. **EMBA? Yes.** The majority of catch occurs off the south western, southern and south eastern coast of Tasmania along the continental slope. The EMBA intersects 44.5% of the fishery.	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 were: • 2018/19 – 20 t. • 2017/18 – 16 t. • 2016/17 – 30 t. • 2015/16 – 20 t. • 2014/15 – 23 t.
Commercial Dive Fishery (Figure 5.48)	Short spined sea urchin (*Heliocidaris erythrogramma*), long	Entire Tasmanian coastline (refer to Figure 5.48).	**Survey area? No.** Consultation with DPIPWE did not indicate that catch	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

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
	spined sea urchin (*Centrostephanus rodgersii*), periwinkles (genus *Turbo*) and Japanese kelp (*Undaria pinnatifida*).		is taken from the survey area. The survey area intersects 2.0% of the fishery. **EMBA? Yes** EMBA intersects the northern and western and north eastern reporting zones of the fishery. The EMBA intersects 54.2% of the fishery.			reporting was 76 tonnes with no value assigned. Historic catch data is not available.
Octopus Fishery (Figure 5.47)	Pale octopus (*Octopus pallidus*).	Entire Tasmanian coastline, the fishery shares the same reporting grid as the scalefish fishery (refer to Figure 5.47).	**Survey area? Yes.** Catch data reported in the fishery's 2018/19 assessment indicates that fishing activity occurs in the survey area (refer to Figure 5.49 and Figure 5.50). The survey area intersects 1.23% of the fishery. **EMBA?** Yes. Catch data reported in the fishery's 2018/19 assessment indicates that fishing activity occurs in the EMBA. The EMBA intersects 51.94% of the fishery.	Year round.	There are only two active vessel licences. In 2017/18, the total catch of pale octopus was 64.4 tonnes, representing the lowest level observed in six years (the average annual average catch for the previous decade was 85.4 tonnes. In contrast, effort was the third highest level recorded since reporting began, with 366,500 potlifts in 2017/18, and slightly exceeded the proposed reference point of 350,000 potlifts.	From the reporting grid overlapping the survey area, more than 20 tonnes were caught from 2012-13 to 2016-17, with 13-20 tonnes caught in 2017-18. In the fishing grid with the greatest overlap with the survey area, 3-12 tonnes of octopus were caught. This contrasts with the information provided by DPIPWE as noted previously. Based on consultation with DPIPWE, there is very low catch from within the survey area, so low (<50 kg) that it could not be disclosed to Beach for confidentiality purposes. 30-55 m depth layer most prolific in the southern third of the survey area, shelly-gravelly substrate preferred by the target species. Northern third less important due to the muddy substrate. The fishery is active year-round, but the most important period is between March-July, with catch

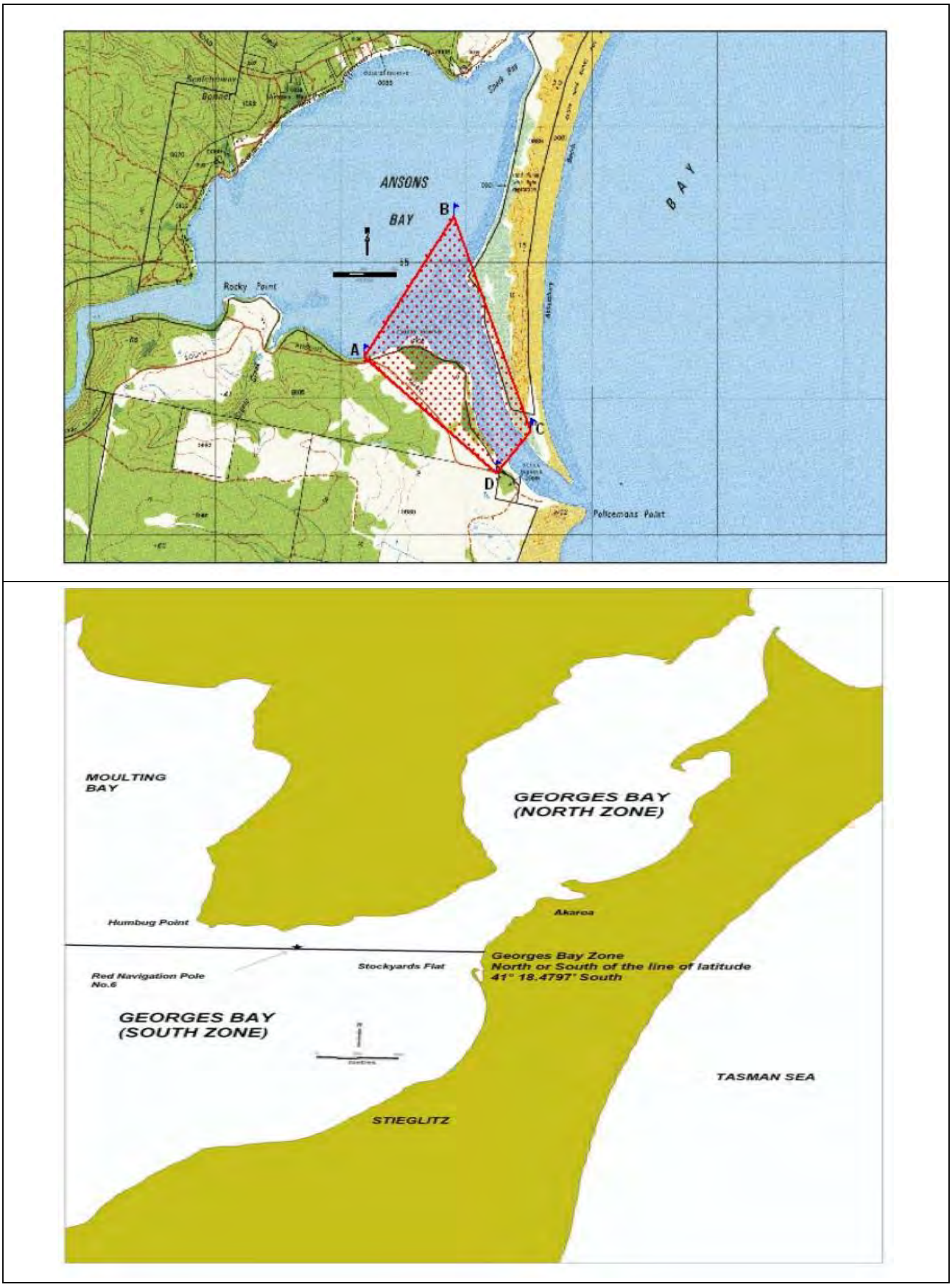
Fishery	Target species	Geographic extent of fishery	Does fishing occur in the survey area or EMBA?	Fishing season	Fishing methods, vessels and licences	Catch data and other information
						from August-December being patchier and more widely distributed. The northern half of the survey area is of minimal concern to the fishery as the water depths and substrate types do not represent ideal areas for fishing.

Source: DPIPWE (2020), Moore & Hartmann (2019), Emery et al (2015), Hill et al (2020).



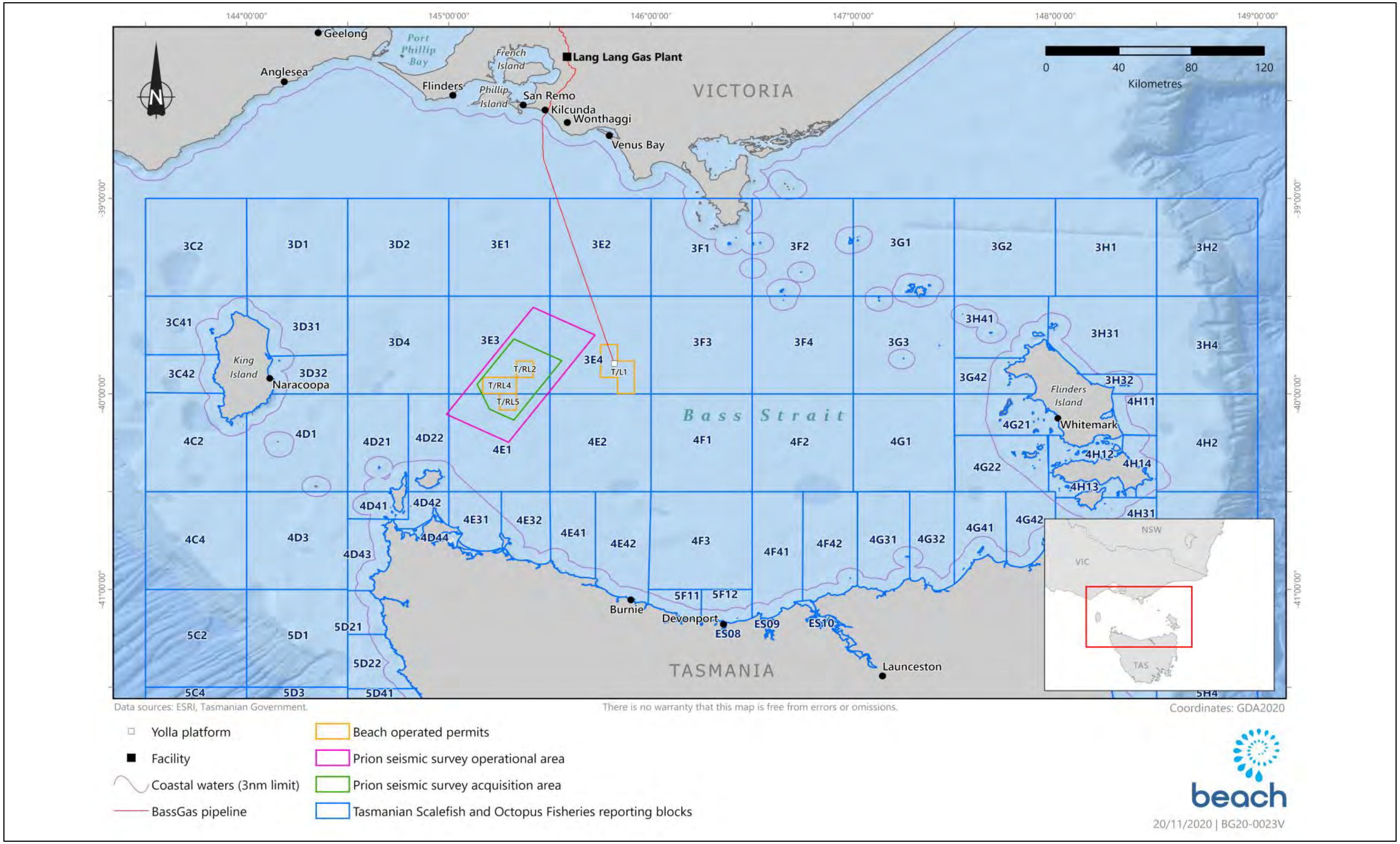
Source: DPIPWE (2020b)

Figure 5.45. Jurisdiction and reporting blocks of the Tasmanian Rock Lobster and Giant Crab Fishery



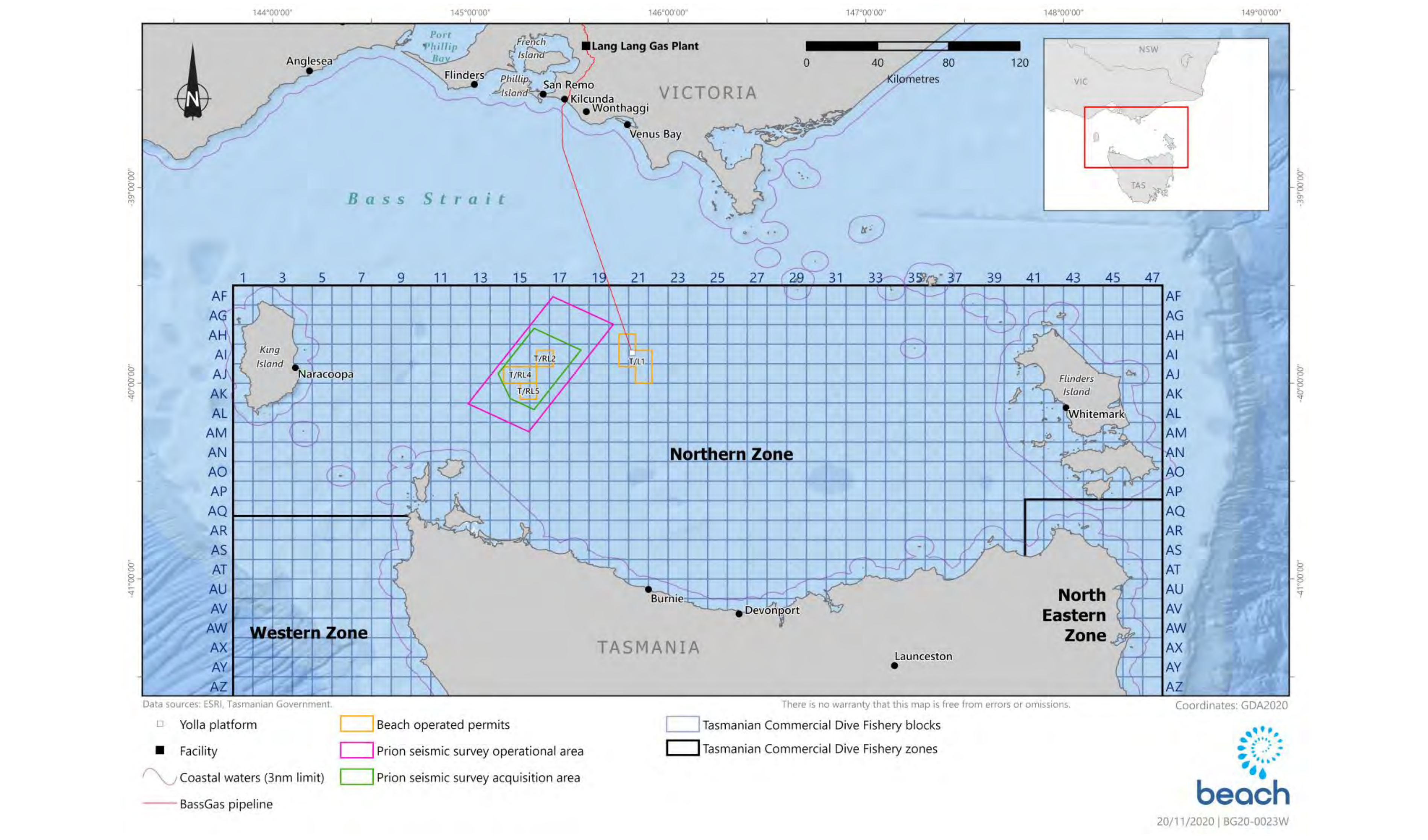
Source: DPIPWE (2020c)

Figure 5.46. Tasmanian Shellfish Fishery areas of high catch and effort



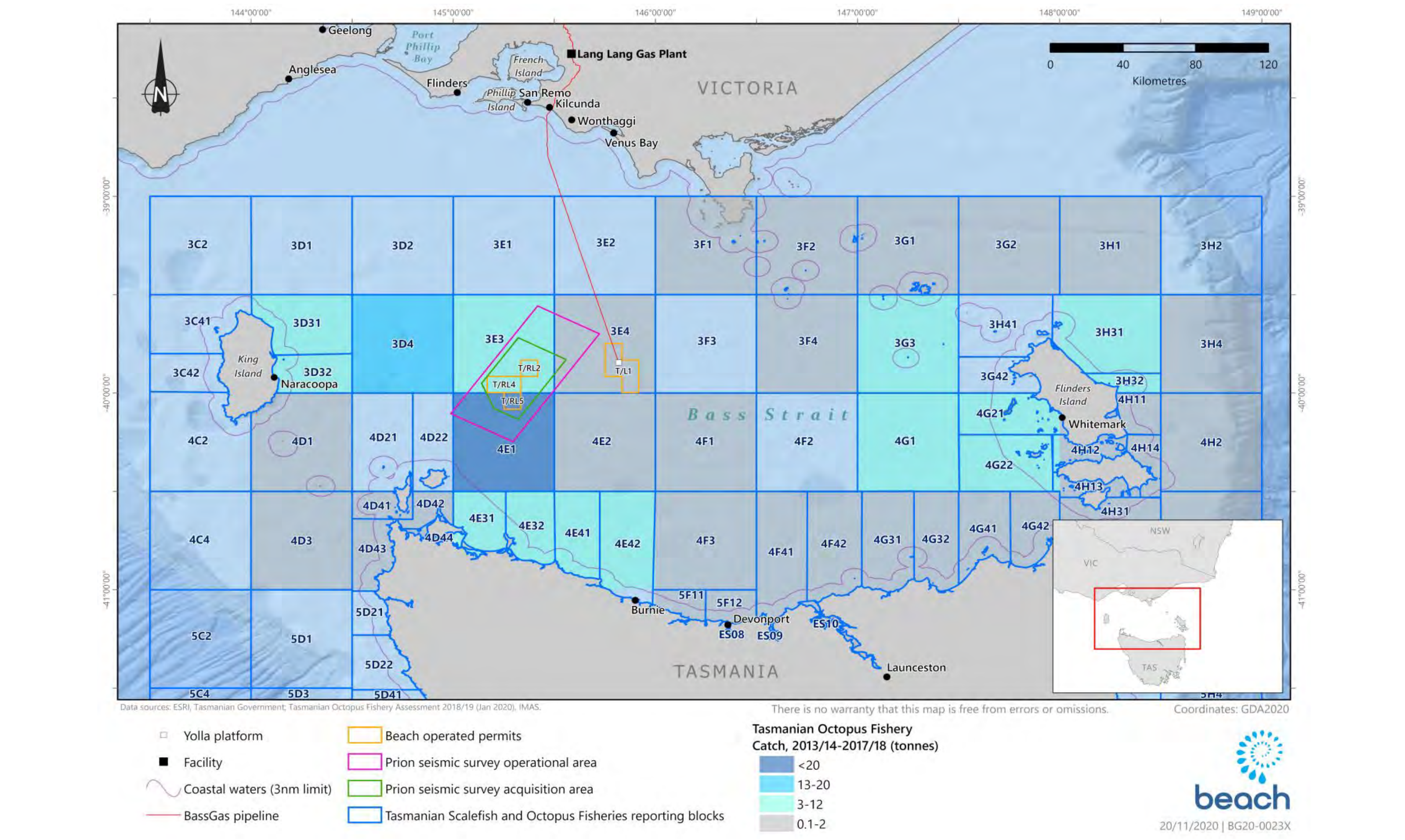
Source: DPIPWE (2020g)

Figure 5.47. Jurisdiction and reporting blocks of the Tasmanian Scalefish and Octopus Fisheries



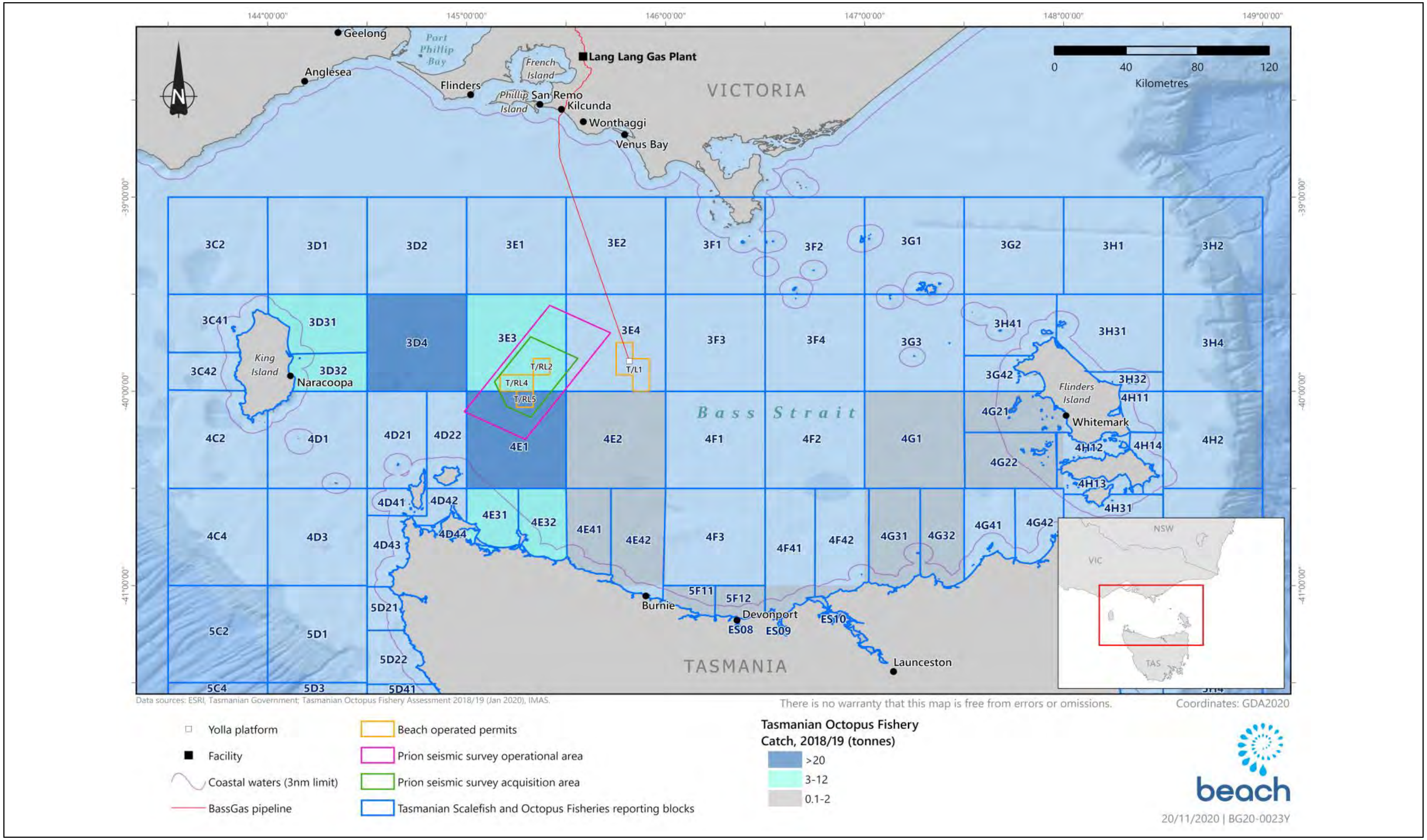
Source: DPIPWE (2020h)

Figure 5.48. Jurisdiction and reporting blocks of the Tasmanian Commercial Dive Fishery



(Source: Hill et al., 2020)

Figure 5.49. Reported catch of the Tasmanian Octopus Fishery for 2013/14 – 2017/18 in relation to the survey area



(Source: Hill et al., 2020)

Figure 5.50. Reported catch of the Tasmanian Octopus Fishery for 2018/19 in relation to the survey area

Tasmanian Octopus Fishery

Through data analysis and consultation with fishing industry associations, representatives and government agencies, Beach has determined that the Tasmanian octopus fishery is a key stakeholder for the survey. Beach conducted a meeting with the key octopus fisher in late July 2020 and presented survey design information and sought feedback from the fisher on his operations (see Chapter 4).

The stakeholder explained that the southern one-third of the survey area is actively fished for octopus. It was explained that their operations do set lines to the south and west of the survey area with the most prolific fishing grounds located in water depths of 30–50 m with sandy shelly substrate in the areas to the west, southwest and south of the survey area. Beach learned that the most important period for the fishery is between March and July. The stakeholder explained that from August to December, the octopus catch is patchier and more widely distributed. The fisher stated that the northern half of the survey area is of minimal concern to the octopus fishery due to the unsuitable muddy substrate and does not represent an important fishing ground. The octopus trap lines are 4 km long and contain 500 traps per line. These are laid on the seabed and surface buoys are used to mark their locations, with the lines left on the seabed for several weeks at a time. Locations where the octopus fisher has fished in the 18 months prior to the July 2020 meeting in relation to the survey area is presented in Figure 5.51.

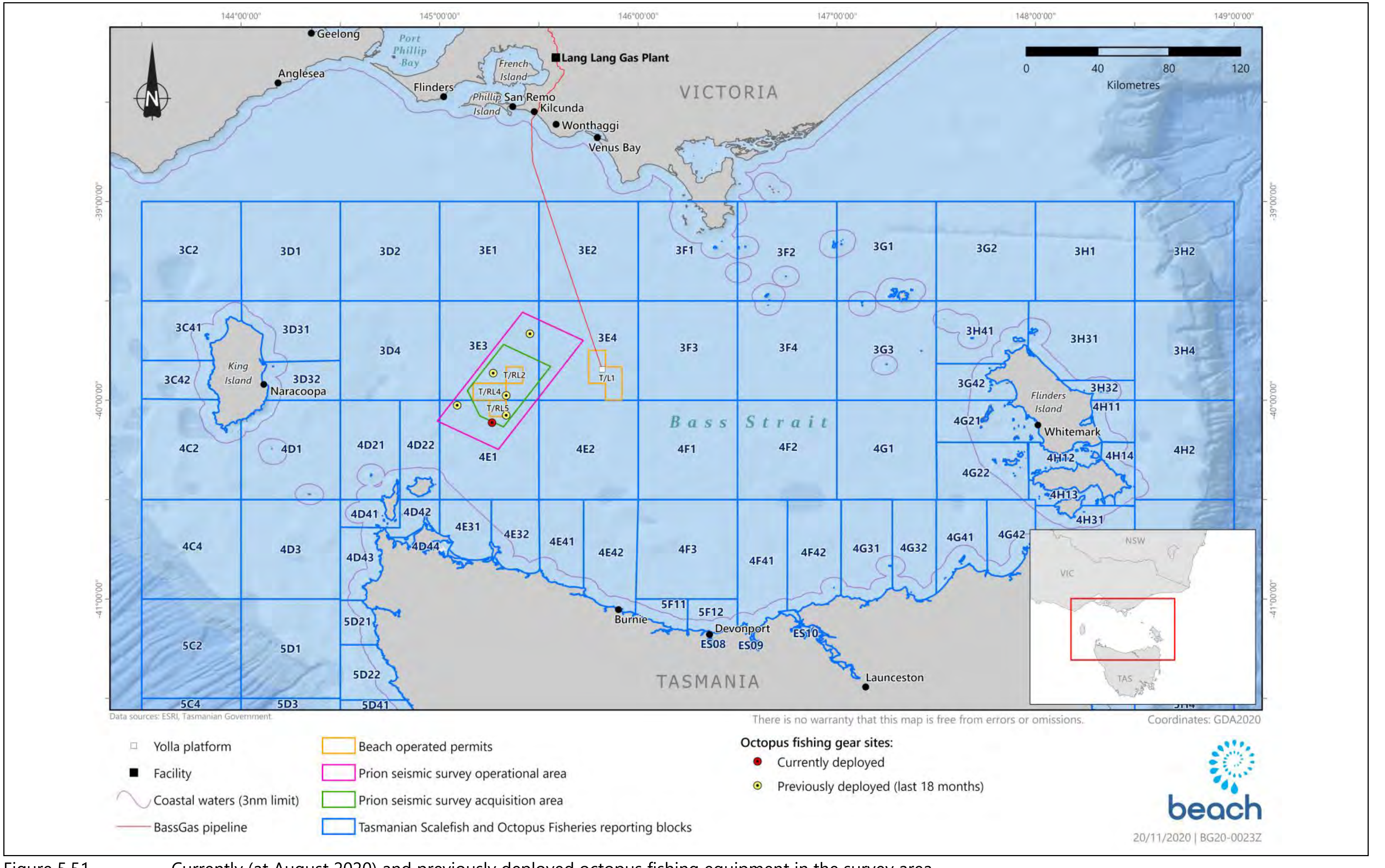


Figure 5.51. Currently (at August 2020) and previously deployed octopus fishing equipment in the survey area

5.7.7 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). A random extract of monthly shipping traffic recorded by AMSA for the survey area and central Bass Strait is presented in Table 5.20 (April 2020). Vessels indicated by the data as cargo ships, tankers and passenger ships are the most common entries. The longest ship recorded in the data is 334 m and the top speed recorded is 26.8 knots.

The 'Spirit of Tasmania' (indicated as 'Passenger ship' in Table 5.21) ferry service runs between Melbourne and Devonport (northern Tasmania) on a daily basis. The crossing is 429 km long and during non-peak times (May to August) the ferry departs each port in the evening and during peak times (September to April) day sailings are offered as well. The voyage ferry takes 11 hours on days of single sailings and 9 hours of days of double sailings. The ferry service route is illustrated in Figure 5.52 (blue dashed line), which intersects the northeast part of the survey area. Using the route identified in Figure 5.52, the ferry service takes approximately one hour to traverse the survey area.

The route for other maritime traffic that flows between Melbourne and the Australian east coast passes close to Wilsons Promontory (see Figure 5.52).

Table 5.20. Summary of monthly shipping traffic within and adjacent to the survey area (April 2020)

Vessel type	Number of vessels	Average length (m)	Average speed (km/h)
Cargo ship	156	218	25
Tanker	34	146	24
Spirit of Tasmania	2	193	40
Engaged in dredging or underwater operations	1	84	16

Based on the extract of shipping traffic recorded by AMSA for the survey area and central Bass Strait, a total of 391 ships passed through this area during April. The majority of these (241) are cargo ships with passenger ships (i.e., the Spirit of Tasmania) being the next most frequent (58). Based on this data, an average of 13 ships per day either idle in or pass through the waters of the survey area and its immediate surrounds. This information is consistent with the assertion that this area of central Bass Strait is a busy shipping area. A summary of the shipping traffic data is presented in Table 5.21.

Table 5.21. Summary of shipping traffic recorded by AMSA in waters within and adjacent to the survey area (April 2020)

Vessel type	Number of vessels
Cargo ship	241
Tanker	39
Passenger ship	58
Other	53
Total	**391**

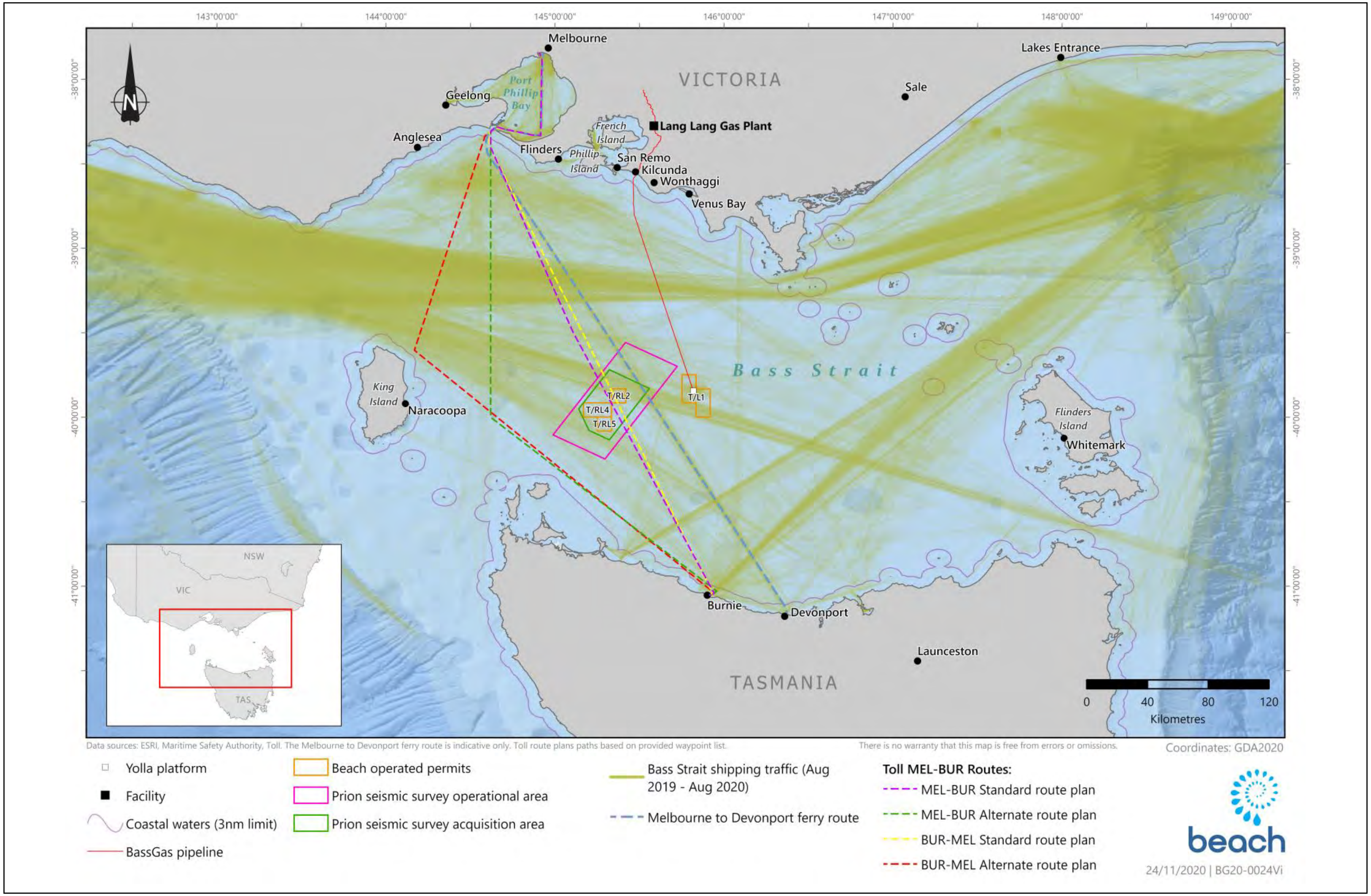


Figure 5.52. Commercial shipping traffic in the survey area

6. Environmental Impact and Risk Assessment Methodology

As required under Regulation 13(5) of the OPGGS(E), this chapter describes the environmental impact and risk assessment methodology used in this EP. Beach uses its Corporate Risk Assessment Framework and risk toolkit for all its activities. This methodology is consistent with the Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000:2018, *Risk Management – Principles and Guidelines*).

Figure 6.1 outlines the Beach risk assessment management process, with each step of this process described in this chapter.

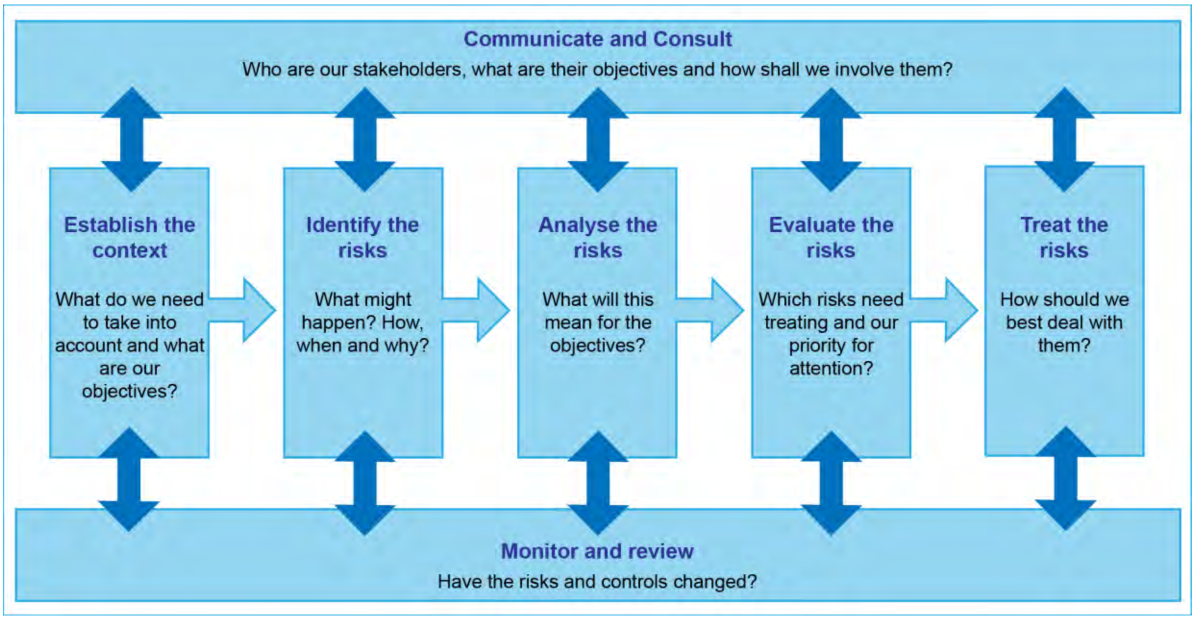


Figure 6.1. Beach risk assessment process

6.1 Step 1 - Communicate and Consult

In accordance with Regulations 11A and 14(9) of the OPGGS(E), Beach has consulted with relevant persons (stakeholders) in the development of this EP to obtain information about their functions, activities and interests and assess how the Prion 3DMSS may impact on these. This information has been used to inform the impact and risk assessment in the EP. The stakeholder consultation process is described in detail in Chapter 4.

6.2 Step 2 - Establish the Content

The first step in the risk assessment process (outlined in Figure 6.1) is to establish the context. This involves:

- Understanding the regulatory framework in which the activity takes place (described in the 'Regulatory Framework' in Chapter 2);
- Defining the activities that will cause impacts and create risks (outlined in the 'Activity Description' in Chapter 3);
- Understanding the concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Chapter 4, 'Stakeholder Consultation'); and
- Describing the environment in which the activity takes place (the 'Existing Environment' is described in Chapter 5).

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 Step 3 - Identify the Risks

Beach's Corporate Risk Assessment Framework requires the following steps to be implemented:

- Identify the activities and the potential impacts associated with them;
- Identify the sensitive environmental resources at risk within and adjacent to the operational area;
- Identify the environmental consequences of each potential impact, corresponding to the maximum reasonable impact;
- Identify the likelihood (probability) of occurrence of each potential environmental impact (i.e., the probability of the event occurring);
- Identify applicable control measures; and
- Assign a level of risk to each potential environmental impact using a risk matrix.

In accordance with this framework, all risks must be reduced to a level that is considered to be As Low As Reasonably Practicable (ALARP) (see Section 6.3.3).

A risk identification and assessment workshop was undertaken by Beach on the 10th of November 2020 to identify the key impacts and risks associated with the Prion 3DMSS. The workshop involved a multi-disciplinary team, including personnel from the geophysical, environment and community teams. Following the review of each hazard and their associated impacts and risks, control measures were also reviewed to ensure the impact consequence or risk rating is ALARP. An assessment of what is 'reasonably practicable' requires professional judgements to be made against the relevant matrices using the advice of technical experts as well as published standards, availability of mitigation measures and industry practice.

The information from this workshop was captured within the Prion 3DMSS environmental impact and risk register.

6.3.1 Definitions

For context, Table 6.1 provides the definitions of impacts and risk according to the OPGGS(E) and international risk management standards.

The OPGGS(E) Regulations 14(5)(6) require that the EP detail and evaluate the environmental impacts and risks for an activity, including control measures used to reduce the impacts and risks of the activity to ALARP and an acceptable level. This must include impacts and risks arising directly or indirectly from all activity operations (i.e., planned events) or potential emergency conditions or incidents (i.e., unplanned events).

In its *Environment plan content requirements* guidance note (N-04750-GN1344, Rev 4, April 2019), NOPSEMA distinguishes between environmental impacts and risks. Environmental impact is defined in Table 6.1 in accordance with the OPGGS(E). Table 6.1 also highlights that environmental risk is not defined in both sets of regulations.

Table 6.1. Definitions of impact and risk

Source	Impact	Risk
OPGGS(E)	Any change to the environment, whether adverse or beneficial, that wholly or partially results from an activity.	Not defined.
ISO AS/NZS 31000: 2018 (Risk management – Principles and guidelines)	Not defined.	The effect of uncertainty on objectives.
ISO AS/NZS 14001: 2016 (Environmental management systems – Requirements with guidance for use)	Not defined.	The effect of uncertainty on objectives.
ISO AS/NZS 4360: 2004 (Risk management)	Not defined.	The chance of something happening that will have an impact on objectives.
HB203: 2012 (Managing environment-related risk)	Any change to the environment or a component of the environment, whether adverse or beneficial, wholly or partly resulting from an organisation's environmental aspects.	The effect of uncertainty on objectives. The level of risk can be expressed in terms of a combination of the consequences and the likelihoods of those consequences occurring.

For this activity, Beach has determined that impacts and risks are defined as follows:

- **Impacts** result from **planned events** – there *will* be consequences (known or unknown) 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** result 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 this is not a certainty. 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 (Table 6.2).

6.4 Step 4 – Analyse the Risks

After the impacts and risks have been identified, environmental performance outcomes (EPO) (or objectives) are developed to provide a measurable level of performance for each environmental hazard to ensure that the environmental impacts and risks are managed to be ALARP and acceptable.

Table 6.2. Beach risk assessment matrix

Consequence Rating	Natural Environment	Reputational and/or Community damage / impact / social / cultural heritage	Likelihood of Occurrence					
			Remote (1)	Highly Unlikely (2)	Unlikely (3)	Possible (4)	Likely (5)	Almost Certain (6)
			<1% chance of occurring within the next year. Occurrence requires exceptional circumstances. Exceptionally unlikely event in the long-term future. Only occur as a 100-year event.	>1% chance of occurring within the next year. May occur but not anticipated. Could occur years to decades.	>5% chance of occurring in the next year. May occur but not for a while. Could occur within a few years.	>10% chance of occurring within the next year. May occur shortly but a distinct possibility it will not. Could occur within months to years.	>50% chance of occurring within the next year. Balance of probability that it will occur. Could occur within weeks to months.	99% chance of occurring within the next year. Impact is occurring now. Could occur within days to weeks.
Catastrophic (6)	Long-term destruction of highly valued ecosystem or very significant effects on endangered species or habitats (formally managed).	Irreparable damage of highly valued items or structures of great cultural significance. Negative international or prolonged national media (e.g., 2 weeks).	High	High	Severe	Severe	Extreme	Extreme
Critical (5)	Significant impact on highly valued (formally managed) species or habitats to the point of eradication or impairment of ecosystem. Widespread long-term impact.	Major irreparable damage to highly valued structures/ items of cultural significance. Negative national media for 2 days or more. Significant public outcry.	Medium	Medium	High	Severe	Severe	Extreme
Major (4)	Very serious environmental effects, such as displacement of species and partial impairment of ecosystem (formally managed). Widespread medium and some long-term impact.	Significant damage to items of cultural significance. Negative national media for one day. Adverse attention from non-government organisations (NGOs).	Medium	Medium	Medium	High	Severe	Severe
Serious (3)	Moderate effects on biological or physical environment (formally managed) and serious short-term effects but not affecting ecosystem functions.	Permanent damage to items of cultural significance. Negative State media. Heightened concern from local community. Criticism by NGOs.	Low	Medium	Medium	Medium	High	Severe
Moderate (2)	Minor short-term damage to area of limited significance (not formally managed). Short-term effects but not affecting ecosystem functions.	Some damage to items of cultural significance. Minor adverse local public or media attention and complaints.	Low	Low	Medium	Medium	Medium	High
Minor (1)	No lasting effects. Low-level impacts on biological and physical environment to an area of low significance (not formally managed).	Low level repairable damage to commonplace structures. Public concern restricted to local complaints.	Low	Low	Low	Medium	Medium	Medium

6.5 Step 5 – Evaluate the Risks

The purpose of impact and risk evaluation (herein referred to simply as risk assessment) is to assist in making decisions, based on the outcomes of analysis, about the sorts of controls required to reduce an impact or risk to ALARP. Planned and unplanned events are subject to risk assessment in the same manner.

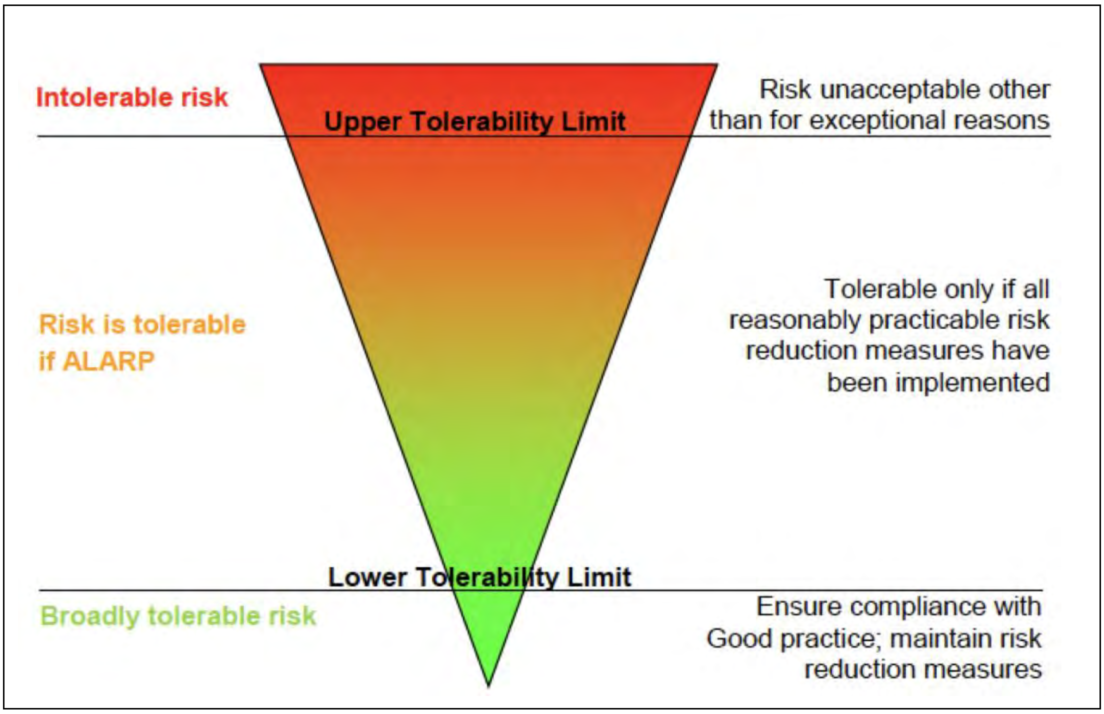
Beach's risk assessment process is described below and was followed in the risk identification and assessment workshop described in Section 6.3:

- Identify and describe the risks (see Chapter 7).
- Determine the maximum credible consequence (to the natural environment and community/social/cultural heritage) arising from the impact or risk without introducing additional controls. This determination is provided in the risk assessment tables throughout Chapter 7.
- Adopt controls for each impact or risk.

- Undertake an assessment of the consequence of the impact or risk, corresponding to the maximum credible impact across the consequence categories (see Table 6.2, previous page) considering the controls identified and their effectiveness.
- Identify the likelihood of occurrence of those consequences ('remote' through to 'almost certain'), considering the controls identified and their effectiveness, as outlined in Table 6.2.
- For risks, multiply the consequence and likelihood to determine the overall risk raking, outlined in Table 6.2.

6.5.1 Demonstration of ALARP

The ALARP principle states that it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the 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 6.2.



Source: CER (2015).

Figure 6.2. The ALARP Principle

Beach's approach to demonstrating ALARP includes:

- Systematically identifying and assessing all potential environmental impacts and risks associated with the activity;
- Where relevant, applying industry 'good practice' controls to manage impacts and risks;
- 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.

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 deemed 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 is outlined in Table 6.3.

Table 6.3. Alignment of ALARP with impacts (using consequence ranking) and risks (using risk ranking)

Consequence ranking	Minor	Moderate	Serious	Major	Critical	Catastrophic
ALARP level – planned event	Broadly acceptable	Tolerable if ALARP		Intolerable		
Residual impact category	Lower order		Higher order			
Risk ranking	Low	Medium	High	Severe	Extreme	
ALARP level - unplanned event	Broadly acceptable	Tolerable if ALARP		Intolerable		
Residual risk category	Lower order risks			Higher order risks		

Hierarchy of Controls

Beach demonstrates ALARP, in part, by adopting the 'Hierarchy of Controls' philosophy (Figure 6.4). The Hierarchy of Controls is a system used across hazardous industries to minimise or eliminate exposure to hazards. The hierarchy of controls is, in order of effectiveness:

- Elimination;
- Substitution;
- Engineering controls;
- Administrative controls; and
- Personal protective equipment (PPE) – this has not been included here as it is specific to the assessment of safety risks rather than environmental management.

Although commonly used in the evaluation of occupational health and safety hazard control, the Hierarchy of Controls philosophy is also a useful framework to evaluate potential environmental controls to ensure reasonable and practicable solutions have not been overlooked.

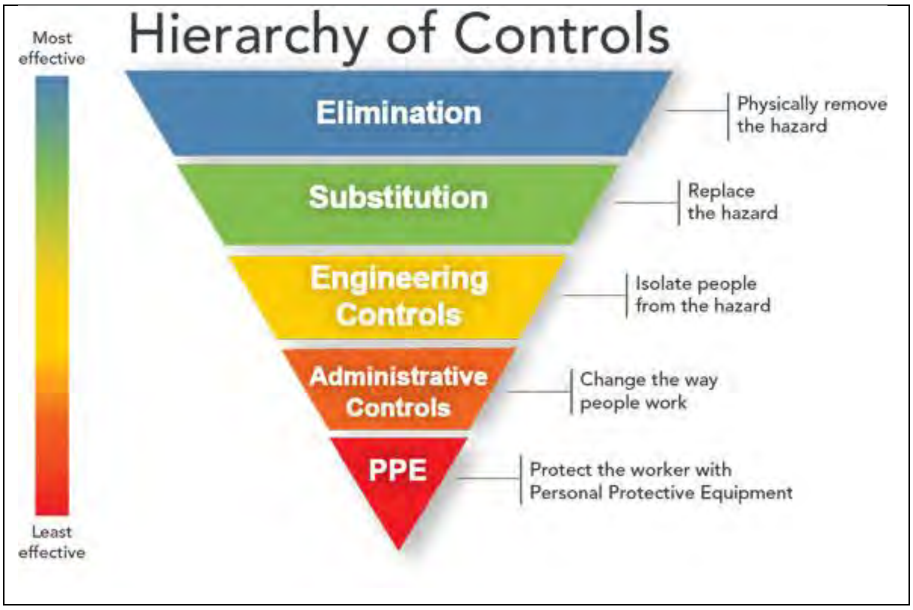


Figure 6.3. The Hierarchy of Controls

When deciding on whether to implement the proposed impact/risk reduction measure, the following issues are considered:

- Does it provide a clear or measurable reduction in risk?
- Is it technically feasible and can it be implemented?
- Will it be supported and utilised by site personnel?
- Is it consistent with national or industry standards and practices?
- Does it introduce additional risk in other operational areas (e.g., will the implementation of an environmental risk reduction measure have an adverse impact on safety)?
- Will the change be effective, taking into account the:
  - Current level of risk with the existing controls;
  - Amount of additional risk reduction that the control will deliver;
  - Level of confidence that the risk reduction impact will be achieved; and
  - Resources, schedule and cost required to implement the control.

Reducing impacts and risks to ALARP is an ongoing process and new risk reduction measures may be identified at any time, including during operations. Beach actively encourages recording and review of observations through its incident management system (CMO database). Incidents and lessons learned within Beach and from the wider industry are reviewed and utilised to identify hazards and controls.

The following section details how the guidance provided in NOPSEMA's *Environment Plan decision making* guideline (GL1721, Rev 6, November 2019) is applied.

6.5.2 Residual Impact and Risk Levels

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 Beach risk matrix (see Table 6.2), the impact consequence is rated as 'minor' or 'moderate' or risks are rated as 'low', 'medium' or 'high' (see also Table 6.3). In these cases, applying 'good industry practice' (see Section 6.5.3) is sufficient to manage the impact or risk to ALARP.

Higher-order Environmental Impacts and Risks

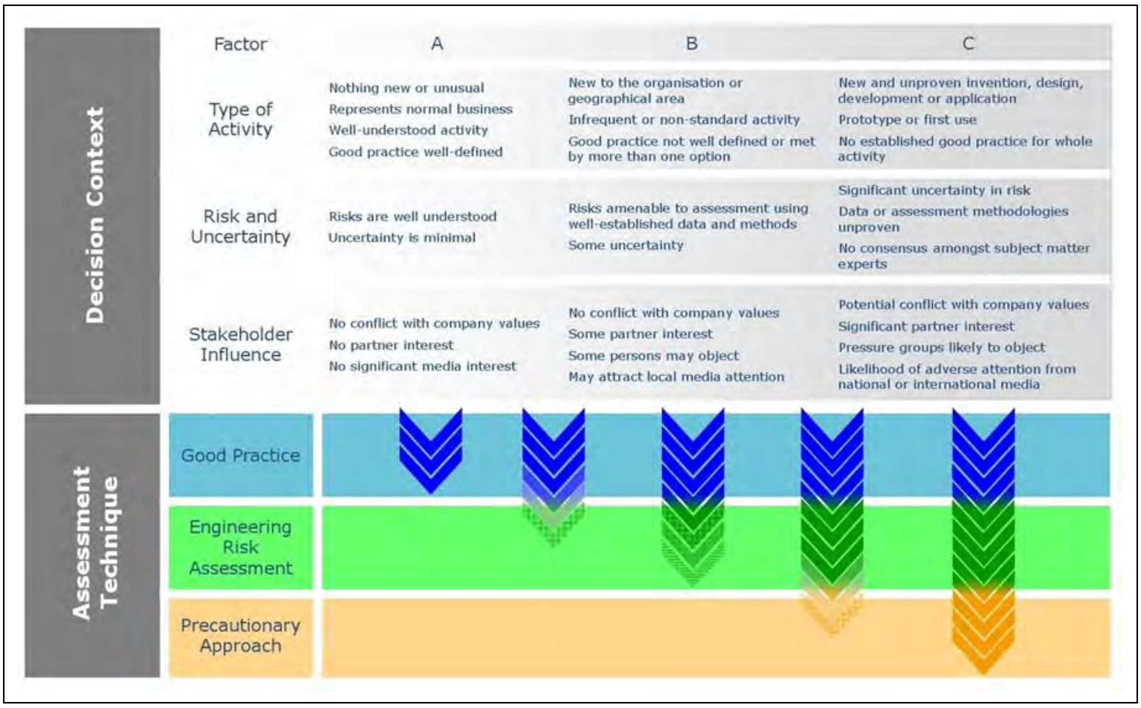
NOPSEMA defines higher-order environmental impacts and risks as those that are not lower order risks or impacts (i.e., where the environment or receptor is formally managed, vulnerable, restricted in distribution, protected or threatened and there is little confidence in the effectiveness of adopted control measures).

Impacts and risks are considered to be higher-order when, using the Beach risk matrix (see Table 6.2), the impact consequence is rated as 'serious', 'major', 'critical' or 'catastrophic', or when the risk is rated as 'severe' or 'extreme' (see also Table 6.3). In these cases, further controls must be considered as per Section 6.5.3.

6.5.3 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 6.4) provides the decision-making framework to establish ALARP.

This framework provides appropriate tools, commensurate to the level of uncertainty or novelty associated with the impact or risk (referred to as the Decision Type A, B or C). The decision type is selected based on an informed decision around the uncertainty of the risk. Decision types and methodologies to establish ALARP are outlined in Table 6.4.



Source: CER (2015).

Figure 6.4. Impact and risk 'uncertainty' decision-making framework

Table 6.4. ALARP decision-making based upon level of uncertainty

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.

The decision-making tools outlined in Table 6.4 are explained further below.

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 2.2);
- Government policies (outlined in Section 3.5);
- Government guidance (outlined in Section 2.3);
- Industry standards (outlined in Section 2.5 and Section 2.6); and
- International conventions (outlined in Section 2.2.1).

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 6.5.1).

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.*

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.

6.5.4 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.

Beach 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 6.5. The criteria for demonstrating acceptability were developed based on Beach'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 6.5. Acceptability criteria

Test	Question	Acceptability demonstrated
Internal context		
Policy compliance	Is the proposed management of the hazard aligned with Beach's Environmental 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 Beach's Operations Excellence Management System (OEMS)?	Where specific Beach 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		

Test	Question	Acceptability demonstrated
Legislative context	Do the management controls meet the expectations of existing Victorian or Commonwealth 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 aligned 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.
Ecologically Sustainable Development (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 6.6 for further information.

6.5.5 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 6.6 outlines the principles of ESD as defined under the EPBC Act and describes how this EP aligns with these principles.

6.6 Step 6 – Treat the Risks

The Prion 3DMSS environmental impact and risk register (discussed in Section 6.3) records the environmental control measures (e.g., measures to prevent, minimise and mitigate impacts and risks) that were determined by an expert team familiar with MSS and the sensitivities of the existing environment.

These controls are listed throughout the EIA and ERA tables in Chapter 7.

6.7 Step 7 - Monitor and Review

Monitoring and review activities are incorporated into the impact and risk management 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 environmental hazard. Monitoring and review are described in detail in the Implementation Strategy (Chapter 8).

Table 6.6. 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 Prion 3DMSS has been eliminated through the project design (see Chapter 3). 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.
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 principle 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 survey 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.

7. Environmental Impact and Risk Assessment

This chapter presents the EIA and ERA for the environmental impacts and risks identified for Prion 3DMSS using the methodology described in Chapter 6, as required under Regulations 13(5)(6) of the OPGGS(E).

This chapter also presents the EPO, 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.

Table 7.1. Prion 3DMSS environmental impacts and risk summary

Hazard			Inherent	Residual
Impact			Consequence rating	
Survey-specific impacts				
1	Underwater sound – impacts to biological receptors			
	-	Plankton	Minor	Minor
	-	Crustaceans (i.e., rock lobster, crabs)	Minor	Minor
	-	Molluscs – benthic (e.g., scallops)	Minor	Minor
	-	Molluscs – pelagic (e.g., octopus, squid)	Minor	Minor
	-	Fish - with swim bladders	Minor	Minor
	-	Fish - without swim bladders	Minor	Minor
	-	Cetaceans – low-frequency	Minor	Minor
	-	Cetaceans – mid-frequency	Minor	Minor
	-	Cetaceans – high-frequency	Minor	Minor
	-	Pinnipeds	Minor	Minor
	-	Turtles	Minor	Minor
	-	Avifauna	Minor	Minor
	Underwater sound – disruption to commercial fisheries			
	-	BSCZSF	Minor	Minor
	-	SESS	Minor	Minor
	-	Squid	Minor	Minor
	-	Octopus	Minor	Minor
	Impacts to the Boags AMP		No impacts	
	Impacts to telecommunications cables		No impacts	
Routine vessel impacts				

2	Light emissions	Minor	Minor
3	Atmospheric emissions	Minor	Minor
4	Putrescible waste discharges	Minor	Minor
5	Sewage and grey water discharges	Minor	Minor
6	Cooling and brine water discharges	Minor	Minor
7	Bilge water and deck drainage discharges	Minor	Minor
Risk		Risk rating	
Survey-specific risks			
1	Interactions with third party vessels – displacement	Medium	Low
	Interactions with third party vessels – interference	Medium	Low
2	Vessel strike or entanglement with megafauna – individual animal	Medium	Low
	Vessel strike or entanglement with megafauna – population	Low	Low
Routine vessel risks			
3	Accidental discharge of waste to the ocean	Medium	Low
4	Introduction of invasive marine species	Medium	Medium
5	Diesel spill – biological receptors	Low	Low
	Diesel spill – commercial fisheries receptors	Low	Low
	Diesel spill – amenity beaches	Medium	Low
	Diesel spill – desalination plant	Medium	Low
6	Diesel spill response activities – fauna disturbance	Medium	Low
	Diesel spill response activities – fauna injury	Medium	Low
	Diesel spill response activities – fauna death	Low	Low
	Diesel spill response activities – shoreline habitat damage	Medium	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.

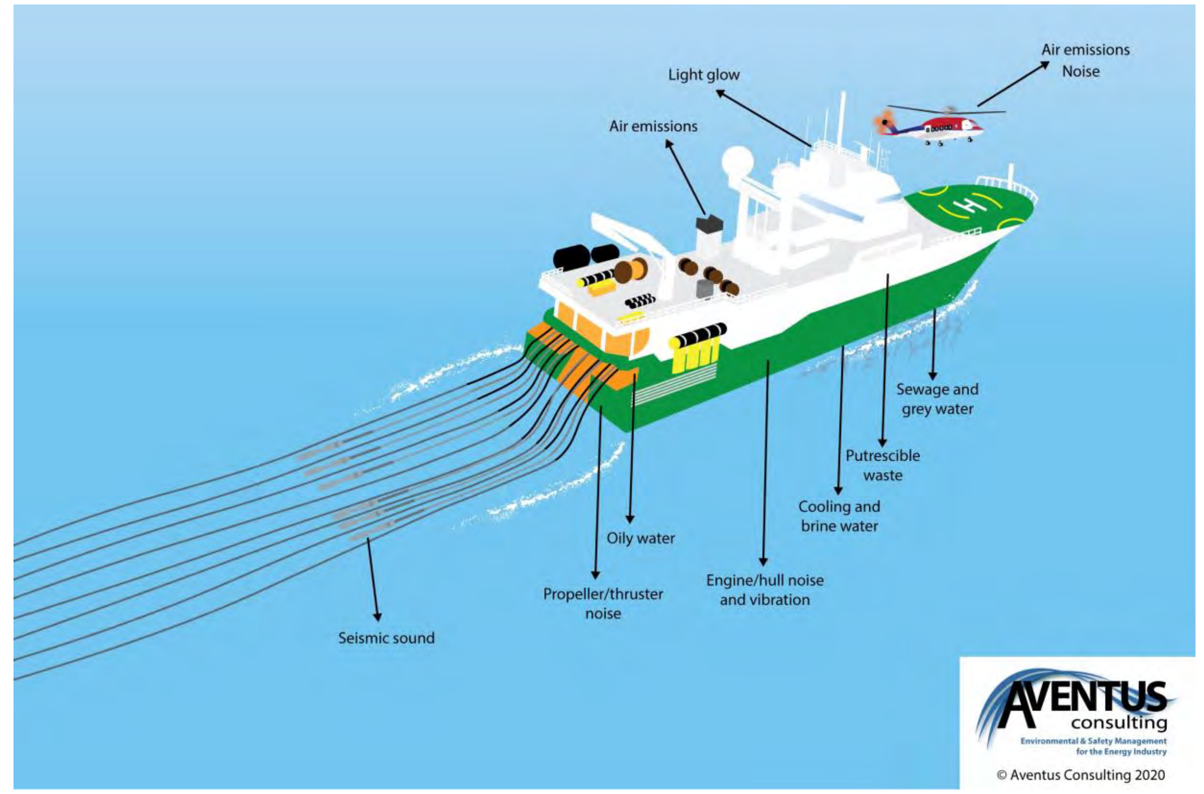


Figure 7.1. Simplified pictorial representation of impacts arising from the survey vessel

7.1 IMPACT 1 – Underwater Sound from the Survey

7.1.1 Hazard

The following activities will generate underwater sound:

- Sound pulses from the seismic airgun array; and
- Engine noise transmitted through the hull and propeller noise from the source and support vessels.

Seismic source

The dominant source of underwater sound during the MSS will be from the operation of the seismic source (airgun array). The seismic survey contractor has not been selected at the time of submitting this EP and, therefore, the exact configuration of the airgun arrays is not known, however the maximum and minimum sound levels to undertake the survey have been defined, 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 at dominant 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 airguns 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 airgun 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

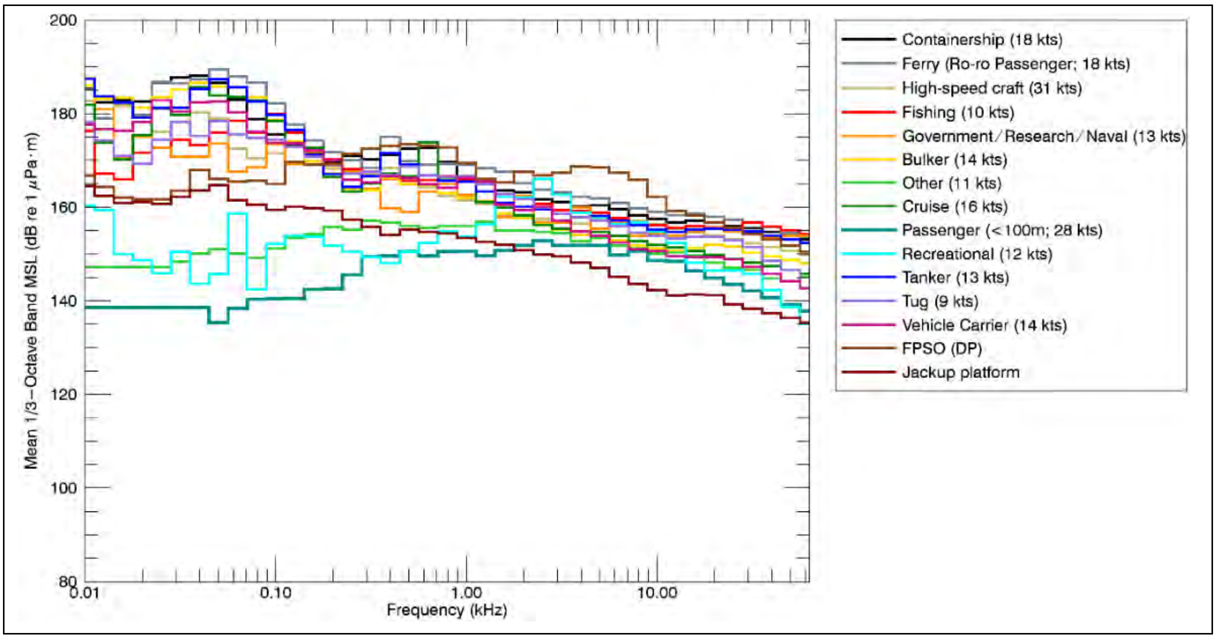
The survey and support vessels will generate continuous sound. The operation of motorised vessels involves numerous mechanical processes that create underwater sound as a by-product. These processes range from sound of the propeller, cavitation caused by propellers, flow noise from a vessel moving through water, engines and auxiliary machinery in the vessel hull.

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. The assessment of underwater sound from general vessel operations is, therefore, based upon underwater sound from the airgun arrays being the dominant sources.

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 dynamic positioning (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) vessels. Seismic survey vessels fall within the 'Government/Research/Naval' class shown.

The survey vessel for the Prion 3DMSS is expected to be up to 130 m in length, while the support vessels are likely to be about 20 m in length.



Source: McPherson et al (2019).

Figure 7.2. Example of frequency-dependent source levels for several categories of vessels in 1/3 octave band

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	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 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; Tennessen & 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 and in the vicinity of the acquisition area, 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 increase.
  - 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 or in close proximity to the Prion 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., scallop and shark); and
- Environmental values of nearby marine parks.

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 STLM results, presented throughout this section. Table 7.2 and Table 7.3 list the distances to behavioural, TTS, PTS, injury and mortality thresholds for the various groups of fauna.

Table 7.2. 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 species in the water column

<table>
<tr><th rowspan="2">Species in the water column</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>223 m</td></tr>
<tr><td>Fish (with no swim bladders, including sharks)</td><td rowspan="2">Near^ – high
Intermediate^ – moderate
Far^ - low</td><td>6.7 km</td><td>N/A</td><td>40 m</td><td>91 m</td></tr>
<tr><td>Fish (with swim bladders, involved and not involved in hearing)</td><td>6.7 km</td><td>*</td><td>150 m</td><td>223 m</td></tr>
<tr><td>Fish eggs and larvae</td><td>Near – high
Intermediate – high
Far - moderate</td><td>*</td><td>*</td><td>*</td><td>*</td></tr>
</table>

Cephalopods*	3.66 km	*	*	*	*
Cetaceans – low frequency	9.1 km	27.9 km	5.45 km	*	*
Cetaceans – mid-frequency		10 m	Not reached	*	*
Cetaceans – high-frequency		2.37 km	360 m	*	*
Fur-seals	9.1 km	50 m	Not reached	*	*
Turtles	4.9 km	Not reached	Not reached	*	*

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 seabed, 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.

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

Benthic fauna	Behavioural	Injury			No effect
		TTS	PTS	Risk of recoverable injury	
Sponges and corals	*	*	*	*	Not reached
Bivalves	*	*	*	*	8 m
Crustaceans	*	*	*	761 m	*

** No formal or defined exposure criteria is available to measure against.*

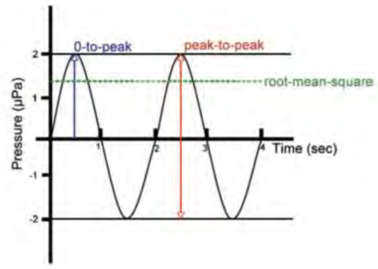
7.1.4 Evaluation of environmental impacts

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 7.4 defines the acoustic terms used through this EIA.

Table 7.4. EMBA for TTS and PTS for various fauna groups

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.

Term	Definition
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. Impulsive sound is sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA, 2013). Airguns used for seismic surveys are a good example of impulsive sound.
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 $\mu Pa^2 \cdot s$
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_{24h}.
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.

Term	Definition
	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 airgun 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, however the airgun array proposed for the Prion 3DMSS, a 2,495 cui array, has a horizontal per-impulse SEL source level of 224.1 dB re 1 µPa^2·s (Koessler & McPherson, 2020).

When considering long-range transmission of sound underwater, it is the near-horizontal energy output from the sound source that is the most critical. 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 focussed vertically downwards towards the seafloor to be most efficient and effective in transmitting the tuned sound source signal through the water column to the seabed.

Attenuation of sound sources with distance varies according to the source propagation levels, the depth of water and the nature of the seabed. For example, pulses travelling upslope and along rock or sand bottoms are attenuated faster than those radiated alongshore or downslope (Richardson *et al.*, 1995).

Beach commissioned JASCO Applied Sciences (JASCO) to undertake STLM for the Prion 3DMSS (**Appendix 9**) to enable an EIA specific to the survey to be undertaken (Koessler & McPherson, 2020). The STLM includes:

- Adoption of a 2,495 cui sound volume from a known array configuration;
- Establishing four modelling sites across representative water depths of the acquisition area (50 m, 54 m, 58 m and 79 m) (Table 7.5);
- Single-shot propagation modelling – sampling at each modelling site;
- Accumulated SEL – 15,416 impulses over a 24-hour period for three survey lines, where the first two lines took 7.2 hours each and the third line was partially traversed for 3 hours, with 3.4 hours required for each line turn; 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 seabed directly below the source array at three of the single shot modelling locations to assess for impacts to benthic species such as scallops.

The metrics of sound pressure levels (SP, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK, $L_{pk\text{-}pk}$), particle acceleration (peak magnitude) and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) 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 (noting that these modelling locations were selected and the modelling undertaken prior to the reduction in survey area). The representative tow direction for each site is 30° and 210°.

Table 7.5. Location details for the STLM sites

Site	Water depth	Latitude	Longitude	Location
1*	50 m	40° 10' 18.60" S	145° 18' 15.53" E	2.5 km west of the southwest point of the acquisition area, closest to known scallop fishing grounds
2*	58 m	39° 59' 19.90" S	145° 16' 14.55" E	In the southern half of the acquisition area
3*	79 m	39° 44' 09.52" S	145° 33' 08.76" E	In the northeast turning circle area
4	54 m	40° 00' 46.31" S	145° 03' 14.96" E	1 km east of the southeast-most turning circle

** This is also a modelling site for particle motion.*

Table 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 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 400 Hz. Table 7.6 shows the PK and per-pulse SEL source levels in the horizontal-plane broadside (perpendicular to the tow direction), endfire (along the tow direction) and vertical directions.

Table 7.6. Far-field source level specifications for the 2,495 cui source for a 7 m tow depth

Direction	Peak source pressure level ($L_{S,pk}$; dB re 1 µPa m)	Per-pulse source SEL ($L_{S,E}$; dB re 1 µPa^{2}m^{2}s)	
		10-2,000 Hz	2,000-25,000 Hz
Broadside	248.6	224.1	183.8
Endfire	244.6	222.1	187.0
Vertical	254.6	227.5	194.3
Vertical (surface affected source level)	254.6	229.8	197.2

STLM scenario

Four stand-alone single impulse sites were modelled for survey operations over 24 hours to assess accumulated SEL (as listed in Table 7.5) and illustrated in Figure 7.3 (noting that this was undertaken when the survey area was larger). The modelling assumed that a survey vessel sailed along survey lines at ~4.0 knots, with an impulse interval of 12.5 m. The 24-hour modelling scenario considered three sail lines.

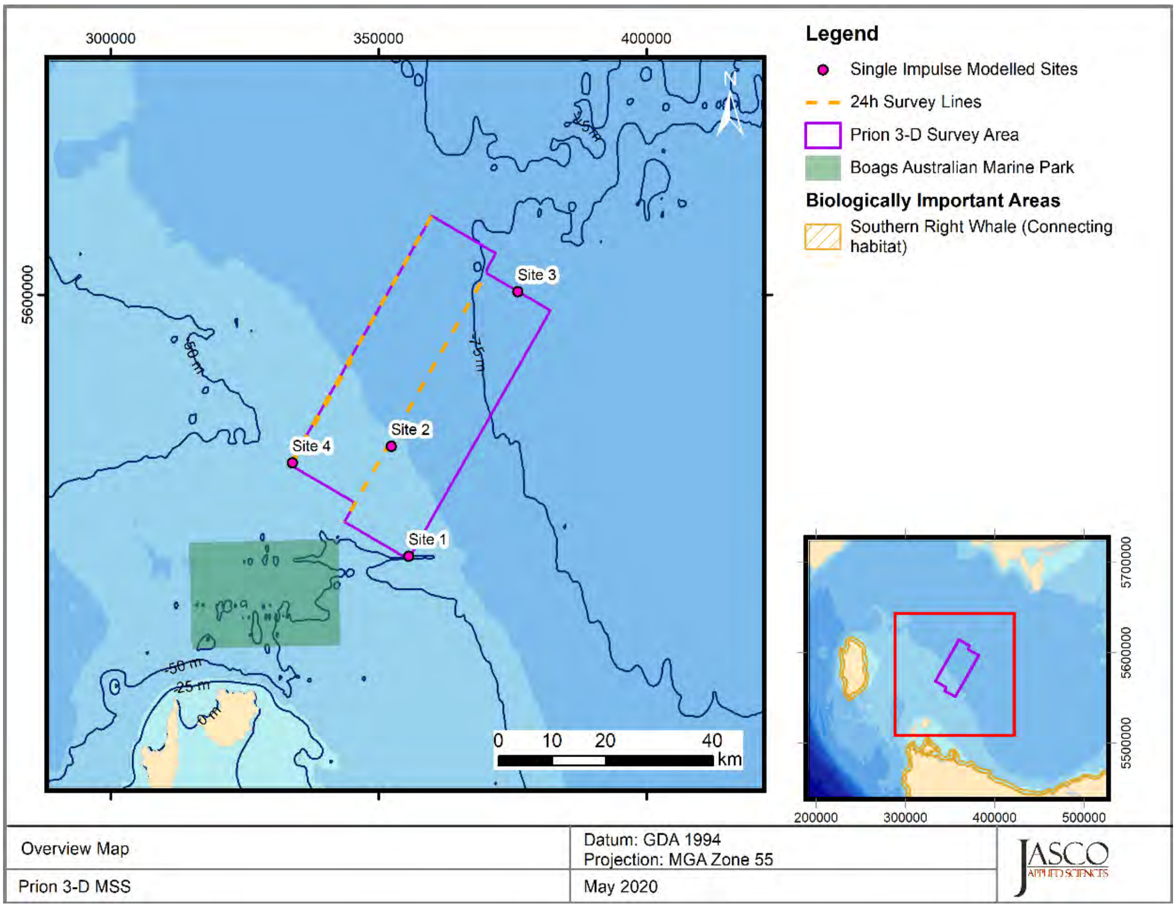


Figure 7.3. Overview of the modelled sites

The single impulse sites and accumulated SEL scenarios were selected based on the survey lines being acquired along lines orientated 30°/210°. The orientations of the single impulse sites were selected as they provide for the greatest sound propagation radii broadside from the seismic source towards an area of interest to the Commonwealth-managed BSCZSF and Tasmanian Scallop Fishery to the immediate west of the acquisition area (modelling Site 4 is located 6 km south of an area of low intensity scallop fishing [see Figure 5.28] and modelling Site 2 is located 15 km southeast of the same area).

Water column single impulse PK levels (maximum-over-depth) were assessed only at Site 2 in the centre of the survey area. This is a reasonable approach due to the small variation in bathymetry across the survey area.

Three lines were modelled for a 24-hour period, where the first two acquisition lines took 7.2 hours each to traverse and the third, which was a partial segment of a full acquisition line, took 3.0 hours to traverse. The time to complete a turn was ~3.4 hours per turn. There were 15,416 impulses modelled during each respective 24-hour period of acquisition. During line turns, the seismic source was not operating.

Table 7.7 and Table 7.8 present the per-pulse results for the 2,495 cui seismic source towed at 7 m for SPL and SEL isopleths in the water column from each of the modelled sites.

Table 7.7. Maximum (R_{max}) and 95% ($R_{95\%}$) 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_E; dB re 1 µPa^2·s)	**Site 1 (50 m)**		**Site 2 (58 m)**		**Site 3 (79 m)**		**Site 4 (54 m)**	
	R_{max}	**$R_{95\%}$**	**R_{max}**	**$R_{95\%}$**	**R_{max}**	**$R_{95\%}$**	**R_{max}**	**$R_{95\%}$**
190	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
180	0.28	0.23	0.28	0.23	0.28	0.23	0.28	0.23
170	1.29	1.12	1.32	1.11	1.22	1.04	1.41	1.15
162*	3.45	2.78	3.35	2.81	3.66	2.94	3.40	2.89
160**	4.26	3.43	4.07	3.43	4.50	3.55	4.16	3.49
150	9.53	7.93	9.69	7.91	10.6	8.55	9.60	7.92
140	20.7	17.1	21.8	16.8	21.9	18.0	19.6	15.7
130	42.4	34.0	45.8	34.1	43.7	34.9	36.2	29.1
120	74.0	58.7	80.3	60.7	75.5	59.6	62.8	50.1

** Threshold for squid behavioural response (inking) to impulsive sound (Fewtrell and McCauley, 2012).*

*** Low power zone assessment criteria (DEWHA, 2008).*

Table 7.8. Maximum (R_{max}) and 95% ($R_{95\%}$) 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 (50 m)**		**Site 2 (58 m)**		**Site 3 (79 m)**		**Site 4 (54 m)**	
	R_{max}	**$R_{95\%}$**	**R_{max}**	**$R_{95\%}$**	**R_{max}**	**$R_{95\%}$**	**R_{max}**	**$R_{95\%}$**
200	0.05	0.05	0.03	0.03	0.03	0.03	0.03	0.03
190	0.23	0.21	0.23	0.21	0.23	0.20	0.25	0.22
180	1.22	0.99	1.16	0.95	1.08	0.88	1.17	0.98
175*	2.07	1.75	2.11	1.80	1.96	1.71	2.19	1.78
170	3.47	2.80	3.36	2.81	3.65	2.94	3.41	2.88
166**	4.92	3.99	4.91	4.07	5.11	4.23	4.93	4.11
160***	8.13	6.78	8.30	6.81	9.10	7.33	8.34	6.79
150	18.3	15.3	19.4	15.1	19.7	16.2	17.6	14.1
140	38.8	31.3	41.8	31.1	40.1	32.2	33.5	27.0
130	69.4	54.8	75.2	56.5	70.6	55.7	58.3	46.8

** 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).*

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 5.4.2) 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

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, crabs or scallops (Carroll *et al*., 2017).

International studies

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 airguns 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).

Research on zooplankton published by Fields et al (2019) 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 $\mu Pa^2 \cdot s$, 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 airguns, but not significantly different from the controls at a distance of 20 m from the airguns;
- The increase in cumulative mortality (relative to controls) after one week did not exceed 30% of copepods at any distance from the airgun;
- 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 airgun 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.

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 μPa^2.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. 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.

<u>Australian studies</u>

In a study of the effects of seismic airgun exposure on early-stage embryonic (entirely soft tissue) southern rock lobster (*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. These results are aligned with those of Pearson et al (2014) that indicate early life stage crustaceans may be more resilient to seismic airgun 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.

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 airgun 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 airgun - 0, 200 and 800 m. The experiment estimated the proportion of the zooplankton that was dead, both before and after exposure to airgun 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 airguns 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, notably 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, APPEA commissioned the 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 km^2, 60 survey lines, waters 300-800 m deep, an airgun 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 as such is 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 the 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.

Table 7.9. Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts for plankton, fish eggs and larvae

	Mortality/potential mortal injury	**Recoverable injury and TTS**	**Behavioural**
Threshold value	Per pulse: 207 dB PK	Near distance: tens of metres (moderate risk)	
	24 hrs: 210 dB SEL_{24h}	Intermediate distance: hundreds of metres (low risk)	
		Far distance: thousands of metres (low risk)	
Threshold criteria	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.	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.	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.
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 (R_{MAX}) are:

- Mortality or potential mortality;
  - Maximum-over-depth (MOD) PK (against the per pulse threshold of 207 dB PK) – 210 m.
  - Seafloor PK (against the per pulse threshold of 207 dB PK) – 191 m (shallowest water) to 223 m (deepest water).
- 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 seabed 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 at al (2014) threshold values.

Any mortality of plankton as a result of the survey will have a **minor** consequence because it will be localised and temporary. It will be inconsequential when compared to natural mortality rates of 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.

Additionally, 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 as opposed to weeks. The influence of the EAC from the east and the Bonney Upwelling in the west means that plankton populations in and around the survey area are likely to undergo rapid replenishment throughout the year.

The impacts of plankton mortality localised to an area around the airguns on other fauna reliant on plankton as a food source are assessed as **minor** because:

- The acquisition area is located 280 km southwest of the 'Upwelling East of Eden' KEF, meaning that if the survey takes place at the same time as the upwelling (the timing of which varies seasonally, but generally occurs during spring and summer), planktonic blooms resulting from this upwelling will not be exposed to seismic sound. If the survey proceeds during the preferred summer months, when the EAC is strongest, the movement of water from the east will bring with it plankton from this KEF (dependent on exact timing of the upwelling and subsequent plankton blooms), acting as a source of replenishment to plankton populations in and around the acquisition area.

- The EMBA for impacts to plankton (the acquisition area and a radius of 223 m around it, equal to 907 km^2) represents 1.4% of the Bass Strait Shelf Province (see Figure 5.2). This is a low figure and the plankton circulating through the rest of the bioregion will quickly replenish any affected area. At this provincial bioregion level, plankton mortality will have no meaningful effects on regional ecology.

- The 'possible foraging' BIA for PBW, which is overlapped by the acquisition area, is vast. The acquisition area overlaps 0.55% of this BIA, so it is not likely that plankton mortality in and around the acquisition area represents a significant lost food resource for the whales. PBW foraging is concentrated along the southwest Victorian coast and the far east Victorian coast (associated with cold water upwellings) rather than central Bass Strait.

- The 'known core range' BIA for SRW, which is overlapped by the acquisition area, is vast. The acquisition area overlaps 0.46% of this BIA, so it is not likely that plankton mortality in and around the acquisition area represents a significant lost food resource for the whales.

The impacts of plankton mortality localised to an area around the airguns on commercial fisheries of concern (the principal one being commercial scallops) are assessed as **minor** based on the results of the Parry et al (2002) 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 Section 6.5.4, 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, on par with natural variations in mortality, and do not result in long-term impacts to diversity and abundance.</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>Beach Environmental Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>OEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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)
(see Chapter 4 for more detail)</td><td colspan="2">Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders 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've read indicate mass mortality. These concerns have been addressed through Beach providing these stakeholders:
• Detailed mapping of scallop fishing intensity in relation to the survey area.
• A reference list of material about the effects of MSS on various receptors (general background papers, industry guidelines, crustaceans, molluscs, cetaceans, fisheries and so forth).
• A presentation from JASCO Applied Sciences about the modelling results.
• The JASCO Applied Sciences STLM report.
• A draft of the sound EIA sub-chapter for review prior to public exhibition.
Other than commercial fisheries associations, no other stakeholders have expressed concerns about the effects of underwater sound on plankton.</td></tr>
<tr><td>Legislative context
(see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)</td><td colspan="2">There is no legislation relevant to the effects of underwater sound on plankton.</td></tr>
<tr><td rowspan="3">Industry practice
(see Sections 2.7 & 2.8 for descriptions)</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 plankton: no specific application.</td></tr>
<tr><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 Beach 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 plankton: no specific application.</td></tr>
</table>

	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. **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.
	APPEA CoEP (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 5.5.1)	There is a 14.9 km^2 overlap between the operational area and the Boags AMP (a 2.7% overlap). The acquisition area does not overlap the Boags 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 plankton:** no specific application. Plankton is not listed as a conservation value of the Boags AMP.
	Ramsar wetlands (Section 5.5.4)	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 5.5.6)	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 5.5.7)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest KEFs. **Relevance to plankton:** no specific application.
	NIWs (Section 5.5.8)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at NIWs. **Relevance to plankton:** no specific application.
	Nationally threatened and migratory species (Section 5.4)	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.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	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	The species of most concern to stakeholders, being commercial scallops, has in place the BSCZSF Management Arrangements Booklet 2019 (AFMA, 2019). The Prion 3DMSS does not impact on the management arrangements outlined in the plan.
ESD principles	The application of the ESD principles to **plankton** are outlined here.	
	A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	The preferred 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.
	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 plankton is likely only within tens of metres of the sound source and that impacts are not irreversible – plankton populations rapidly return to pre-impact levels.
	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 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.
	D. 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.
	E. 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 5.4.7. In this section, fish includes elasmobranchs (sharks and rays) and refers to 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.

1. 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.).
2. 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.

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 7.11 presents a summary from Carroll et al (2017) for investigations into the impacts of seismic airgun 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 (Miller & Crisp, 2013 in Webster *et al*., 2018). Fish in this study were exposed to SELs of less than 187 dB re 1 µPa^{2}s 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 (Miller & Crisp, 2013 in 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 Western Australian waters less than 250 m deep (as is the case with the Prion survey), 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.

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;

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 Prion 3DMSS
Pallid sturgeon (*Scaphirhynchus albus*) and on Paddlefish (*Polyodon spathula*)+	620 cui airguns	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 airgun 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 tolerance or a change in hearing threshold.	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.
Rainbow trout (*Salmo gairdneri*)	130 cui airguns	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 airguns (M)	No mortality observed.	Thomsen (2002) *, C, #	Not relevant to mortality as levels significantly lower than those in criteria.

Organism	Source	Source levels	Distance of receptor from source	Received levels	Results	Reference	Relevance to Prion 3DMSS
Demersal fish, blue whiting and some pelagic fish	4,752 cui airgun 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 airgun 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 airgun array	256.9 PK (vertical) 247.7 PK broadside	55–7,500 m	Sand eels within the near-field of the array on the seafloor under tracklines	No differences in mortality between control and experimental groups attributable to airgun exposure. Where mortalities occurred, they were attributed to handling procedures (i.e., similar in control and experimental fish).	Hassel et al (2003; 2004) C	Relevant – study with similar sized commercial array to this survey. Tracklines directly over habitat with no impact shown.
Twelve fish species	Single 20 cui airgun	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 airgun 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, airgun, and transmission loss environment.

Organism	Source	Source levels	Distance of receptor from source	Received levels	Results	Reference	Relevance to Prion 3DMSS
Juvenile sea bass (*Dicentrarchus labrax*)	Airguns 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*)	Airguns	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: 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 $\mu Pa^2.s$). 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.

- 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).

Although the species studied (flathead, whiting) are not key fisheries targets in the Prion survey area, Beach understands that the interim results from this study show high levels of short-term impact (consistent with research indicating localised and temporary behavioural changes, such as displacement, see below), medium and long-term impacts are yet to be assessed.

Behavioural Impacts

Gausland (2000) postulates that while seismic airgun 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 airguns, 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 airgun 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 airgun. 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 airgun 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 airgun 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 airgun signal level dropped accordingly;
    - Startle responses may be generated by fish within 300 m and up to 2,000 m of an operating airgun 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), also 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 seabed 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 seabed, 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 1µPa^2.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 Prion survey area, there are no known habitats (e.g., reef) that would result in the presence of site-attached species (see Section 5.4.1).

As such, whilst lethal effects to fishes from MSS have not been observed, sub-lethal effects have been reasonably well documented. Whilst the ecological effects of sub-lethal effects have not been well studied, it is possible that they could expose some fishes to increased mortality via increased predation through lowered fitness (Popper & Hastings, 2009) depending on the fishes' life history. Additionally, 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 to 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.

Note that accumulated SEL and single-impulse SPL at the boundary of the Boags AMP (see Section 5.5.1) (located 8.5 km from the southern-most seismic acquisition lines) are predicted to be below levels resulting in any effect criteria for fish (including TTS, recoverable injury or mortality). As such, impacts to fish in the AMP from the MSS are not expected.

A summary of the potential impacts of low-frequency seismic sound on fish is presented in Figure 7.4.

Limited research has been conducted on responses from elasmobranchs (sharks and rays, including juveniles) to MSS (as highlighted in Figure 7.4). 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, there are no EPS proposed dealing specifically with sharks.

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.

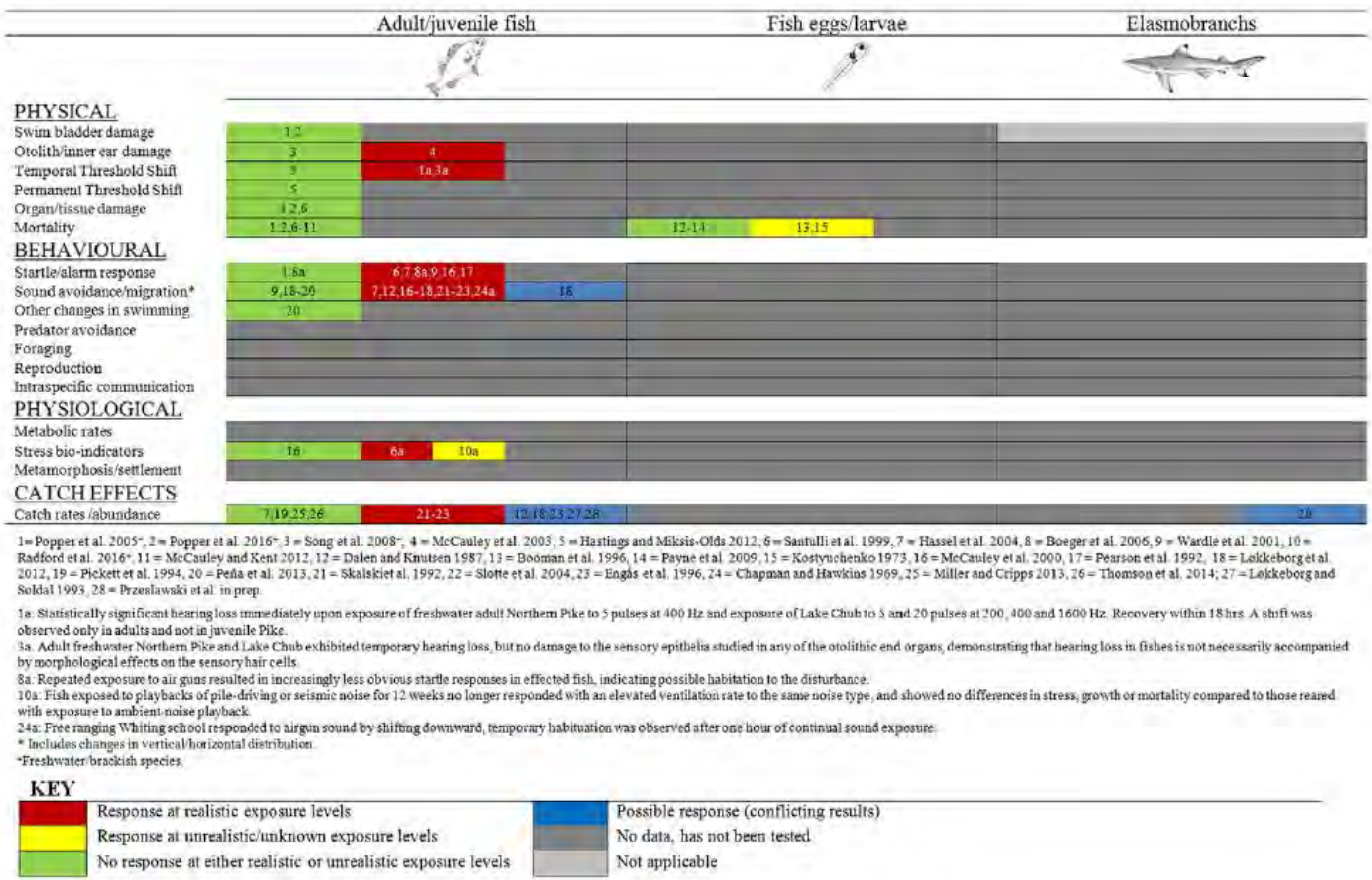
Table 7.12. Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts for fish

	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 airgun 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 airguns 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_{cum} levels >186 dB re 1 uPa^2·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 on 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 from 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, 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.*



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).

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 1 (50 m)	91 m seafloor	40 m MOD* Threshold not reached at seafloor	As per mortality/ potential mortal injury	40 m MOD* Threshold not reached at seafloor	N/A	6.7 km MOD 6.44 km seafloor
Site 2 (58 m)	70 m MOD 84 m seafloor					
Site 3 (79 m)	72 m seafloor					
Group II - Fish with swim bladder – not 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 1 (50 m)	191 m seafloor	40 m MOD* Threshold not reached at seafloor	As per mortality/ potential mortal injury	100 m MOD* 150 m seafloor	N/A	6.7 km MOD 6.44 km seafloor
Site 2 (58 m)	210 m MOD 205 m seafloor					
Site 3 (79 m)	223 m seafloor					
Group III - Fish with swim bladder – involved in hearing						
Threshold value	**207 dB PK**	**207 dB SEL_{24h}**	**207 dB PK**	**203 dB SEL_{24h}**	**No criteria**	**186 dB SEL_{24h}**
Site 1 (50 m)	191 m seafloor	40 m MOD* Threshold not reached at seafloor	As per mortality/ potential mortal injury	100 m MOD* 150 m seafloor	N/A	6.7 km MOD 6.44 km seafloor
Site 2 (58 m)	210 m MOD 205 m seafloor					
Site 3 (79 m)	223 m seafloor					

** Distances represent the perpendicular distance from the closest survey line to the relevant isopleth.*

Table 7.13 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 70 m (for fish with no swim bladder) to 210 m (for fish with a swim bladder).
- At the seafloor – a maximum distance of 91 m (for fish with no swim bladder) to 223 m (for fish with a swim bladder).

Table 7.13 also indicates that using the multiple pulse metric (SEL_{24hr}) (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 40 m from the source array in the water column;
- Recoverable injury may occur up to a maximum distance of 40-100 m from the source array in the water column and up to a distance of 150 m at the seafloor, dependent on the type of fish; and
- TTS may occur up to a maximum distance of 6.7 km from the source array in the water column and 6.4 km at the seafloor.

Impact Assessment

Impacts to fish as a result of the Prion 3DMSS will have a **minor** 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 airguns 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 (e.g., white shark foraging areas and seasonal breeding areas are located over 80 km to the northeast).
- 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 0.45% of the shark's 'known distribution' BIA (or 0.85% with the 6.7 km distance to TTS applied as a buffer around the acquisition area). The survey area does not overlap the white shark's foraging or breeding BIAs.
- Mortality of fish (both immediate and delayed) is considered highly unlikely based on no documented cases of fish mortality upon exposure to seismic airgun sound under experimental or field operating conditions. Free-swimming fish can detect seismic sound and move away from it to avoid injury.
- In the absence of notable seabed features, such as rocky reefs, shoals, canyons, trenches and volcanic mounts in and around the survey area, there are unlikely to be species with restricted ranges present that would not be able to move away from the seismic sound. As such, temporary displacement of site-attached species or those with an affinity for a particular habitat (such as rocky reefs) are highly unlikely.
- 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 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 5.4.7 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 airguns). In general, their shallow water habitat means they are located too far from the survey area to be impacted by seismic sound generated in central Bass Strait.
Oceanic	
Great white shark Grey nurse shark (east coast population) Shortfin mako shark Porbeagle shark (no conservation advice or plan) Whale 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 Prion 3DMSS is not inconsistent with these management.
Black rockcod	While this species possesses a swim bladder, it inhabits caves, gutters and crevices generally to depths of 50 m. These habitats do not occur in or around 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.
Giant manta ray	Globally, this species is most common in tropical waters, only occasionally seen in temperate waters (such as Bass Strait). The giant manta ray is likely to be present, if at all, only in the outer parts of the hydrocarbon spill EMBA and thus will not be affected by seismic sound.
Red handfish	This species inhabits a small geographic area in the coastal waters of southeast Tasmania and is present only in the outer parts of the hydrocarbon spill EMBA and thus will not be affected by seismic sound.

Impacts to commercial fin-fish fisheries as a result of the survey will have a **minor** consequence based on the following (in addition to the general factors listed above):

- The only fin-fish fishery operating in the area is the 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.
  - The survey area represents 0.17% of the fishery. This small area, the short duration of the survey and the low susceptibility of sharks to seismic sound make it unlikely that there will be loss of catch as a result of the survey.
  - Beach has been liaising with SETFIA, who is representing the SESS (Gillnet, Hook and Trap sector) fishery. They have indicated that they endorse the *Fair Ocean Access* procedure developed by Beach for this survey as an acceptable method of dealing with any potential lost catch resulting from vessel displacement during 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 Section 6.5.4, Table 7.15 presents a demonstration of acceptability.

Table 7.15. Demonstration of acceptability for potential impacts to fish

Statement of acceptability	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. Commercial fisheries operators are no worse off financially as a result of the survey.	
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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) (see Chapter 4 for more detail)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS, such as commercial fisheries associations. **Relevance to fish:** Commercial fisheries associations have not raised specific concerns about the impacts of MSS on fish, with most concern relating to impacts to scallops, octopus and squid (all discussed separately later in this chapter). The SESS (Gillnet, Hook and Trap sector) fishery has acknowledged the low impacts to their fishery and feedback has focussed on potential displacement and potential economic loss, for which the Beach Community Engagement Standard would apply. Other than commercial fisheries associations, no other stakeholders have expressed concerns about the effects of underwater sound on fish.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of: • EPBC Act 1999 (Cth). o EPBC Policy Statement 1.1 (Significance Guidelines). o EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales). • OPGGS Act 2006 (Cth). o 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 seabed (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.	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 fish:** no specific application.
	Recommended monitoring and mitigation measures for	This document provides guidelines regarding:

	cetaceans during marine seismic survey geophysical operations, Report 579 (IOGP, 2017)	• 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 Beach 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 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. **Relevance to fish:** 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 fish:** 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 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, but implementing this guideline also assists to minimise impacts to fish.

	APPEA CoEP (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 5.5.1)	There is a 15 km^2 overlap between the southern end of the operational area and the northern part of the Boags 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 fish:** no specific application. Fish are not listed as a conservation value of the Boags AMP – it is recognised mostly for the foraging habitat for seabirds. The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 states that white sharks forage in the AMP. Potential impacts to this species are previously addressed.
	Ramsar wetlands (Section 5.5.4)	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 5.5.6)	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 5.5.7)	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 5.5.8)	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 5.4)	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 (see Section 5.4.7) 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. • 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.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	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	Table 7.14 lists the threatened fish species known or likely to occur within the survey area and 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. **Appendix 2** provides an assessment of the potential impacts of the survey on the management aims of threatened species plans.
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 preferred 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.
	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 generations.	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.
	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 mechanisms should 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.

The potential impacts of seismic sound on molluscs is currently the subject of far more study than has been the case in the past.

The marine invertebrates of most concern in and around the survey area are those of commercial interest, these being the molluscs - commercial scallops (*Pecten fumatus*), pale octopus (*Octopus pallidus*) and arrow squid (*Nototodarus gouldi*). Other molluscs present within the survey area are listed in Section 5.4.1 (and **Appendix 7** and **Appendix 8**).

Marine invertebrates also include sponges and corals. 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 not reached at any site. As such, the impacts of seismic sound on these invertebrates is not discussed here.

Sensitivity to Sound

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 and 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 and 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 airguns 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 airgun 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. Christian et al (2003) found major developmental differences between control and treatment groups of snow crab eggs exposed to a PK of 216 dB re 1 µPa every 10 seconds for 33 minutes. 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).

Cephalopods are more capable of 'hearing' seismic surveys (Samson *et al*., 2016). A range of responses has been observed, including escape and startle type behaviour in relation to loud low frequency sounds (McMauley *et al*., 2000b, Fewtrell and McCauley, 2012; Samson *et al*., 2016; Jones *et al*., 2020). Octopus however have shown only changes in respiratory rates during exposures to low frequency sound (Kaifu *et al*., 2008).

Marine invertebrates generally have far lower mobility than pelagic vertebrates and are often localised to particular microhabitats. As such, they generally have less ability to avoid seismic sound by moving away from an area. Marine invertebrates living on the seabed have limited ability to move fast enough at the distances required to avoid the ground transmission of noise (Prideaux, 2017). The exception to this is 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.

There is, however, no evidence of population level impacts on invertebrates from seismic noise. 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).

Sensitivity to Sound – Scallops

A UK study on benthic invertebrates, including the Manila clam (*Ruditapes philippinarum*), examined their exposure to simulated continuous ship noise (equivalent to 100 m distance) and simulated pile driving sounds typical during offshore wind turbine construction (equivalent to 60 m distance) for seven days. The noise appeared to affect clam behaviour by repressing the burying and bio-irrigation behaviour, and potentially reducing locomotor activity compared to controls (Solan *et al.,* 2016). The observed behaviour was postulated to lead to reduce the capacity of the organism to mix the upper sediment profile and prevent suspension feeding from taking place.

A laboratory-based study intended to simulate an MSS had a catastrophic effect on scallop larvae (*Pecten novazelandiae*), characterised by abnormal morphological development (Aguilar de Soto *et al.,* 2013). However, the lengthy exposure period of 3 second shot intervals for an exposure duration of 90 hours at

1 m from the sound source is not realistic in an actual survey. 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).

<u>TAFI 2010 Bass Strait study</u>

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 airgun 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;

1. Live scallops;
2. Clappers (very new dead scallops with two shell halves still joined together);
3. New dead shells; and
4. 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).

Scallop fishers that Beach has consulted with report that there was a later die-off of these scallops that resulted in lost catches of millions of dollars that they attribute to 2DMSS that was undertaken by the Victorian Government. No standard useable or verifiable information is available about the extent or cause of this die-off, though Przeslawski et al (2016a) reports that a pronounced thermal spike in the eastern Bass Strait between February and May 2010, coinciding almost exactly with dates of operation for the 2DMSS. In September 2010, mass mortalities of scallops and other bivalves were observed, indicating a die-off occurred sometime between early June (when Harrington et al (2010) detected no significant mortality) and September (when fishermen recorded mass mortality in dredges). These events occurred in the study areas where the waters were warmest and also where the 2010 2DMSS operated. Courtney et al (2015) and Caputi et al (2015) have reported that high temperatures have been linked to scallop death in Queensland and Western Australia, respectively.

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 airgun 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 10 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 airguns. 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.

<u>UTAS-FRDC 2014 Tasmanian study</u>

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 airgun 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 airgun, 2,000 psi);
- July 2014 (150 cui airgun, 1,300 psi and 2,000 psi); and
- February 2015 (150 cui airgun, 2,000 psi).

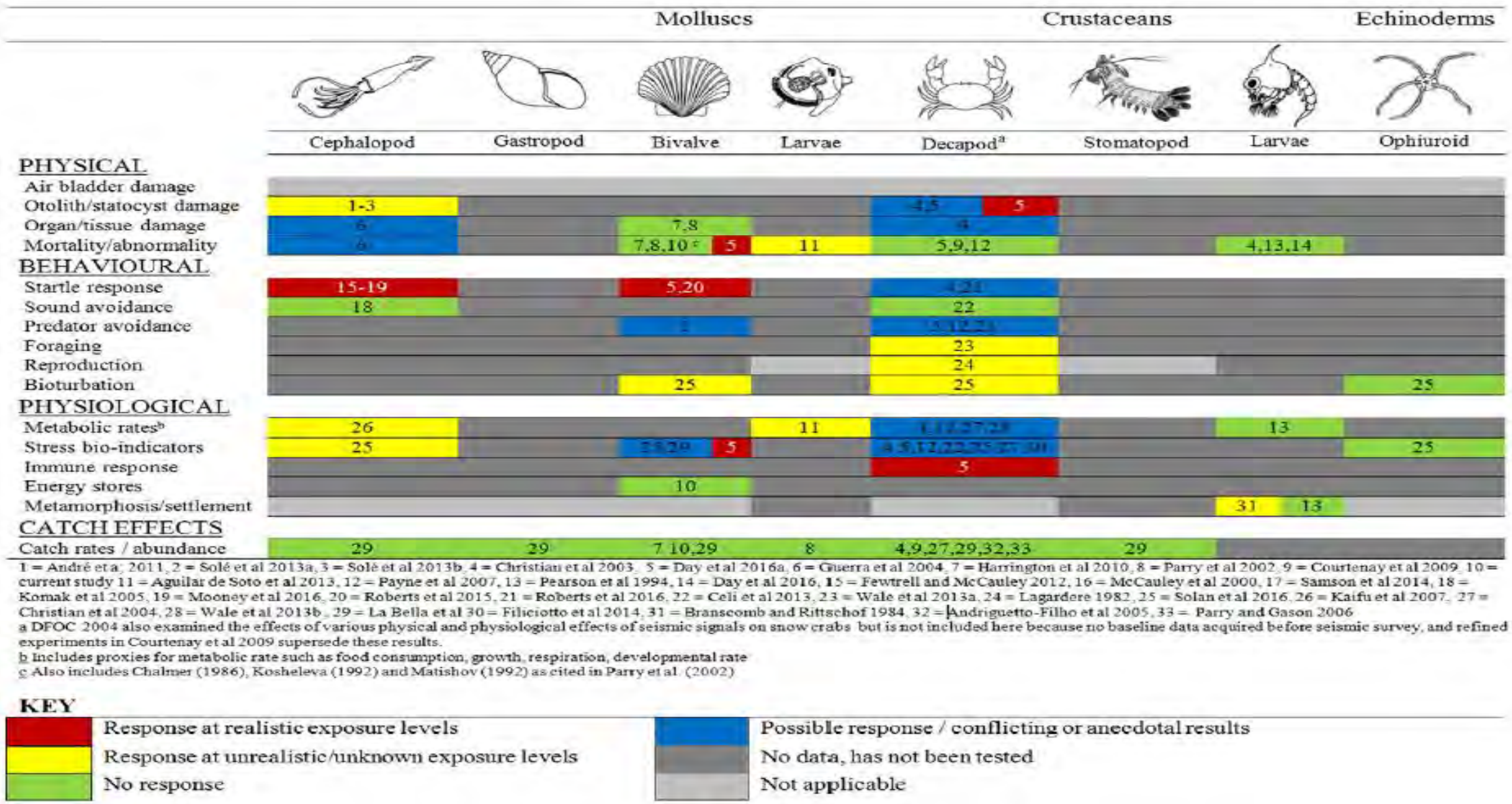
The airgun was towed at approximately 5 m depth from a distance of 1 km away from the scallop enclosure and at a speed of approximately 3-4 nm per hour (approximately 5.5-7.4 km/hr) and the shot interval was 11.6 seconds. The maximum calculated exposures were 212 dB re 1 µPa PK-PK, a per-pulse SEL of 190 dB re 1 µPa^{2}·s, an accumulated SEL of 199 dB re 1 µPa^{2}·s and maximum peak magnitude of ground acceleration of 68 ms^{-2}. However, this was likely an outlier.

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 in^3 sources. The magnitude from the ground borne motion from the 150 in^3 air gun emulated that measured for a 3130 in^3 array at around 100-200 m.

Source: Przeslawski et al (2016b).



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).

Figure 7.5. A summary of the potential impacts of low-frequency sound on various responses of marine invertebrates

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 airgun 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 airguns 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 airgun 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).

Sensitivity to Sound - Cephalopods

Cephalopods (squid, octopus and cuttlefish) that are known to be present in the survey area are listed described in Section 5.4.1.

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.

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.

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.

Squid are not known to utilize 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.

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 (including scallops) (for scallops) from exposure to an airgun. 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.

Based on JASCO's expert advice, the key sound parameter for the assessment of potential impacts on scallops 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 the results of Day et al (2016b). The maximum particle acceleration assessed for scallops was 37.57 ms^{-2}, which is considered appropriate for bivalves.

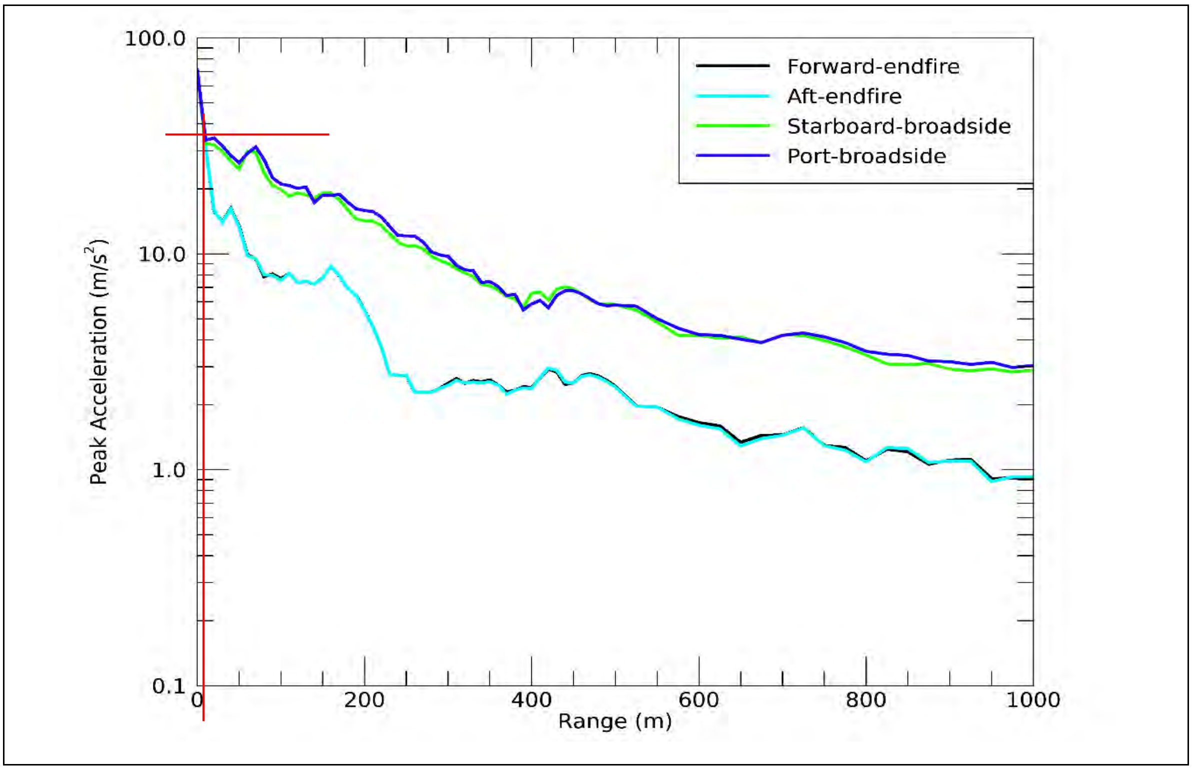
Table 7.17 presents the thresholds used for the marine invertebrates EIA.

Table 7.17. STLM thresholds for marine invertebrates

Group	Threshold	Criteria
Molluscs – scallops and bivalves	**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}
Molluscs – octopus and squid	**Behavioural** Startle response - inking (Fewtrell & McCauley, 2012)	162 dB re 1 µPa^2.s
Crustaceans	**Recoverable injury** No mortality or damage to mechano-sensory systems (Payne *et al.*, 2008)	202 dB re 1 µPa PK-PK
Sponges and corals	**Mortality/mortal injury** No impacts (Heyward *et al.*, 2018)	226 dB re 1 µPa PK

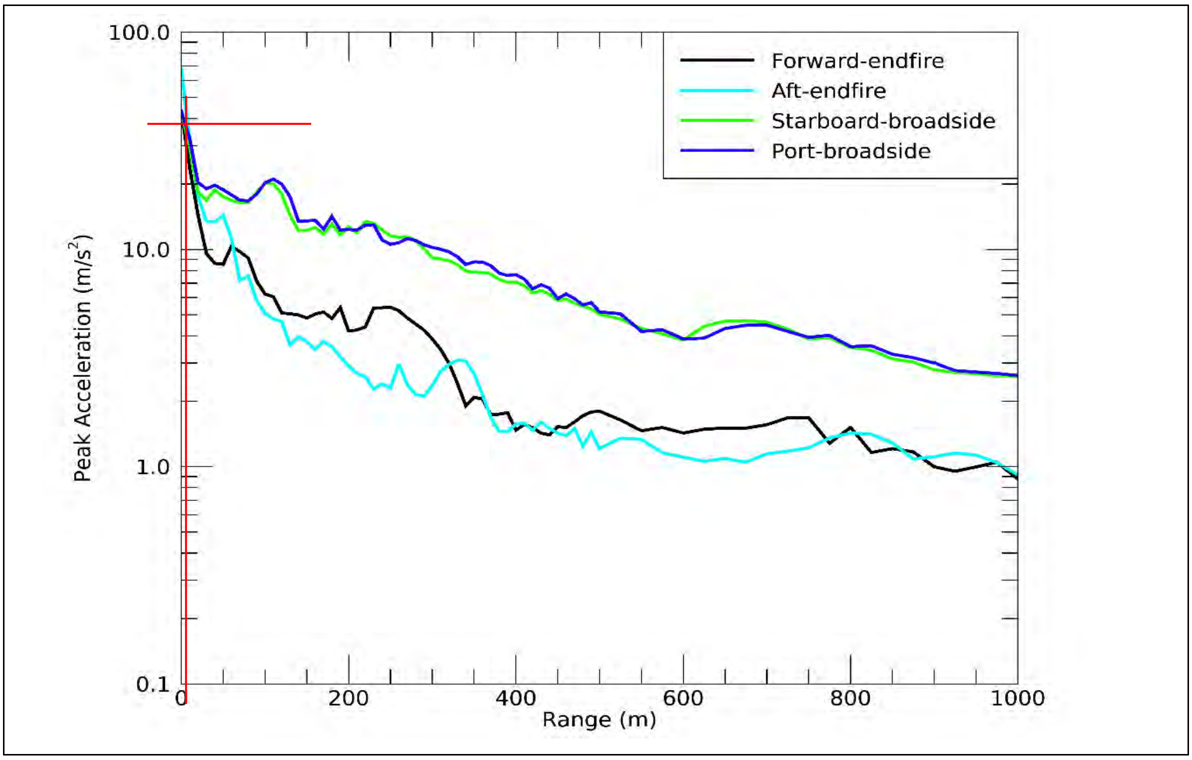
STLM Results

Figure 7.6, Figure 7.7 and Figure 7.8 graph the modelled maximum particle acceleration as a function of horizontal range in four perpendicular directions from the centre of the 2,495 cui seismic source at the three shallowest modelled sites (Sites 1–3, 50–79 m water depth). This assessment is relevant to benthic invertebrates such as scallops and lobsters. This modelling study has demonstrated that the maximum distance to a particle acceleration of the closest value to 37.57 ms^{-2}, used for comparison to Day *et al* (2016a;b), is 8 m. This means that there are no impacts (ranging from impaired reflexes and immunity response to long-term mortality) to scallops beyond 8 m of the sound source.



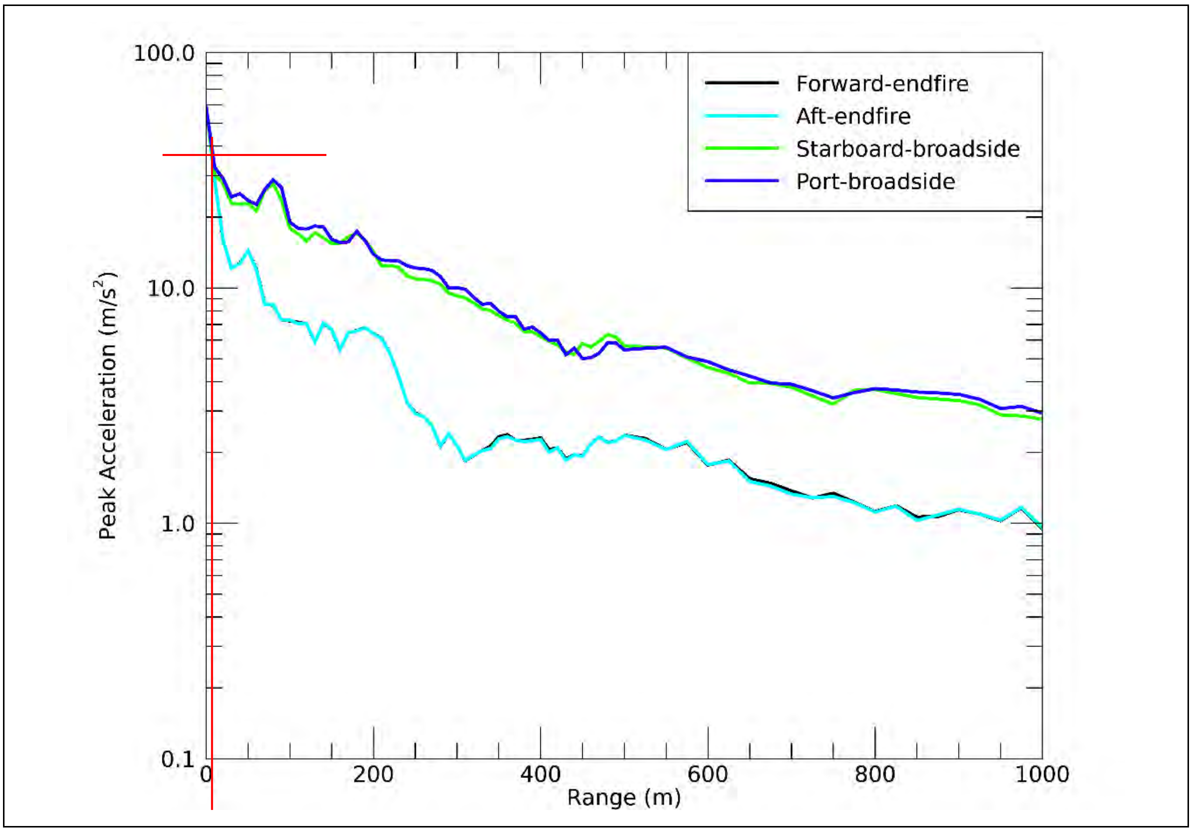
*Source: Koessler & McPherson (2020). * Red lines denote where the 37.57 ms^{-2} criterion is met.*

Figure 7.6. Site 1 (50 m water depth): Maximum particle acceleration at the seafloor as a function of horizontal range from the centre of the seismic source along four directions at Site 1 (50 m water depth)



*Source: Koessler & McPherson (2020). * Red lines denote where the 37.57 ms^{-2} criterion is met.*

Figure 7.7. Maximum particle acceleration at the seafloor as a function of horizontal range from the centre of the seismic source along four directions at Site 2 (58 m water depth)



*Source: Koessler & McPherson (2020). * Red lines denote where the 37.57 ms^{-2} criterion is met.*

Figure 7.8. Maximum particle acceleration at the seafloor as a function of horizontal range from the centre of the seismic source along four directions at Site 3 (79 m water depth)

Table 7.18 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 benthic invertebrates. This indicates that the no-effect distance ranges between 187 m and 761 m, depending on water depth of the comparison study. Note that the figures in Table 7.18 use the less relevant pressure metric (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 209-213 dB re 1 µPa PK-PK thresholds are listed in Table 7.18 to indicate the distance to no effect (Day *et al*., 2016a; 2017; 2019).

Table 7.18. Maximum horizontal distances from the seismic source to modelled seafloor PK-PK pressure levels from single impulse sites relevant to benthic invertebrates

PK-PK (L_{PK-PK}; dB re 1 µPa)	**Distance R_{MAX} (km)**		
	Site 1 (50 m)	**Site 2 (58 m)**	**Site 3 (79 m)**
213[a, b, c]	187	200	217
212[b, c]	198	210	235
210[a, b]	228	241	267
209[a, b]	355	258	286
202[d]	747	761	650
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.
d	Payne et al (2008) – lobster, no mortality or damage to mechano-sensory systems, recoverable injury.

Table 7.19 presents the maximum horizontal distances from the seismic source to modelled MOD unweighted per pulse SEL isopleths from single impulse sites relevant to octopus and squid. This indicates that the maximum distance to threshold (i.e., a startle response that involves inking) is between 3.35 km and 3.66 km, depending on water depth.

Table 7.19. Maximum horizontal distances from the seismic source to modelled MOD unweighted per pulse SEL isopleths from single impulse sites relevant to octopus and squid

Per pulse SEL (L_E; dB re 1 µPa².s)	**Distance R_{MAX} (km)**			
	Site 1 (50 m)	**Site 2 (58 m)**	**Site 3 (79 m)**	**Site 4 (54 m)**
162	3.45	3.35	3.66	3.40

In summary, these tables and graphs indicate that for the following marine invertebrates:

- Bivalves (scallops) - the threshold for potential impacts does not extend beyond 8 m using the particle motion threshold (the most relevant for benthic invertebrates) or beyond 761 m (using the less relevant sound pressure thresholds);
- Octopus and squid - the maximum distance to threshold (i.e., a startle response that involves inking) is 3.66 km; and
- Sponges and corals – distance to threshold was not reached.

Impact Assessment

Impacts to marine invertebrates as a result of the Prion 3DMSS for molluscs, sponges and corals are outlined below.

- The sound at any one location will be localised and temporary.
- Commercial scallops –
  - 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 insignificant.
  - Using the particle motion threshold (the most relevant metric given that scallops are attached to the seabed), 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 8 m from each seismic impulse location at the seabed. This represents 8% of the acquisition area.
  - Only the southern half of the acquisition area contains sediments suitable for commercial scallops. As such, impacts are restricted to this area.

- The consequence to the commercial scallop population is assessed as **minor**.

  Fisheries-specific (BSCZSF) impact assessment

- The scallop fishers that Beach has consulted with have indicated that the northern part of the survey area is not important to the fishery as it comprises mostly muddy sediments that are not suitable for scallop settlement.
- Using commercial fishing intensity maps as the basis for understanding where scallops occur in commercially viable concentrations through central Bass Strait, there is likely to be negligible impact to current scallop fishing grounds because there is little overlap between fished scallop beds and the acquisition area. Where scallops occur, physiological effects may be experienced at the individual level, but research indicates that mass mortality at the population level will not occur.
- Based on the 8 m distance to no effect for commercial scallops and mapped fishing intensity of commercial scallops for recent years (see Figures 5.28a-f in Section 5.7.6), there will be no impacts to known beds of commercial scallops or historically fished areas.
  - The proposed acquisition area overlaps a very small proportion of the BSCZSF (0.59%).
  - Using SETFIA's catch figures of an average of 9.3 t of scallops caught from the survey area for each of the last 10 years (2009-2018) represents 0.31% of the BSCZSF catch of 2,931 t in 2019 and 0.28% of the catch of 3,253 t in 2018. Assuming there was complete mortality of scallops in the acquisition area (which the literature does not support), this does not place the sustainability of the fishery at risk.
  - The 8 m distance to no effect is calculated to cover 8% of the acquisition area (Figure 7.9 and Table 7.20).
  - The 8 m distance to no effect is based on assuming the scallops are 50 cm off the seabed (rather than in/on the seabed). This modelling methodology is conservative because when the receiver is closer to the seafloor, the expected waterborne particle acceleration would be lower.
  - Based on the 8 m distance to no effect, the areas of most intense scallop fishing in recent years will not be affected by particle motion. Using the most recent 2019 scallop fishing intensity mapping (which are the closest fishing grounds to the acquisition area compared to previous years), the acquisition area is located:
    - 1.1 km (0.7 nm) from the 'low' level fishing intensity;
    - 5.5 km (3.0 nm) from the 'medium' level fishing intensity; and
    - 9 km (4.9 nm) from the 'high' level fishing intensity.
  - One of the scallop fishers working in the area requested that Beach avoids undertaking the survey over the 'KI-BDSE' (King Island-Blue Dot South East) and 'blue dot' juvenile scallop beds (see Figure 5.28) and that adequate buffer is maintained around them. The distances between these nominated scallop beds and the acquisition area means there will be no effects to scallops. The acquisition area is located:
    - 4.3 km east of 'KI-BDSE'; and
    - 20 km southeast of 'Blue dot.'
  - The scallop fisheries representatives advised Beach that the key area for scallop fishing is the 50-55 m depth range. In response to this information, Beach revised the acquisition area to completely excise this water depth range to minimise impacts. The 3.7 nm distance of ramp-up sound required to take place within the operational area (to meet EPBC Policy

Statement 2.1) also does not intersect this depth range. The former shape of the acquisition area overlapped 1% of this depth range.

- There may be some impact to scallop spawning if the survey proceeds during the preferred window of October to December (with peak scallop spawning occurring in November and December according to SFAT). However, as per the impact assessment for plankton (scallop spawn belong in this category), mortality or injury is only likely within several meters of the sound source. If the survey timing does overlap with scallop spawning and the six-week period in which the larvae drift in the planktonic phase, the larvae may be subject to mortal injury or mortality if they are present within a few metres of the seismic source. Mass mortality of scallop larvae is not credible given the very low likelihood of all of a given scallop population's larvae being concentrated in the survey area and specifically within 223 m of the seismic pulse (the modelled distance to mortality/potential mortality).
- Despite all efforts to minimise impacts to nearby commercially important scallop fishing grounds, and to demonstrate low impacts to scallops within the acquisition area, the BSSIA, TSIC, SIV and SFAT insist that the survey will have detrimental effects to future scallop fishing that may take place in the acquisition area. In order to determine the importance of the southern part of the acquisition area for the scallop fishery (i.e., whether it may represent a stock recruitment area for the fishing grounds to the west or future productive fishing grounds), Beach will undertake a pre-MSS scallop dredge (with the dredge designed by Fishwell Consulting) to determine the abundance and condition of scallops in the proposed acquisition area. More information about this process is discussed in Section 8.11.1.

- The consequence to the BSCZSF is assessed as **minor**.

- Octopus –
  - The startle response (inking) for octopus may occur within 3.66 km of the sound source, assuming that the source of the sound is sudden. Beyond the initial startle, octopus 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 (see Section 7.1.5 for controls) 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 consequence to octopus is assessed as **minor**.

Fisheries-specific impact assessment

- DPIPWE states that there is very little fishing (<50 kg each year) in the survey area for Tasmanian-managed fisheries (such as octopus).
- The octopus fisher that Beach has consulted with (who holds both licences) stated that only the southern third of the survey area is fished for octopus, with the 30-50 m water depth range being the most important (which is outside the acquisition area).
- The acquisition area overlaps only 0.73% of the Tasmanian octopus fishery.
- The octopus fisher stated that he is most active in this area between March and July and that octopus eggs are generally observed in traps from April to June. If the survey proceeds during the preferred window of October to December, impacts to octopus fishing and spawning will be avoided. If the survey takes place outside this window, impacts will be minor in nature, related more to exclusion (displacement) of fishing rather than impact to stock.

- The consequence to the octopus fishery is assessed as **minor**.

- Squid –
  - The startle response (inking) for squid may occur within 3.66 km of the sound source, assuming that the source of the sound is sudden. Beyond the initial startle, squid are likely to disperse from the sound source and therefore not be subject to additional sound levels that result in physiological impacts.
  - The consequence to squid is assessed as **minor**.

  Fisheries-specific impact assessment

  - The records of commercial fishing of squid in the survey area are extremely low (with no fishing since March 2017).
  - The squid fisher that Beach has consulted with states that he does fish in the survey area but that the catch is minimal, and this is generally during February. This fisher stated he was not particularly concerned about the survey given the low catch in the area.
  - If the survey proceeds during the preferred window of November-December, impacts to squid fishing will be avoided. If the survey takes place outside this window, impacts will be minor in nature, related more to exclusion of fishing rather than impact to stock.
  - The consequence to the squid fishery is assessed as **minor**.

- Sponges and corals, if and where present through the survey area, will not be impacted in any way by seismic sound.

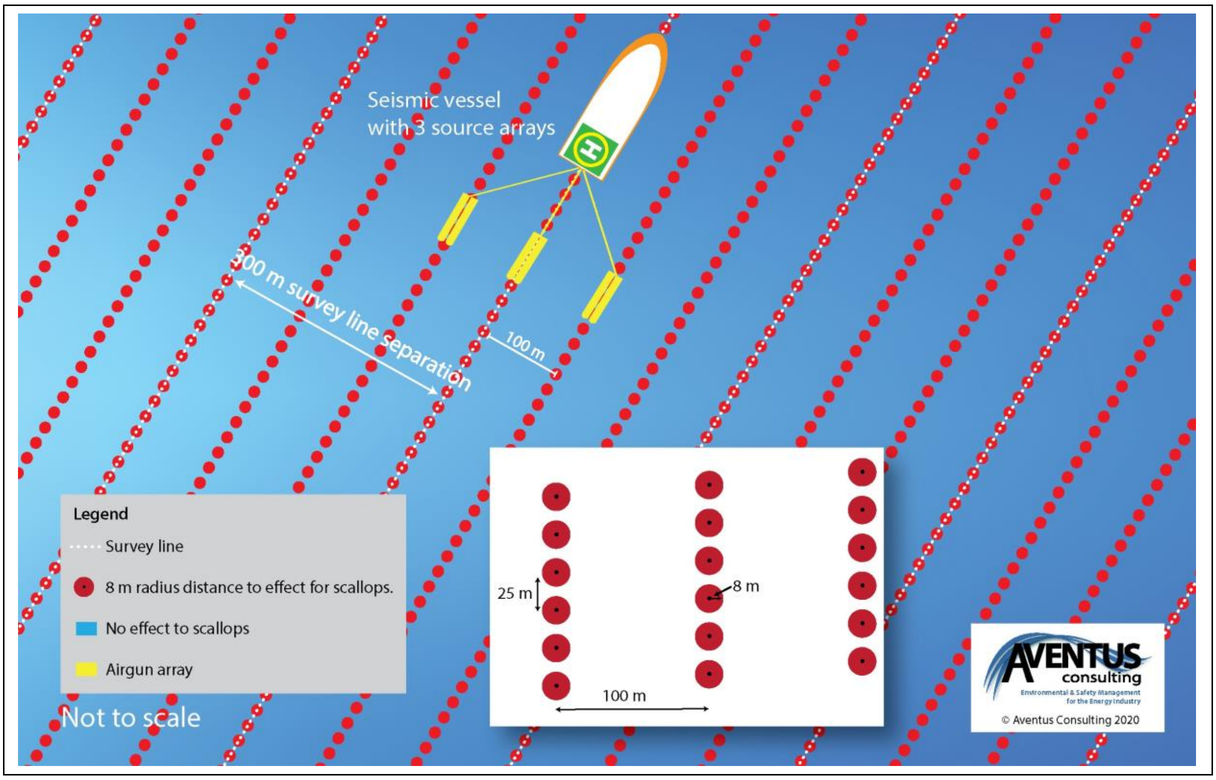


Figure 7.9. Diagrammatic representation of the distance to effect for scallops

Table 7.20. Calculation of area of impact for scallops

Percentage of area within 8m of a shot

ACQUISITION PARAMETERS		
Sail line interval		300m
Source separation		100m
Number of sources		3
Source line spacing		100m
Shot point interval	8.33m x 3 sources	25m

CALCULATIONS		
Area affected by each shot	Area = πr^2 = 3.14 x 8m x 8m (8m is the radius at sea floor)	201m²
Source lines per km	1000m/100m	10
Shots per km	1000m/25m	40 shots/km
Shots per sq km	source lines/km x shots/km	400 shots/km²
Area per sq km within 8m	400 shots x 201 sq/m per shot	80425m²
Percentage of seafloor within 8m of shot location	1,000,000m² per km²	8.04%
Plus 25% infill		10.05%

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 Section 6.5.4, Table 7.21 presents a demonstration of acceptability.

Table 7.21. Demonstration of acceptability for potential impacts to molluscs, sponges and corals

Statement of acceptability	Impacts to molluscs, sponges and corals are localised and temporary, with no mass mortality attributable to the MSS. There are no long-term impacts to the sustainability of the scallop fishery. Commercial scallop fishers are no worse off financially as a result of the MSS.	
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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) (see Chapter 4 for more detail)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. **Relevance to molluscs, sponges and corals:** Engagement with commercial fisheries associations and fishers is summarised below.	
	Scallop fishers	TSIC, SFAT and BSSIA raised concerns about the impacts of MSS on the BSCZSF. These relate primarily to concerns that the survey will result in mass mortality of the scallop beds thought to occur in the area, including claims of a juvenile scallop bed in the survey area (which will be confirmed via the scallop investigation dredge). On the other hand, SFAT states that the bulk of the survey area has no scallop fishing effort and that scallop fishing doesn't typically take place more than 40 nm (78 km) east of King Island (i.e., not within the survey area). These concerns have been addressed through Beach providing these stakeholders: • Detailed mapping of scallop fishing intensity in relation to the survey area.

		• A reference list of material about the effects of MSS on various receptors (general background papers, industry guidelines, scientific papers on the effects of MSS on crustaceans, molluscs, fisheries and so forth). • A presentation from JASCO Applied Sciences about underwater sound modelling and the associated results. • The JASCO Applied Sciences modelling report. • A draft of the underwater sound EIA sub-chapter for review prior to public exhibition. • Agreement to undertake a pre-MSS scallop dredge to determine abundance and condition of scallops in the acquisition area, working with industry affiliates to design the dredge. • Establishment of an Advisory Panel to inform the dredge design and review the results (see Section 8.11.1).
	Octopus fishers	The octopus fisher who holds the only two licences for fishing in the region stated that only the southern third of the survey area is fished for octopus, with the 30-50 m water depth range being the most important (which is outside the acquisition area). He is most active in this area between March and July and that octopus eggs are generally noticed in traps from April to June. This stakeholder is more concerned about effects of displacement (avoiding the survey vessel and streamers) than the potential impacts on octopus catch.
	Squid fishers	The main squid fisher operating in the region stated that he is not too concerned about the survey given the very low squid catch in this area.
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of: • EPBC Act 1999 (Cth). o EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales). • OPGGS Act 2006 (Cth). o 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 seabed (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 molluscs 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.	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 molluscs, sponges and corals:** Implementation of soft starts will provide molluscs in the water column (e.g., octopus and squid) with the opportunity to move away from intense sound.
	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical	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.

	operations, Report 579 (IOGP, 2017)	• 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 Beach 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 molluscs, sponges and corals:** Implementation of soft-starts will provide molluscs 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. **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 molluscs 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 molluscs 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	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).

	whales (DEWHA, 2008)	**Relevance to molluscs, sponges and corals:** Implementation of soft starts will provide molluscs in the water column (e.g., octopus and squid) with the opportunity to move away from sound intense sound.
	APPEA CoEP (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 5.5.1)	There is a 15 km^2 overlap between the southern end of the operational area and the northern part of the Boags 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 molluscs, sponges and corals:** no specific application. Marine invertebrates are not listed as a conservation value of the Boags AMP – it is recognised mostly for the seabird foraging habitat.
	Ramsar wetlands (Section 5.5.4)	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 5.5.6)	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 5.5.7)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest KEFs. **Relevance to molluscs, sponges and corals:** no specific application. Marine invertebrates in these KEFs will not be affected by the seismic sound
	NIWs (Section 5.5.8)	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 5.4)	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 5.5.9 & 5.5.10)	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.

<table>
<tr><td rowspan="2"></td><td></td><td colspan="2">Relevance to molluscs, sponges and corals: no specific application. Marine invertebrates in these marine parks will not be affected by the seismic sound.</td></tr>
<tr><td>Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans</td><td colspan="2">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.</td></tr>
<tr><td rowspan="6">ESD principles</td><td colspan="3">The application of the ESD principles to molluscs, sponges and corals are outlined here.</td></tr>
<tr><td colspan="2">A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.</td><td>The preferred 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.
Impacts to molluscs have been determined as minor.</td></tr>
<tr><td colspan="2">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.</td><td>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.</td></tr>
<tr><td colspan="2">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.</td><td>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.</td></tr>
<tr><td colspan="2">D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.</td><td>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.</td></tr>
<tr><td colspan="2">E. Improved valuation, pricing and incentive mechanisms should be promoted.</td><td>Not relevant.</td></tr>
</table>

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 that may be present in the survey area, such as southern rock lobsters, are described in Section 5.4.1.

There are no threatened crustacean species in the survey area and none that are commercially fished (e.g., rock lobsters, giant crabs).

Research Results – Marine Invertebrates in General

As per 'Impacts to Marine Invertebrates (molluscs).'

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; Day *et al.*, 2016a; Przeslawski *et al.*, 2016a;b; Carroll *et al.*, 2017), 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 Prion acquisition area:

- 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$^{\cdot s}$. 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 (*Chionoecetes 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$^{\cdot s}$) 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 µPa$_{0\text{-}p}$. 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 (*Metacarcinus magister*) to single discharges from a seven-airgun 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.

- 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 Before-After-Control-Impact (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 southern rock lobster 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 southern rock lobster 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 Prion 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.

<u>FRDC Study (2016)</u>

In order to further understand interactions between MSS and marine invertebrates, the CarbonNet Project contributed funding (along with the Commonwealth Government's Fisheries Research Development Corporation [FRDC] and Origin Energy Ltd) to a research program assessing the impact of MSS on southern rock lobster (*Jasus edwardsii*) (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 southern rock lobsters is provided herein.

The research program involved exposure of cohorts of southern rock lobster to multiple seismic airgun 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 airgun, 2,000 psi), July 2014 (150 cui airgun, 1,300 psi and 2,000 psi) and February 2015 (150 cui airgun, 2,000 psi). The airgun 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 $\mu Pa^{2.s}$, an accumulated SEL of 199 dB re 1 $\mu Pa^{2.s}$ 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 airgun 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 airguns 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 airgun 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 and Gardner, 2009).

The abundance of southern rock lobsters 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 southern rock lobster 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 southern rock lobster 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 southern rock lobster exposed to MSS:

- Mortality of adult lobsters at a rate greater than natural mortality 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 southern rock lobster 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 extremely close range.

In response to the Day et al (2016a) findings about the effects of MSS on southern rock lobsters, the IAGC asked several of its members who are expert in seismic sound and fisheries to examine the findings. 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 airguns and the seabed (5-7 m) is not representative of the majority of MSS (and certainly not representative of the Prion MSS). The complexity of sound acoustics in shallow waters means caution should be applied when interpreting these results in deeper waters.
- The potential effects to rock lobster 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 seismic surveys (see earlier point).

<u>CarbonNet Pelican 3DMSS Study (2018)</u>

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 southern rock lobster (*Jasus edwardsii*) 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 rock lobsters 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 southern rock lobsters 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 Prion acquisition area because as seen in Figure 5.52, there is a high amount of existing anthropogenic sound in the acquisition area from multiple daily north-south ferry movements and east-west merchant vessel traffic that benthic fauna, such as cetaceans, are subject to.

For this study, southern rock lobsters 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 was 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.

Thresholds for STLM

The background information relating to STLM thresholds presented in 'Impacts to Marine Invertebrates (molluscs)' applies equally here for crustaceans.

Table 7.22 presents the threshold used for the crustaceans EIA.

Table 7.22. STLM thresholds for crustaceans

Group	Threshold	Criteria
Crustaceans	**No impact** 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, sponges and corals' applies

Table 7.23 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., southern rock lobsters). This indicates that the maximum no-effect distance is 761 m (varying from 650 m to 761 m depending on water depth). Table 7.23 presents the results of modelling against the less relevant sound pressure thresholds (because sound waves are relevant to the water column rather than the seabed, where particle motion is the relevant predictor for sound impacts).

Table 7.23. 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} (km)		
	Site 1 (50 m)	Site 2 (58 m)	Site 3 (79 m)
Most relevant			
202[d]	747	761	650
Least relevant			
209[a, b]	355	258	286
210[a, b]	228	241	267
212[b, c]	198	210	235
213[a, b, c]	187	200	217
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.		
d	Payne et al (2008) – lobster, no mortality or damage to mechano-sensory systems, recoverable injury.		

The particle motion results for crustaceans are the same as those presented for scallops in Figures 7.5, 7.6 and 7.7.

Impact Assessment

Crustaceans present within 761 m of each seismic impulse at the seabed 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 761 m from the sound source will have a **minor** consequence because:

- The sound at any one location will be localised and temporary;
- The absence of suitable seabed habitat (e.g., rocky reef) for commercially important crustaceans such as southern rock lobsters indicates that this species (and other crustaceans with similar habitat requirements) is highly unlikely to be present in the survey area, and therefore will not be impacted;

- Rock lobster 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 5.4.1) (up to about mid-November). The preferred timing of the Prion 3DMSS may overlap with the spawning period and/or the plankton drifting phase. 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; and
- The high existing levels of shipping passing through the acquisition area make it likely that crustaceans have adapted to anthropogenic sound and that MSS will not exacerbate pre-existing damage to statocysts caused by shipping.

<u>Fisheries-specific impact assessment</u>

- There is no fishing for crustaceans in the proposed survey area.

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 Section 6.5.4, Table 7.24 presents a demonstration of acceptability.

Table 7.24. Demonstration of acceptability for potential impacts to crustaceans

Statement of acceptability	Impacts to crustaceans are localised and temporary, with no mass mortality reported subsequent to the MSS.	
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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) (see Chapter 4 for more detail)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. **Relevance to crustaceans:** Engagement with commercial fisheries associations and fishers has not revealed concerns with crustaceans given the absence of a lobster or crab fishery in the survey area.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of: • EPBC Act 1999 (Cth). o EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales). • OPGGS Act 2006 (Cth). o 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 seabed (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 seabed as they are not as fast moving as free-swimming demersal or pelagic species.	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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	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:

	industry (IOGP-IPIECA, 2020)	• 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.
	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 Beach 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. **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.
	APPEA CoEP (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 5.5.1)	There is a 15 km^2 overlap between the southern end of the operational area and the northern part of the Boags 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. Marine invertebrates are not listed as a conservation value of the Boags AMP – it is recognised mostly for its seabird foraging habitat.
	Ramsar wetlands (Section 5.5.4)	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 5.5.6)	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 5.5.7)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest KEFs. **Relevance to crustaceans:** no specific application. Marine invertebrates in these KEFs will not be affected by the seismic sound
	NIWs (Section 5.5.8)	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 5.4)	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 5.5.9 & 5.5.10)	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 preferred 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. 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. Free-swimming marine invertebrates will detect the sound and induce behavioural responses such as inking and movement away from the sound source. For slow moving crustaceans, a low level of stress that is unlikely to lead to mortality is likely to result within 761 m 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 and 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 and 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. There is no recognised unambiguous evidence of a link between sounds of seismic surveys and mortality of cetaceans (Gotz *et al*., 2009).

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 µPa^{2}·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 $\mu Pa^2 \cdot s$ 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 $\mu Pa^2 \cdot s$ at <1 km, the survey must operate with a 2 km exclusion zone (applicable to this survey).

The 160 dB re 1 $\mu Pa^2 \cdot s$ 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 Iorio and 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 μPa^2s. 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 airgun 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 and 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 Iorio and Clark (2010), who found that blue whales increased their discrete, audible calls during a seismic survey.

Numerous MSS have occurred along the Bonney coast (southeast South Australia/southwest Victoria) since the Blue Whale Study was initiated in 1998. The Blue Whale Study uses 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 blue whale 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 blue whale within the Astrolabe 3DMSS (Otway Basin), and eight blue whales within a 10 km buffer area around the survey area. The total number of blue whale 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. Blue whales 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 blue whale 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 5.13). 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 and 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 blue whale based on analysing data from an array of seismometers mounted on the seafloor during an MSS (using an airgun 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 small 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).

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**
Low-frequency cetaceans (mysticetes – e.g., blue, southern right 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)
Mid-frequency cetaceans (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
High-frequency cetaceans (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
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 airgun 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 ad 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.					

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 (R_{max}) horizontal distance from the source array to modelled maximum-over-depth peak pressure level (PK) thresholds for cetaceans

Site 2 (58 m water depth)	**Impairment – PTS**		**Impairment – TTS**		**Behavioural***	
	Per pulse	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**	**Per pulse**	**Over 24 hrs**
Low-frequency cetaceans, LFC (mysticetes – e.g., blue, southern right and humpback whales)						
Distance R_{MAX} (km)	30 m	5.45 km	70 m	27.9 km	9.1 km	Not measurable
Mid-frequency cetaceans, MFC (some odontocetes – e.g., toothed whales and dolphins)						
Distance R_{MAX} (km)	Not reached	Not reached	Not reached	10 m	9.1 km	Not measurable
High-frequency cetaceans, HFC (odontocetes – e.g., porpoises)						
Distance R_{MAX} (km)	360 m	50 m	790 m	2.37 km	9.1 km	Not measurable

* *Site 3 used for behavioural effects as the most conservative (the longest distances to effect).*

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 9.1 km (Site 3) (relevant to LFC, MFC and HFC).
- TTS – only likely to occur in close proximity to the operating airgun array, with the peak pressure criteria exceeded at a maximum horizontal distance of 70 m for LFC, and 790 m for HFC, while the peak pressure criteria for MFC was not reached. The distances to PTS using the 24-hour metric (ranging from 10 m for MFC, 2.37 km for HFC and 27.9 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 airgun 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 360 m for HFC, while the peak pressure criteria for MFC was not reached. The distances to PTS using the 24-hour metric (ranging from 50 m for HFC to 5.45 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 are outlined in Table 7.27.

Table 7.27. Potential impacts to threatened and migratory cetaceans recorded to occur in the survey area

Species or group	**Impact – preferred survey window (Oct-Dec)**	**Impact – outside preferred survey window**
LFC		
PBW	<u>Temporal</u> Very low likelihood of presence. Avoiding temporal overlap avoids impacts.	<u>Temporal</u> The survey may temporally overlap PBW migration season (which is December to April). <u>Spatial</u>

<table>
<tr><th>Species or group</th><th>Impact – preferred survey window (Oct-Dec)</th><th>Impact – outside preferred survey window</th></tr>
<tr><td></td><td></td><td>Spatially, the acquisition area overlaps the 'possible foraging area' BIA but is outside of 'known' and 'high use' foraging BIAs (see Figure 5.12).
The survey has the potential to cause behavioural disturbance or avoidance behaviour for PBW if the MSS takes place during the migration season (December to April) and/or peak foraging times (February and March).
The acquisition area overlaps 0.61% of this species' 'possible foraging area' BIA. Applying a 9.1 km buffer for the distance to behavioural effects to the acquisition area, this increases to a 1.56% overlap.
With the extensive foraging habitat available for PBW (see Figure 5.12), such overlap is not likely to represent a significant impact on the ability to forage, especially when considering that plankton (its key food source) are only likely to be subject to mortal injury within a few metres of the airguns.
As such, the consequence of the MSS on PBW is assessed as minor.</td></tr>
<tr><td>SRW</td><td><u>Temporal</u>
The survey temporally overlaps part of the SRW's migration season (May to October).
<u>Spatial</u>
There is likely to be little to no overlap with migration. Although Figure 5.13 illustrates that the acquisition area overlaps the 'known core range' BIA for this species (0.4% overlap), there is little data to support the notion that this area is important for migration or foraging. Applying a 9.1 km buffer for the distance to behavioural effects to the acquisition area, this increases to a 1.03% 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 (90 km to the northeast);
• 'Connecting habitat' BIA on the northern Tasmanian coast (40 km south) and the King Island coast (76 km west); and
• 'Aggregation' BIA in southwest Victoria (280 km away), a known calving and nursery ground.
These areas are beyond the 9.1 km distance to behavioural effect and the 27.9 km distance to effect for TTS.</td><td><u>Temporal</u>
Outside of the preferred survey window, the survey may partly overlap the SRW's migration season (May to October).
As such, the impacts may be the same as those for the preferred survey window.</td></tr>
</table>

<table>
<tr><th>Species or group</th><th>Impact – preferred survey window (Oct-Dec)</th><th>Impact – outside preferred survey window</th></tr>
<tr><td></td><td>As such, the consequence of the MSS on SRW is assessed as minor.</td><td></td></tr>
<tr><td>Humpback whale</td><td><u>Temporal</u>
There is overlap with the first half of the humpback whale southern migration season (October to December).
<u>Spatial</u>
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 0.58% of this species' 'core range' BIA in eastern and southeast Australia. Applying a 9.1 km buffer for the distance to behavioural effects to the acquisition area, this increases to a 1.48% 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 consequence of the MSS on humpback whales is assessed as minor.</td><td><u>Temporal</u>
Outside of the preferred survey window, the survey may still partly overlap with the species' migration season (October to December).
As such, the impacts may be the same as those for the preferred survey window.</td></tr>
<tr><td>Sei whale</td><td colspan="2">Temporally, the survey overlaps with their southern migration (October to December).
Spatially, sei whales prefer deep oceanic waters.
As such, no impacts to this species are likely.</td></tr>
<tr><td>Fin whale</td><td colspan="2">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, 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.</td></tr>
<tr><td>Pgymy right whale</td><td colspan="2">There is too little information known about this species to predict impacts. The lack of sightings in central and eastern Bass Strait and absence of a BIG in Australian waters suggests this species may not occur in the survey area, meaning that impacts to this species are not likely.</td></tr>
<tr><td colspan="3">MFC</td></tr>
<tr><td>Dusky dolphin</td><td colspan="2">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 and PTS will not be reached (TTS for the 24-hour metric is unlikely to be relevant as dolphins 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 MSS, the most likely impact is avoidance behaviour, which may add several kilometres to their migration path.</td></tr>
</table>

Species or group	Impact – preferred survey window (Oct-Dec)	Impact – outside preferred survey window
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 and PTS will not be reached (TTS for the 24-hour metric is unlikely to be relevant as dolphins 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.	
HFC		
None of the HFC listed as potentially occurring in the survey area have a conservation management plan or conservation advice in place.		

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 not likely that TTS or PTS onset will occur.

To determine whether the Prion 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	Not relevant, as noted above.

Plan	Relevant aim/objective	Assessment
	pathways be identified, a noise management plan should be developed.	
	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.	No information on BIAs for this species is available.
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.	No information on BIAs for this species is available.

The Prion 3DMSS will not have a ‘significant’ impact on critically endangered or vulnerable cetacean species (see Section 5.4.5) 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 Section 6.5.4, Table 7.29 presents a demonstration of acceptability.

Table 7.29. Demonstration of acceptability for potential impacts to cetaceans

Statement of acceptability	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.	
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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) (see Chapter 4 for more detail)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. **Relevance to cetaceans:** There has been no concern expressed by stakeholders about impacts to cetaceans.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound align with the requirements of: • EPBC Act 1999 (Cth). o Section 229, 229A – all cetaceans are protected in Australian waters, and it is an offence to kill, injure or interfere with a cetacean. o EPBC Policy Statement 1.1 (Significance Guidelines). o EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales). • OPGGS Act 2006 (Cth). o 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 seabed (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 will provide cetaceans with the opportunity to move away from sound before it can cause TTS or PTS.	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 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.
	Recommended monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations, Report	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.

	579 (IOGP, 2017)	• 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 Beach 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 MSS 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. **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 5.5.1)	There is a 15 km^2 overlap between the southern end of the operational area and the northern part of the Boags 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 cetaceans:** no seismic survey acquisition or soft starts will be undertaken in the AMP. The Boags AMP does not list cetaceans as one of its key values.
	Ramsar wetlands (Section 5.5.4)	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 5.5.6)	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 5.5.7)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest KEFs. **Relevance to cetaceans:** the KEF of relevance to cetaceans is the Upwelling East of Eden, which is a feeding ground for blue whales and humpback whales. Seismic sound will not extend to this KEF.
	NIWs (Section 5.5.8)	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 5.4)	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 airguns, 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 (see Section 5.4.5) 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, with those for the sei and fin whales assigning this a consequence rating of 'minor.' 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 5.5.9 & 5.5.10)	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.

<table>
<tr><td></td><td></td><td colspan="2">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.</td></tr>
<tr><td></td><td>Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans</td><td colspan="2">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 Southern Right Whale (DSEWPaC, 2012).
• Conservation Advice for Balaenoptera borealis (sei whale) (TSSC, 2015b).
• Conservation Advice for Balaenoptera physalus (fin whale) (TSSC, 2015c).
• Conservation Advice for Megaptera novaeangliae (humpback whale) (TSSC, 2015d).
Table 7.28 provides an assessment of the management aims relevant to underwater sound for each of these plans.</td></tr>
<tr><td>ESD principles</td><td colspan="3">The application of the ESD principles to cetaceans are outlined here.</td></tr>
<tr><td></td><td colspan="2">A. Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.</td><td>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, sea state considerations and safe vessel operations.</td></tr>
<tr><td></td><td colspan="2">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.</td><td>The scientific literature cited throughout this section indicates the PTS in cetaceans is likely only within close 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 9.1 km from the sound source, will not lead to serious or irreversible damage to cetaceans.</td></tr>
<tr><td></td><td colspan="2">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.</td><td>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.</td></tr>
<tr><td></td><td colspan="2">D. The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.</td><td>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.</td></tr>
<tr><td></td><td colspan="2">E. Improved valuation, pricing and incentive mechanisms should be promoted.</td><td>Not relevant.</td></tr>
</table>

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 5.4.6).
- 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 airguns (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 airgun 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 airguns and approached the airgun 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 pinnipeds

Threshold	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). 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 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. 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 pinnipeds, so per pulse SPL of 160 dB re 1 µPA is used to assess these impacts (as it is for all marine mammals).	
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 seals 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 (R_{max}) horizontal distances from the source array to modelled PK levels for otariid pinnipeds at site 2

Threshold	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	Not reached	50 m	9.1 km	Not measurable

* *Site 3 used for behavioural effects as the most conservative (the longest distances to effect).*

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 9.1 km.
- TTS – the distance to sound levels associated with the onset of TTS is not reached for single sound pulses, and is reached within 50 m using the SEL_{24h} 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 SEL_{24h} metrics) is not reached for otariid pinnipeds.

Impact Assessment

The STLM results indicate that there is no potential for TTS and PTS impacts to pinnipeds.

Behavioural impacts for seals may extend 9.1 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 5.18), it is possible that seal feeding grounds may be subject to sound ensonification that results in behavioural changes. However, given the abundance of foraging habitat for seals throughout Bass Strait, and the fact that the survey area does not represent limiting habitat, any temporary exclusion from feeding grounds is expected to be of **minor** consequence.

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 **minor**.

As described in Section 5.4.6, the acquisition area is located a significant distance from known breeding sites of the Australian fur-seal and New Zealand fur-seal. Distances to behavioural, TTS and PTS thresholds do not extend to the waters adjacent to these sites, so impacts to breeding success will not occur.

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 Section 6.5.4, Table 7.32 presents a demonstration of acceptability.

Table 7.32. Demonstration of acceptability for potential impacts to otariid pinnipeds

Statement of acceptability	The survey does not result in injury or displacement of seals from foraging, breeding areas or haul-out sites.	
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.

<table>
<tr>
<td>External context (stakeholder engagement)
(see Chapter 4 for more detail)</td>
<td colspan="2">Beach 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 pinnipeds.</td>
</tr>
<tr>
<td>Legislative context
(see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)</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 seabed (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="5">Industry practice
(see Sections 2.7 & 2.8 for descriptions)</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 pinnipeds: the application of EPBC Act Policy Statement 2.1 for cetaceans will also minimise the risk to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 dB re 1 $\mu Pa^2 \cdot s$ for marine mammals. Shut downs are not required to take place for seals.</td>
</tr>
<tr>
<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.
Relevance to pinnipeds: the application of EPBC Act Policy Statement 2.1 for cetaceans will also minimise the risk to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 dB re 1 µPa for marine mammals. Shut downs are not required to take place for seals.</td>
</tr>
<tr>
<td>Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities
(Prideaux, 2017)</td>
<td>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 pinnipeds: 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 TTS and PTS thresholds noted are the same as those used for the STLM.</td>
</tr>
<tr>
<td>Effective planning strategies for managing</td>
<td>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.</td>
</tr>
</table>

	environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	**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-shut-down 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 the risk to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 dB re 1 µPa 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 the risk to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 dB re 1 µPa 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 the risk to seals because the shut-down zone is designed to minimise behavioural effects triggered at 160 dB re 1 µPa for marine mammals. Shut downs are not required to take place for seals.
	APPEA CoEP (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 5.5.1)	There is a 15 km^2 overlap between the southern end of the operational area and the northern part of the Boags 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 pinnipeds:** no seismic survey acquisition or soft starts will be undertaken in the AMP. The Boags AMP does not list pinnipeds as one of

		its key values. The distance to behavioural effects of 9.1 km means sound at this threshold will not reach the Boags AMP (which is 9.8 km from the southern-most acquisition lines).	
	Ramsar wetlands (Section 5.5.4)	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 5.5.6)	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 sites of pinniped feeding, breeding or haul-outs.	
	KEFs (Section 5.5.7)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest KEFs. **Relevance to pinnipeds:** no specific application.	
	NIWs (Section 5.5.8)	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. Pinnipeds do not live in these wetlands.	
	Nationally threatened and migratory species (Section 5.4)	**Relevance to pinnipeds:** no specific application. Pinnipeds are listed marine species and not threatened or migratory.	
	Other matters		
	State marine parks (Sections 5.5.9 & 5.5.10)	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 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, listing 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 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 pinnipeds will not be triggered by this survey. Behavioural impacts, which extend up to distances of 9.1 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 airguns 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 airgun (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 airgun 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 airgun 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 airgun (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 airgun.

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 airgun 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 airgun 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 airgun pulses. Although some information is available about effects of exposure to sounds from a single airgun 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 airguns 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 SEL_{24h}	226 dB re 1 µPa (PK)	189 dB SEL_{24h}	Response: 166 dB SPL – McCauley et al (2000) Disturbance: 175 dB SPL – NSF (2011)	N/A
Threshold criteria	Thresholds defined recently by Finneran et al (2017) for PTS and TTS in marine turtles have been adopted. The rationale in Finneran et al (2017) 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 fishes than to marine mammals (Popper *et al*., 2014).				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.	

	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.	Both criteria are used in the modelling – response and behaviour.
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 four modelled sites.

Table 7.34. Maximum (R_{max}) horizontal distances from the source array to modelled seafloor PK levels from four transects for turtles

SPL (dB re 1 µPa @ 1 m)	R_{MAX} (km)			
	Site 1	Site 2	Site 3	Site 4
166 dB – behavioural response	4.92	4.91	5.11	4.93
175 dB – behavioural disturbance	2.07	2.11	1.96	2.19

Table 7.34 indicates that the greatest distance from the sound source is predicted to be 5.11 km for behavioural response and 2.19 km for behavioural disturbance. 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 SEL_{24hr} TTS and PTS thresholds for turtles. These results predict that the greatest distance from the sound source is 3.27 km for TTS and 60 m for PTS.

Table 7.35. Maximum-over-depth distances to SEL_{24hr}-based turtle criteria

SEL_{24hr} (dB re 1 µPa^2·s)	R_{MAX} (km)	Area (km^2)
189 dB – TTS	3.27	470
204 dB – PTS	0.06	5.01

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.
- The per-pulse TTS and PTS thresholds are not triggered.

- Behavioural response may be exceeded at distances ranging between 4.91 km and 5.11 km from the sound source, and behavioural disturbance may be exceeded at distances between 1.96 km and 2.19 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, and this is the limit of impacts.
- The SEL_{24hr} 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 Section 6.5.4, Table 7.36 presents a demonstration of acceptability.

Table 7.36. Demonstration of acceptability for potential impacts to turtles

Statement of acceptability	Turtles are not injured or displaced from foraging, breeding and nesting grounds or migratory routes. The survey is not inconsistent with the aims of the Recovery Plan for Marine Turtles in Australia (DoEE, 2017).	
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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) (see Chapter 4 for more detail)	Beach 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.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The EPS developed to avoid, minimise or mitigate for the impacts of underwater sound to turtles align with the requirements of: • EPBC Act 1999 (Cth). o 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). o 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 seabed (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 (see Sections 2.7 & 2.8 for descriptions)	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 turtles: not applicable; there are no recognised migration, feeding, breeding or nesting grounds in Bass Strait.
	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 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. **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.

	APPEA CoEP (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 5.5.1)	There is a 15 km^2 overlap between the southern end of the operational area and the northern part of the Boags 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 turtles:** the Boags AMP does not list turtles as one of its key values.
	Ramsar wetlands (Section 5.5.4)	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 5.5.6)	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 sites of turtle feeding, breeding or migration.
	KEFs (Section 5.5.7)	The STLM indicates sound created by the MSS will not reach levels above ambient sound at the nearest KEFs. **Relevance to turtles:** no specific application.
	NIWs (Section 5.5.8)	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.
	Nationally threatened and migratory species (Section 5.4)	**Relevance to turtles:** turtles are listed migratory and threatened species. This EIA addresses potential impacts of the survey to turtles, which predicts only behavioural disturbance is likely (no TTS or PTS).
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	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 marine parks are recognised areas of importance for turtle migration, feeding, breeding or nesting.
	Species Conservation Advice/ Recovery Plans/ Threat Abatement Plans	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 potential impacts of the activity on the management aims of this plan.

ESD principles	The application of the ESD principles to **turtles** 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 there are unlikely to be short-term or long-term impacts to individual turtles or turtle populations.
	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 per-pulse TTS and PTS thresholds for turtles will not be triggered by this survey. Behavioural impacts, which extend up to distances of 5.11 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 Avifauna

Seabirds

The proposed acquisition area contains potential foraging habitat for a diverse array of seabirds, including:

- Foraging or feeding BIAs –six albatross species, three petrel species, the short-tailed shearwater, Australasian gannet and white-fronted tern;
- Roosting BIA – sharp-tailed sandpiper, sanderling, great knot, double-banded plover; and
- Foraging & roosting BIA – little penguin (see Section 5.4.4**Error! Reference source not found.**).

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 small size of the proposed acquisition area is not significant relative to their normal foraging environment. 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 habitat outside of the acquisition area.

Shorebirds

Shorebird species such as the Australian fairy tern and hooded plover will not be affected by the MSS, given their prey is concentrated within the intertidal part of the coastline, far from the underwater sound EMBA.

Aquatic birds

Little penguins have foraging and breeding BIAs around many of the islands of Bass Strait (see Figure 5.9).

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, 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 **minor** 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 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, 41 km 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 may form part of their foraging grounds. However, as noted above, 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 the negligible impacts to avifauna from the MSS, there is no requirement to demonstrate acceptability.

Impacts to the Boags AMP

The Boags AMP is located 9.8 km south of the acquisition area and is overlapped by the operational area. At this distance, and based on the USTLM and bathymetry of the AMP (50-55 m), which means that USTLM sites 1, 2 and 4 are most relevant), sound from the survey will not reach the behavioural, TTS or PTS thresholds for any of the fauna groups examined in this chapter.

The conservation values of the Boags AMP and how they may be affected by the Prion 3DMSS are described in **Appendix 1**. There is no park-specific management plan in place for the AMPs within the South-east Marine Region, so this assessment uses the IUCN reserve management principles.

The primary objective of IUCN Category VI (being the category of relevance to the multiple use zonation of the Boags AMP) is:

> *To protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.*

Because sound levels from the proposed Prion 3DMSS are not predicted to reach thresholds for behavioural effects, TTS or PTS for any marine species within the Boags AMP (either in the water column or at the seabed), the survey is not inconsistent with the primary objective and is therefore acceptable.

Impacts to Communications Cables

As described in Section 5.7.3, a 19.6 km long section of the Bass Strait telephone cable 2 dissects the northeast part of the acquisition area (with 12.9 km of this overlapped by acquisition lines).

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 seabed, 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 seabed, and was not reached in the STLM (see Table 7.3) (including at modelling site 3, the closest site to the cable). As such, no impacts to the telecommunications cable are predicted.

At least two MSS have been undertaken over sections of this telecommunications cable since it was laid in 2003 (Figure 7.10); these being:

- Labatt 3DMSS was acquired in 2008 and overlapped 23.3 km of the cable; and
- Chappell 3DMSS was acquired in 2011 and overlapped 12.6 km of the cable.

No impacts from these surveys to the cable were reported. Therefore, it is expected that the Prion 3DMSS will similarly have no impact on the cable. Attempts to consultation with the cable's owner, Telstra, have not resulted in that stakeholder raising concerns about the survey's potential impacts on the cable.

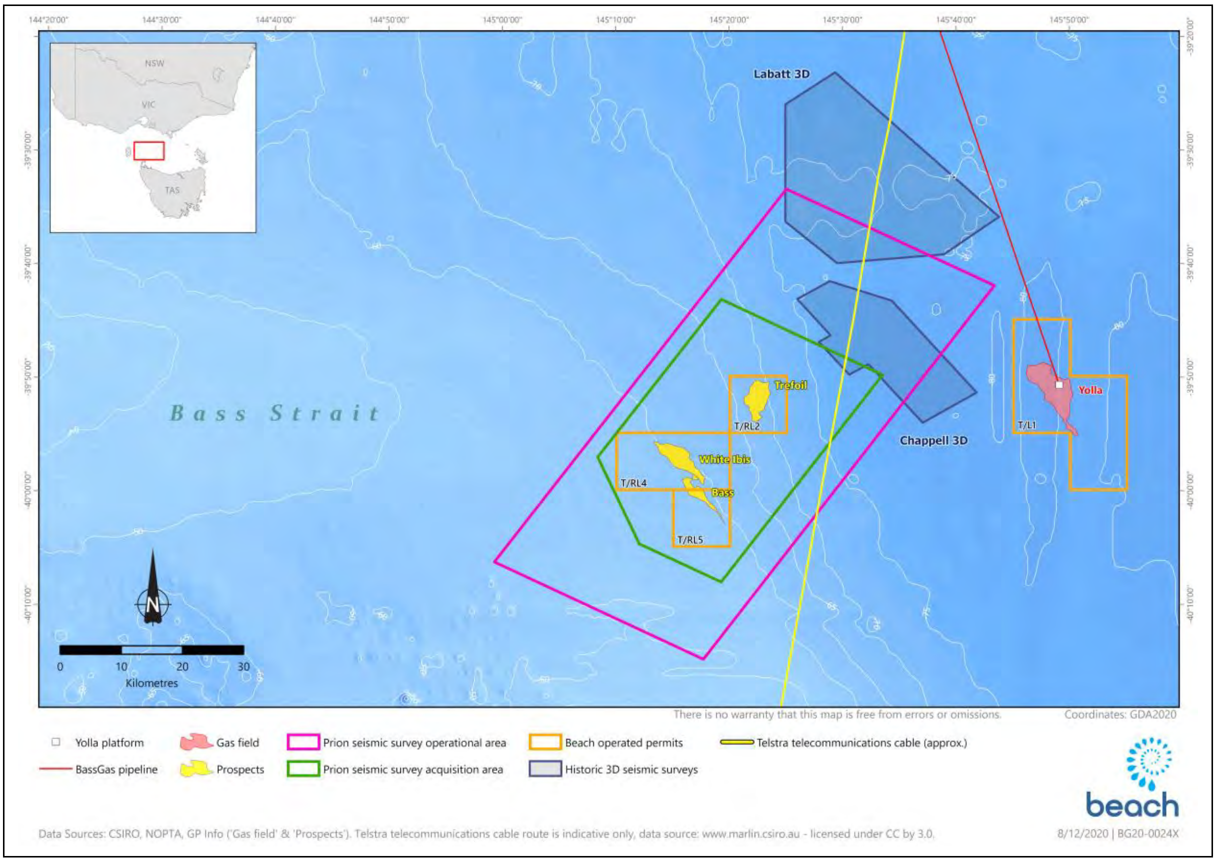


Figure 7.10. Overlap between the Telstra 2 telecommunications cable and previous 3DMSS

The Indigo communications cable, which connects Perth and Sydney, is located 17 km north of the acquisition area and 4 km north of the operational area at its closest point (see Figure 5.27). At this distance, there will be no impact to the integrity or the operation of the cable.

Cumulative Impact Assessment

Cumulative impacts are 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.
- Interactions between sound and other stressors.

Section 3.4.2 of the 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 Prion 3DMSS in Table 7.37.

Table 7.37. 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.	
Multiple exposures from consecutive activities	
Recent	
Trefoil geophysical survey	Beach undertook this geophysical survey in T/RL2 and T/RL3 (the northern half of the acquisition area) from 9-25 June 2020. A total of 821 line kilometres of survey data was acquired. The EP for this activity (T-5200-75-RP-0009, Rev 0, February 2020) assessed the residual impacts to marine fauna from underwater sound to be 'low.' This low impact and the duration of time between that activity and the proposed Prion 3DMSS (a minimum of 15 months if it commences at the start of the preferred acquisition window of October to December 2021) means that, applying the NMFS 'resetting' and Popper (2018) guidance, 15 months after exposure to previous seismic similar sound levels is sufficient time for resident fauna (i.e., benthic fauna) to recover from any TTS or behavioural disturbance experienced by the geophysical survey. As such, cumulative impacts are not likely.
Historic MSS	

There have been no seismic surveys undertaken over the proposed Prion 3DMSS in the last five years. The most recent surveys are listed below (see also Section 3.3). Due to the elapsed time since the last MSS in the acquisition area (10 years by the time Prion is potentially acquired), fauna resident in the area (i.e., benthic fauna) will have recovered from any TTS or behavioural disturbance experienced by these MSS by the time the Prion survey commences. As such, cumulative impacts are not likely.	
Chappell 3DMSS 2011 (3 – 7 February 2011)	Overlaps with the northwest part of the acquisition and operational areas in T/RL2. The basic parameters of this survey were: • Source volume: 3, 090 cui. • Number of streamers: 12. • Streamer length: 5,100 m. • Line separation: 600 m. ABARES mapping indicates there was no scallop fishing in or around this survey area before, during or after this MSS.
Labatt 3DMSS 2008 (29 Nov 2007 – 1 Jan 2008)	Overlaps with the northernmost part of the operational area. The basic parameters of this survey were: • Source volume: 3, 090 cui. • Number of streamers: 6. • Streamer length: 6,000 m. • Line separation: 300 m.
Silvereye 3DMSS 2008 (2-30 January)	Slight overlap with southwest corner of the acquisition and operational areas, overlap with T/RL4. The basic parameters of this survey were: • Source volume: 3, 090 cui. • Number of streamers: 6. • Streamer length: 6,000 m. • Line separation: 300 m.
Shearwater 3DMSS 2005 (14 Nov – 20 Dec)	Overlaps with T/RL2 and T/RL3. The basic parameters of this survey were: • Source volume: 2,500 cui. • Number of streamers: 4. • Streamer length: 4,350 m. • Line separation: 200 m.
Cumulative impacts over a large area where there are two or more simultaneous sound generating activities	
Other seismic surveys	
Beach is not aware of any MSS that may be undertaken concurrently in close proximity to the Prion 3DMSS. This is primarily because there are no other non-Beach operated exploration permits or production licences within 130 km of the survey area (noting this is subject to change on an annual basis with new permit releases). As such, it is unlikely that sound emanating from seismic activities that may be undertaken in the nearest permits concurrently with the Prion survey would reach the Prion survey area at levels that impact marine fauna.	
Sequoia 3DMSS	Beach is aware that ConocoPhillips is planning to undertake the Sequoia 3DMSS in exploration permit T/49P on the west side of King Island, located 135 km (73 nm) west of the Prion acquisition area. Consultation with ConocoPhillips indicates they are opting for a survey acquisition window of August to October 2021, meaning there is the potential for it to operate either concurrently or just before or after the Prion 3DMSS. The EP for the Sequoia 3DMSS became available for public exhibition on the 4th of December 2020. The EP for the Sequoia 3DMSS indicates that seismic sound from the survey will not extend to the Prion survey area and trigger behavioural, TTS or PTS thresholds for fauna in the Prion survey area. It is also noted that a combination of seismic sound from two MSS operating concurrently in nearby areas would increase sound levels by a maximum of 3 dB SPL if

	the impulses were simultaneously incident at a point in space. Although sound levels in either survey area would not be significantly higher as a result of both MSS operating simultaneously, it would represent a large area of exposure to marine fauna. If both surveys were undertaken during their preferred acquisition windows, this is not likely to significantly impact on the most sensitive fauna (whales, especially PBW) given that their peak migration and foraging times would be avoided. Given that survey contractors allow for a distance of 40 km (21.6 nm) between surveys to preserve acoustic interference and preserve data integrity, if the Prion and Sequoia 3DMSS are undertaken concurrently, the sound generated from each is not likely to cause interference for the other.
Vessel traffic (see Section 5.7.7)	
The survey area is not located in a low noise area, rather, merchant shipping and passenger ferries continuously travel through the survey area (about 13 voyages through the survey area occur per day based on AMSA data for April 2020). This generates underwater sound and it is likely that fauna residing in the survey area (and surrounds) are habituated to high sound levels from these vessel movements, noting that the constant sound of vessel propellors or thrusters is tonal in nature rather than impulsive.	
Merchant shipping	As illustrated in Figure 5.52, there is a significant amount of merchant shipping traffic (such as container, cargo, tanker, bulk carrier ships) moving in an east-west direction through the Prion survey area. The sound intensity of these types of vessels is typically in the range of 170-181 dB re 1 μPa (frequency of 8 Hz) (Simmonds *et al.*, 2004; Richardson *et al.*, 1995). Assuming a slowest speed underway of 16 knots (30 km/hr) (though merchant vessels may travel up to 24 knots (44 km/hr)) (Marine Insight, 2020), it would typically take such vessels one hour to sail through the acquisition area. This slightly increased sound level (over the sound generated by the MSS) for such a short period of time is not expected to result in significant cumulative impacts to marine fauna.
Spirit of Tasmania	This Melbourne to Devonport passenger ferry service runs up to two return services each day using two *Spirit of Tasmania* vessels (see Figure 5.52) that travel in a southeast/northwest direction through the northern part of the survey area. This service has been operating since 1993. Sound levels from this type of vessel would typically be in the range as noted above for general merchant shipping. Based on the ferries' average speed of 27 knots (or 50 km/hr), the *Spirit of Tasmania* will sail the 22 km through the acquisition area in about 18 minutes. This slightly increased sound level (over the sound generated by the MSS) for such a short period of time is not expected to result in significant cumulative impacts to marine fauna.
Toll Shipping	Tolls operates sea freight shipping between Melbourne and Burnie (see Figure 5.52), with one vessel operating this route daily. This route operates in a southeast/northwest direction through the central part of the survey area. Sound levels from this type of vessel would typically be in the range as noted above for general merchant shipping. Assuming a slowest speed underway of 16 knots (30 km/hr) typical of container ships (Marine Insight, 2020), the Toll ships will sail the 36 km through the acquisition area in 1 hour and 12 minutes. This slightly increased sound level (over the sound generated by the MSS) for a short period of time is not expected to result in significant cumulative impacts to marine fauna.
Cumulative impacts over consecutive seasons in areas that are considered biologically important for certain receptors	

PBW	The oceanographic regime of the survey area is separate to that of the Otway region to the west of King Island (Gill, 2020). The Otway Shelf is squarely within the productive, and to a certain extent predictable, Great Southern Australian Upwelling System and is an important, consistently used PBW foraging area (Gill, 2020). The Bass Basin portion of Bass Strait (in which the Prion survey area is located) has been poorly studied in terms of its importance for PBW migration and foraging, but is generally considered to be of less importance to PBW because the effects of upwelling (i.e., krill aggregations) do not extend to this area. This means that if the Prion 3DMSS was to occur after the Sequoia 3DMSS in consecutive seasons, because the Prion survey area is not as important as the Sequoia area for migrating and foraging PBW, there are not likely to be cumulative impacts.
Scallops	Scallops bed locations move over time and the density/health of beds change on a regular basis, with the associated fishery widely recognised as being 'boom-or-bust.' Beach has no plans to undertake another MSS immediately or soon after the Prion survey, so there will not be any cumulative impacts over consecutive seasons of spawning, fishing and so forth. Because there are currently no other permits in the immediate vicinity of the survey area that are not operated by Beach, there is no possibility of a non-Beach operated MSS occurring in the area that would trigger impacts over consecutive seasons.
Cumulative impacts from multiple, different sources of sound	
As per the previous discussion regarding commercial shipping. Waves, currents, storms, lighting, whale vocalising, dolphin clicks and so forth contribute to the natural ambient underwater sound levels of the survey area (and all areas of the ocean). While each type of sound occurs over a specific range of sound intensities and frequencies, it is not possible to determine the additive effect of these sounds with those of ships and the MSS.	
Interactions between sound and other stressors	
The other key stressors in the Prion survey area are commercial fishing (most notably the SESS and BSCZSF) and commercial shipping. Commercial fisheries act to remove the stock potentially impacted by sound from the survey (i.e., sharks and scallops). The STLM results predict very little impact on sharks and scallops, so the impacts to fishing from the survey are assessed as minor. As noted in previous sections of this table, the interaction of commercial fishing and shipping with the Prion survey is not expected to have any measurable effects on other non-fishing receptors.	

Analysis of Approved MSS

A review of the NOPSEMA website to determine what MSS have recently taken place or have accepted EPs in the general vicinity of the Prion 3DMSS has been undertaken. As of the 11th of December 2020, this review indicates the following:

Proposed MSS

- Sequoia 3DMSS – ConocoPhillips Australia proposes to undertake a 3DMSS 135 km to the west of the Prion 3DMSS acquisition area in the T/49P exploration permit. The survey is planned to take 30 days to acquire and is planned to take place in August to October 2021.

Completed

- Otway Basin 2DMC MSS – Schlumberger Australia undertook this multi-client survey from 16 January to 21 April 2020, with its closest acquisition line located about 170 km to the west of the Prion acquisition area.

- CGG Gippsland MSS – undertaken by CGG Services (Australia), this survey took place from the start of January to mid-July 2020, with the nearest acquisition line located about 245 km to the northeast of the Prion acquisition area.

Accepted but not yet acquired

- Otway Deep MSS – proposed by Spectrum Geo Australia (now TGS), this EP was accepted in June 2019 but has not yet been acquired. Beach understands that this survey may commence in late 2021. This survey will target deep waters of the Otway Basin, with its acquisition area located about 180 km to the west of the Prion acquisition area at its nearest point.
- Dorrigo 3DMSS – proposed by 3D Oil, this survey was not conducted. It has been replaced by a proposal by ConocoPhillips (in a joint venture with 3D Oil) to undertake the Sequoia 3DMSS over the same area (with an extension to the north). This is located 135 km to the west of the Prion acquisition area.

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 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.

In summary, it is predicted that undertaking the Prion 3DMSS will not result in any cumulative impacts to sensitive fauna.

Monitoring for other Seismic Surveys

Following acceptance of this EP, Beach will continue to monitor the NOPSEMA website for submitted and accepted MSS EPs that may contribute to cumulative noise in the survey area. If a survey is permitted within 40 km of the Prion 3DMSS and its timing indicates it may overlap that for Prion, Beach will contact the relevant titleholder to ensure arrangements are made to reduce cumulative impacts wherever possible. As a minimum, Beach will not acquire seismic data within 40 km of another actively acquiring seismic vessel.

7.1.5 Impact Assessment

Table 7.38 presents the impact assessment for underwater sound.

Table 7.38. 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 provided in Table 7.2 and Table 7.3.
Duration of impacts	Underwater sound will only be generated for the duration of the survey.

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 framework in Australia.	
Impact Consequence (inherent)		
Receptor		Consequence rating
Biological		
Plankton		Minor
Crustaceans (e.g., southern rock lobster)		Minor
Molluscs - benthic (e.g., scallops)		Minor
Molluscs - pelagic (e.g., octopus/squid)		Minor
Fish – with swim bladders		Minor
Fish – without swim bladders		Minor
Cetaceans - LFC		Minor
Cetaceans - MFC		Minor
Cetaceans - HFC		Minor
Pinnipeds		Minor
Turtles		Minor
Avifauna		Minor
Fisheries		
BSCZSF		Minor
Squid		Minor
Octopus		Minor
SESS (Gillnet and hook)		Minor
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Cetaceans		
Trained and experienced Marine Mammal Observers (MMOs) will undertake marine mammal observations.	EPBC Act Policy 2.1 - Part B.1 Two competent MMOs will be on watch at all times aboard the survey vessel to conduct marine mammal observations for the duration of the survey.	MMO CVs verify they are competent in undertaking MMO duties. MMO sighting data is available for the duration of the survey.

All crew aboard the seismic survey vessel and support vessels are inducted into the EPBC Act Policy 2.1 requirements.	EPBC Act Policy 2.1 - Part A.2 The MMOs undertake cetacean awareness sessions for all survey and support vessel crews.	Cetacean management information is available in the crew induction presentation.
		Induction attendance records verify that awareness sessions took place.
Cetacean sightings are reported to the DAWE.	EPBC Act Policy 2.1 - Part A.4 Beach 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 informs daily operational planning.
Cetaceans continue to migrate through and forage in and around the survey area without displacement or injury.	Full power will not be used outside the acquisition area – only soft-starts will take place in the operational area on the run ins to the survey lines.	Daily operations reports/maps and seismic data verifies no data acquisition in the operational area.
	Pre-survey testing of the airgun array at full power for quality control or survey refinement will only take place in the acquisition area (not in the operational area or areas beyond this).	Daily operations reports verify testing of the airgun array at full power was only undertaken in the acquisition area.
Actions relevant for May to November (outside the peak and shoulder PBW foraging and migration seasons)		
Cetaceans continue to migrate through and forage in and around the survey area without displacement or injury.	EPBC Act Policy 2.1 - Part A.3 *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 the start up procedure 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 shut down. • If a whale is observed within the shutdown zone of the source, the power source will be shut down. 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.	
	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 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.	
	A.3.6 Night-time and low visibility procedure Wherever practicable, commence operations during daylight hours. Where due to operational requirements operations must commence during night-time or low visibility conditions, the soft start procedure outlined previously will be implemented providing that during the previous 24-hour period: • There have not been 3 or more whale instigated power-down or shut-down situations. • 2 hours of continual observations were undertaken in good visibility (to the extent of the 3 km observation zone) and no whales were sighted. Operations may proceed if there have not been 3 or more whale instigated power-downs or shut-downs during the preceding 24 hr period.	
Actions relevant for PBW and SRW from December to April (additional to those for May to November) (PBW shoulder foraging and migration season)		
PBW and SRW continue to migrate through and forage in and around the survey area without displacement or injury.	An MMO will be positioned on each support vessel to provide additional coverage to that of the survey vessel.	MMO data sheets verify that observations take place from the support vessels.
	EPBC Act Policy 2.1 - Part B.4 From the survey vessel, increased precaution zones and soft-start durations will be implemented: • Pre-start visual observations - for 45 minutes out to 5 km (rather than 30 minutes and 3 km). • Soft start – over a period of 45 minutes, with visual observations out to 5 km (rather than 30 minutes and 3 km). • Shut down – if whales are observed within 2 km (rather than 500 m). • Resume soft start – after 45 minutes or once whale has been observed to move beyond 5 km.	MMO data sheets verify that increased precaution zones are implemented.
Actions relevant for PBW and SRW for February and March (additional to those above) (peak PBW foraging season)		
PBW and SRW continue to migrate through and forage in and around the survey area without displacement or injury.	EPBC Act Policy 2.1 - Part B.3 Two spotter vessels with two MMOs on each will be used to enforce the EPS described above. If there are no sightings within a 10 km radius of the airgun array (rounded up from the 9.1 km for the modelled distance to behavioural effects for LFC): • The survey proceeds as is. If there are sightings within a 10 km radius of the airgun array: • Whales migrating only (no obvious feeding) – spotter vessel MMOs to communicate with	Daily MMO reports verify that observations take place from spotter vessels.

	survey vessel MMOs to remain on standby for shutdown. • Whales obviously foraging – spotter vessel MMOs to request survey vessel MMOs to instigate shutdown and remain on current line plan or relocate to another survey line more than 10 km from the whale sighting. Spotter vessel MMOs must attempt to maintain visual contact with the whale/s and communicate this information to the survey vessel. Soft start can only resume once the spotter vessel MMOs, survey or support vessels verify no sightings within 10 km of the airgun array.	
Commercial scallop fishery		
There is no mass mortality of commercial scallops attributable to the MSS.	A scallop biomass dredge is undertaken pre-MSS (see Section 8.11.1) in order to determine whether mass mortality of commercial scallops attributable to the MSS occurs. The need for a follow-up dredge will be decided using the advisory panel consultative process as described in Section 8.11.1.	In comparing the pre- and post-MSS scallop dredge results, it is verified that no mass mortality of commercial scallops occurs.
Particle motion monitoring validates the STLM.	The underwater sound validation study is undertaken during the MSS (see Section 8.11.1) in order to validate the STLM methodology and results.	The underwater sound validation results verify the particle motion results in the STLM report.
All commercial fishers		
Commercial fishers are compensated for any displacement or proven loss of catch.	Beach makes their *Fair Ocean Access* procedure 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.
		Completed claims forms are available.
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.
	If Beach 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.
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.

Impact Consequence (residual)	
Receptor	Consequence rating
Biological	
Plankton	Minor
Crustaceans (e.g., southern rock lobster)	Minor

Molluscs - benthic (e.g., scallops)	Minor
Molluscs - pelagic (e.g., octopus/squid)	Minor
Fish – with swim bladders	Minor
Fish – without swim bladders	Minor
Cetaceans - LFC	Minor
Cetaceans - MFC	Minor
Cetaceans - HFC	Minor
Pinnipeds	Minor
Turtles	Minor
Avifauna	Minor
Fisheries	
BSCZSF	Minor
Squid	Minor
Octopus	Minor
SESS (Gillnet and hook)	Minor

Demonstration of ALARP

'Minor' residual impact consequences are considered to be ALARP and a 'lower order' impact.

The following ALARP analysis provides additional assurance that all risk treatment options have been considered.

Control measures that have been considered to reduce the impacts of underwater sound on biological receptors and fisheries, but not adopted, are outlined below.

Control considered	Hierarchy of control type	Analysis
Use a lower sound volume to minimise the distance to effects for biological receptors.	Engineering	The initial design for the Prion 3DMSS involved using a 3,280 cui source array, which would have been slightly larger than the source used for previous surveys. Seismic source array size is typically increased in proportion to streamer length and target depth in order to provide the signal strength required to accurately image the reservoir. The legacy surveys in the area include the Shearwater 3D (2005), which used a 2,500 cui array for 4,350 m long streamers and the Silvereye 3DMSS (2008) and Chappell 3DMSS (2011) surveys, which both used 3,090 cui arrays for streamer lengths of 6,000 m and 5,100 m, respectively. The final design for the Prion 3DMSS requires the use of 8,000 m long streamers to provide sufficient offsets to enable Full Waveform Inversion (FWI) to target depth. Detailed design work identified the option to use a smaller source array (2,495 cui) in combination with several new acquisition technologies, including: • Very wide-tow sources (200 m rather than 50 m); • Triple Source rather than Dual Source; • More frequent source activation to improve sampling; and • Deep-tow streamers to improve signal to noise and low frequency content.
Do not conduct the MSS over the southern half of the acquisition area to avoid	Elimination	Commercial scallop fishers have advised Beach that the southern part of the Prion survey area overlaps their likely future fishing grounds (with current fishing effort to the west of the survey area gradually moving in a southeast direction).

overlap with the commercial scallop fishery.		The White Ibis and Bass prospects are located in the southern-most permits (T/RL4 and T/RL5) and are the two prospects with the least seismic data available. The Rockhopper and Trefoil prospects on the other hand are better known because the Shearwater 3DMSS (see Section 3.3) covered these prospects. As such, not undertaking the MSS over the southern prospects means the objectives of the survey would not be fulfilled. Scallop fishers have advised Beach that the 50-55 m water depths are important to the fishery, and Beach changed the survey orientation and trimmed the survey outline to minimise the impact over the known fishing area.
Conduct the MSS outside the BSCZSF season (start of April to end of December).	Elimination	Scallop fishing occurs over 9 months of the year, overlapping five of the months (August to December) when the sea state in Bass Strait is most suitable for survey acquisition. Therefore, survey acquisition cannot entirely avoid part of the fishing season. The very short distance to the 'no effect' criterion threshold for scallops means that impacts to scallops and the fishery will be minor.
Conduct the MSS outside the spawning season for commercial scallops (start of June to the end of November).	Elimination	Scallop spawning is thought to occur over 6 months. This spawning season overlaps with at least four months of the year (August to November) when the sea state in Bass Strait is most suitable for survey acquisition. Therefore, the spawning season cannot be ruled out in terms of survey timing. Additionally, the short distance to effect to plankton means that impacts to scallop larvae will be minor.
Conduct the MSS only outside of the PBW migration and foraging season (December to April, with peak in February and March).	Substitution	There is little detail regarding the PBW migration season through central Bass Strait, though best estimates place it from December to April, varying annually depending on the timing of cold water upwellings off southeast South Australia and southwest Victoria. This migration overlaps with the months of August to March when the sea state in Bass Strait is most suitable for survey acquisition. The contracting process for survey vessels means that it is extremely difficult because they can be conducting surveys anywhere in the world; guaranteeing that a vessel will be available during a specific acquisition window is difficult at any time, even more so given the economic conditions created by the COVID-19 pandemic. Beach is aiming to conduct the Prion 3DMSS in the October to December window in order to avoid interactions with PBW (this also presents favourable sea state conditions), but flexibility in timing needs to be available to allow for the most suitable survey contracted to be contracted.
Undertake the survey using Marine Vibroseis methods to minimise sound energy through the water column.	Substitute	Beach is investigating the acquisition of a field trial using alternative marine source technology such as Marine Vibroseis and/or Distributed Source to: (1) Determine if these alternative source technologies can provide the required data quality to meet the technical objectives; (2) Determine the optimum parameters for their use; and (3) Acquire real world field data to calibrate the sound modelling of the SPL and SEL. Several contractors are working on each technology. Marine Vibroseis is still considered to be at prototype stage. Beach is in the process of determining which, if any, technology will be ready for an "in-sea" field trial in the rough waters of the Bass Strait. This has been complicated by the effect COVID-19 has had on the financial position of many of the contractors and the follow-on impact on research and development funding.

		There is not enough information about sound output for each and every technology to allow for underwater sound modelling to take place to inform the EIA required in an EP at this stage.
Use of PAM for the detection of cetaceans.	Engineering	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, although PAM can be a valuable tool in identifying the presence of cetaceans, the following factors limit its effectiveness: • 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. The use of experienced MMOs negates the need for using PAM given that LFC (which surface to breath more regularly that deeper-water MFC and HFC) will generally be able to be easily detected.
Use of greater whale observation, power-down and shut down zones at all times of the year.	Administrative	Central Bass Strait is not critical foraging, resting, breeding or calving habitat for the PBW, SRW, humpback whale or other threatened cetacean species; it essentially forms part the migration path of many cetaceans. This, combined with the low distances to behavioural, TTS and PTS threshold criteria means that the standard suite of EPBC Act Policy Statement 2.1 controls are sufficient to ensure cetacean protection.
Undertake aerial observations for whales during the survey.	Administrative	As above. Flights in small aircraft over open water introduce significant safety risks, and there is no guarantee that whales will be spotted. Previous spotter flights undertaken in Bass Strait have identified that the ability to detect cetaceans can be severely limited during: • Choppy sea states, when white caps make it extremely difficult to spot tell-signs of whale presence, • Calm conditions, when glare from the water can significantly reduce the ability to detect any features on the sea surface, and • Mists and fogs, which can severely reduce visibility. The speed and turning time of the aircraft make positive identification of potential sightings very challenging. Spotter flights are also unable to detect cetaceans that are not active on the ocean surface. Undertaking aerial spotter flights involves has a low likelihood of success and involves taking a high safety risk. This, combined with the high costs of spotter flights, means the risks and costs associated with this control are disproportionately high when considering the 'low' residual impact consequence for cetaceans.

Demonstration of Acceptability

The demonstration of acceptability has been presented on a fauna group basis and is not duplicated here.

Environmental Monitoring

- MMO observations from the survey vessel.
- MMO observations from a support vessel (where relevant).
- Pre-MSS scallop dredge (and post-MSS dredge depending on the pre-MSS dredge results).

- Underwater sound validation

Record Keeping	
• MMO CVs. • MMO daily reports. • MMO end-of-survey report. • MMO CSA data. • MMO induction presentation and sign-on sheets. • Pre-MSS scallop dredge report (and post-MSS dredge report, if applicable).	• Underwater sound validation report. • Daily operations reports. • *Fair Ocean Access* completed claims forms and correspondence. • List of nearby proposed and accepted MSS EPs. • Survey vessel PMS records.

7.2 IMPACT 2 – Routine Emissions - Light

7.2.1 Hazards

Light emissions will always occur from the source and support vessels. The following activities will result in artificial lighting:

- Vessel navigation lighting will be maintained while vessels are on location for maritime safety purposes and deck lighting for the safety of personnel working on deck.

7.2.2 Known and potential environmental impacts

The known and potential impacts of lighting are:

- Light glow may act as an attractant to light-sensitive species (e.g., seabirds, squid, zooplankton), in turn affecting predator-prey dynamics (due to attraction to or disorientation from light).

7.2.3 EMBA

The EMBA for light emissions associated with vessel activities is likely to be less than a 100 m radius of the vessel.

Light-sensitive receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Fish (e.g., squid); and
- Seabirds.

7.2.4 Evaluation of Environmental Impacts

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 vessel are not considered to be significantly different from these sources or make a significant additional contribution.

There are no turtle nesting beaches in Bass Strait, so impacts of light to turtles are not assessed here.

The distance of the closest point of the operational area from the nearest shoreline (29 km) and nearest town (Naracoopa, 78 km) means vessel lighting is not visible from land and therefore the impacts of light from the survey vessel to the public do not occur.

Light glow at the surface

Seabirds

Seabirds may be attracted to light glow at night time. 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 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). 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). The light may provide enhanced capability for seabirds to forage at night.

Migrating seabirds may be attracted by the lights of the survey vessel, which may result in drawing them off course from their usual migration path (DoEE, 2020). DoEE (2020) reports that petrel species in the Southern

Ocean may be unable to take off from a deck. There are no actions within the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-16 (DSEWPC, 2011a) that are compromised by light emissions associated with the MSS.

Due to the absence of bird breeding colonies within the survey area (it is 80 km east of little penguin, short-tailed shearwaters and black-faced cormorants on King Island, 29 km northeast of Important Bird Area (IBA) among the Hunter Island Group off the Tasmanian coastline and 83 km southwest of Curtis Island), light glow from small temporary light sources is unlikely to result in impacts at the species population level or ecosystem level.

Fish and plankton

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.

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 7.39 presents the impact assessment for light emissions.

Table 7.39.Impact assessment for light emissions

Summary		
Summary of impacts	Light glow may act as an attractant to light-sensitive species (e.g., seabirds, fish, zooplankton), in turn affecting predator-prey dynamics (due to attraction to or disorientation from light).	
Extent of impacts	Localised (small radius of light glow around each vessel).	
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 (inherent)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria

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.
Attraction to lights for birds and marine fauna is kept to a minimum.	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 where this is not possible, lights are switched off when not in use.
	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).	
	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 (residual)		
Minor		
Demonstration of ALARP		
A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.		

Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about light emissions.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The EPS outlined in this EP align with the requirements of: • *Navigation Act* 2012 (Cth): o Part 3 (Prevention of Collisions). o AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures). o AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment). o AMSA Marine Orders Part 30 (Prevention of Collisions).	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 mee 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 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	The four practices outlined in this document have been considered (and adopted where practicable) in the development

	geophysical and other imaging surveys (Nowacek & Southall, 2016)	of performance standards 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 are in accordance with 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: • To 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 5.5.1)	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.
	Ramsar wetlands (Section 5.5.4)	Localised light glow does not have any impacts on Ramsar wetlands.
	TECs (Section 5.5.6)	Localised light glow does not have any impacts on TECs.
	NIWs (Section 5.5.8)	Localised light glow does not have any impacts on NIWs.
	Nationally threatened and migratory species (Section 5.4)	Localised light glow does not have any impacts on threatened or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	Localised light glow does 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 sightings of vagrant turtles and absence of turtle BIAs and nesting beaches in Bass Strait. 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		
• Fauna interactions with lighting.		
Record Keeping		
• Vessel class certification		

7.3 IMPACT 3 – Routine Emissions - Atmospheric

7.3.1 Hazards

The following activities generate atmospheric emissions:

- Combustion of marine diesel from the vessel engines, generators and fixed and mobile deck equipment during the survey.

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 diesel combustion; and
- Addition of GHG to the atmosphere (influencing climate change).

7.3.3 EMBA

The EMBA for atmospheric emissions associated is the local air shed – likely to be within hundreds of metres of the survey 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 diesel combustion

The combustion of diesel fuel can create continuous or discontinuous plumes of particulate matter (soot or black smoke) and the emission of non-GHG, such as sulphur oxides (SO_X) and nitrous oxides (NO_X). 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 amount 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.

Particulate matter released from the source and support vessels is not likely to impact on the health or amenity of the nearest human coastal settlements (e.g., Stanley and Naracoopa), 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 carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). While these emissions add to the GHG load in the atmosphere, which adds to global warming potential, they are relatively small on a global scale, representing an insignificant contribution to overall GHG emissions. The activity is similar to other industrial activities contributing to the accumulation of GHG in the atmosphere.

7.3.5 Impact Assessment

Table 7.40 presents the impact assessment for atmospheric emissions.

Table 7.40. Impact assessment from 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 climate change).	
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 (inherent)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
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 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.	Air Pollution Prevention Certificate (IAPP) 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	ODS record book is available and current.

	managed to minimise Ozone Depleting Substances (ODS).	
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 vessel.	Only a MARPOL VI-approved incinerator is used to incinerate solid combustible waste (food waste, paper, cardboard, rags, plastics).	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.
	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.

Impact Consequence (residual)
Minor
Demonstration of ALARP
A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.

Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about atmospheric emissions.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The performance standards outlined in this EP align with the requirements of: • *Navigation Act* 2012 (Cth): o Chapter 4 (Prevention of Pollution). o AMSA Marine Order Part 79 (Marine pollution prevention – air pollution). • *Protection of the Sea (Prevention of Pollution by Ships) Act 1983* (Cth): o Part IIID (Prevention of Air Pollution). o AMSA Marine Orders Part 97 (Air Pollution), enacting MARPOL Annex VI (especially Regulations 6, 14, 16). • *National Greenhouse and Energy Reporting Act* 2007 (Cth).	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 listed in this table meet the relevant mitigation measures listed for offshore activities with regard to: • Section 4.4.3 - Combustion emissions;

		o Use of high efficiency equipment to minimise power demand. o Selection of low sulphur diesel. o Regular plant maintenance. o Regular maintenance and emission control devices on vehicles and machinery.
	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 or 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 have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met 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)	Guidelines met 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)	Objectives regarding atmospheric emissions from offshore geophysical surveys are: • To reduce GHG emissions to ALARP and an acceptable level. The performance standards listed in this table meet these objectives.
Environmental context	MNES	
	AMPs (Section 5.5.1)	Atmospheric emissions do not directly affect nearby AMPs. See **Appendix 1** for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Ramsar wetlands (Section 5.5.4)	Atmospheric emissions do not directly affect any Ramsar wetlands.
	TECs (Section 5.5.6)	Atmospheric emissions do not directly affect any TECs.
	NIWs (Section 5.5.8)	Atmospheric emissions do not directly affect any NIWs.

	Nationally threatened and migratory species (Section 5.4)	Atmospheric emissions do not directly affect threated or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	Atmospheric emissions do 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

- Vessel PMS records.
- Vessel fuel use records.
- Vessel 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 Hazards

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 POB at any time, and the types of meals prepared. However, some anecdotal reports estimate this volume to be in the order of 1-2 kg per person per day (NERA, 2018).

7.4.2 Known and potential environmental impacts

The known and potential environmental impacts of putrescible waste discharges are:

- Temporary and localised increase in the nutrient content of 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 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, Western Australia).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Pelagic fauna (plankton, fish, cetaceans, pinnipeds); 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. This in turn acts as 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, and its physical and microbial breakdown, ensures that the impacts of such discharges are insignificant.

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 7.41 presents the impact assessment for putrescible waste discharges.

Table 7.41. Impact assessment for putrescible waste discharges

Summary		
Summary of impacts	Increase in nutrient content of near-surface waters around the discharge point, which may lead to an increase of scavenging behaviour of pelagic fish and seabirds.	
Extent of impacts	Localised – up to 100 m horizontally and 10 m vertically from the discharge point.	
Duration of impacts	Intermittent and temporary – until the discharge is completely diluted (likely to be several hours).	
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 (inherent)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
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 vessels, 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.
	Waste management and housekeeping requirements are communicated to all personnel boarding the vessels to ensure discharges are in accordance with MARPOL Annex V.	Vessel induction includes waste management requirements.
	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 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 shoreline.	
	For vessels without a macerator and for non-putrescible galley waste, waste is returned to shore for disposal.	
Impact Consequence (residual)		
Minor		
Demonstration of ALARP		
A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.		
Demonstration of Acceptability		

Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about putrescible waste discharges.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The performance standards outlined in this EP align with the requirements of: • *Navigation Act* 2012 (Cth): o Chapter 4 (Prevention of Pollution). o AMSA Marine Order 95 (Marine Pollution Prevention - garbage). • *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth): o Section 26F (which implements MARPOL Annex V).	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 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.
	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: • Environmental monitoring (item 26). The BAT are met for the survey with regard to monitoring waste streams.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met 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 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: • To reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.5.1)	Putrescible waste discharges will not impact the conservation values of nearby AMPs. See **Appendix 1** for additional detail regarding the impacts of routine activities on the management aims of these AMPs.

	Ramsar wetlands (Section 5.5.4)	Putrescible waste discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.5.6)	Putrescible waste discharges will not intersect any TECs.
	NIWs (Section 5.5.8)	Putrescible waste discharges will not intersect any NIWs.
	Nationally threatened and migratory species (Section 5.4)	Putrescible waste discharges do not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	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 matrix. • Induction records.		

7.5 IMPACT 5 – Routine Discharges - Sewage and Grey Water

7.5.1 Hazards

The use of ablution, laundry and galley facilities by vessel crews will result in the discharge of sewage and grey water. While the number of personnel onboard the vessel/s at any one point in time is currently unknown, this activity will result in the discharge of several hundred litres of treated sewage and greywater each day.

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 content of surface waters around the vessels.

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:

- Pelagic fauna (plankton, fish, cetaceans and pinnipeds); 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, eutrophication of receiving waters will not occur. Sewage will be treated through STPs to a tertiary level, so there are no impacts relating to the release of chemicals and pathogens in untreated sewage.

Grey water can contain a wide variety of pollutant substances at different strengths, including oil and some organic compounds, hydrocarbons, detergents and grease, metals, suspended solids, chemical nutrients, food waste, coliform bacteria and some medical waste. Grey water is treated through the STP, so pollutants will be largely removed from the discharge stream.

The effects of sewage and sullage discharges on the water quality at Scott Reef were monitored for a drill rig operating near the edge of the deep-water lagoon area at South Reef. Monitoring at stations 50 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 is unlikely to lead to oxygen depletion of the receiving waters (Black *et al*., 1994), as it will be treated prior to release. On release, surface water currents will assist with oxygenation of the discharge.

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 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 7.42 presents the impact assessment for the discharge of treated sewage and grey water.

Table 7.42. 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 completely diluted (likely to be minutes to hours).	
Level of certainty of impact	HIGH – the impacts of 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 (inherent)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Sewage and grey water is treated prior to overboard	Where sewage is treated in a STP, the STP meets MARPOL standards.	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.
There is no discharge of treated or untreated sewage and grey water in state waters (<3 nm from shore).	In accordance with Regulation 11 of MARPOL Annex IV (as enacted by Marine Order 96), sewage is comminuted, disinfected and only discharged when: • Vessel is >3 nm from nearest land. • Sewage originating in holding tanks is discharged at a moderate rate while the vessel is proceeding en route at a speed not less than 4 knots.	Records verify that treated sewage is only discharged when the vessel is >3 nm from shore.
Untreated sewage will only be discharged when the vessel is greater than 12 nm from shore.	In the event of a STP malfunction, untreated sewage and grey water is only discharged when the vessel is greater than 12 nm from shore in accordance with Regulation 11 of MARPOL Annex IV (enacted by AMSA Marine Orders Part 96, Sewage).	Survey-specific discharges and emissions register verifies that untreated sewage is only discharged when the vessel is greater than 12 nm from shore.
Impact Consequence (residual)		
Minor		
Demonstration of ALARP		
A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.		

Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about sewage and grey water discharges.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The performance standards outlined in this EP align with the requirements of: • *Navigation Act* 2012 (Cth): o Chapter 4 (Prevention of Pollution). o AMSA Marine Order 95 (Marine Pollution Prevention - sewage). • *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth): o Section 26D (which implements MARPOL Annex IV).	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met 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: • To reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.5.1)	Sewage and grey water discharges will not impact the conservation values of nearby AMPs. See **Appendix 1** for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Ramsar wetlands (Section 5.5.4)	Sewage and grey water discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.5.6)	Sewage and grey water discharges will not intersect any TECs.
	NIWs (Section 5.5.8)	Sewage and grey water discharges will not intersect any NIWs.
	Nationally threatened and migratory species (Section 5.4)	Sewage and grey water discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	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 Hazard

Seawater is used as a heat exchange medium for cooling machinery engines on vessels. Brine is created through the desalination processes for potable water generation. 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 (not at surface). 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).

Brine water (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 seawater with a slightly elevated salinity (~10-15% higher than seawater). The freshwater produced is then stored in tanks on board. Upon discharge, the concentration of the brine is (based on other modern vessels) likely to range from 44-61 ppm, which is 9-26 ppm higher than seawater salt concentration (35 ppm). Brine concentration is dependent on throughput and plant efficiency.

7.6.2 Known and potential environmental impacts

The known and potential environmental impacts of cooling water and brine discharges are:

- Temporary and very localised increase in sea water temperature, causing thermal stress to marine biota;
- Temporary and very localised increase in sea surface salinity, potentially causing harm to fauna unable to tolerate higher salinity; and
- Potential toxicity impacts to marine fauna from the ingestion of 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; 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.

Modelling of continuous waste water discharges (including cooling water) undertaken by Woodside for its Torosa South-1 drilling program in the Scott Reef complex 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). As such, impacts to most receptors are expected to be negligible even within this 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, 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 and degrade rapidly and are very 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 7.43 presents the impact assessment for the discharge of cooling and brine water.

Table 7.43. 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 during vessel operations.	
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 (inherent)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
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.
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 (residual)		
Minor		
Demonstration of ALARP		
A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.		

Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about cooling and brine water discharges.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	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.	

(see Sections 2.7 & 2.8 for descriptions)	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 have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met 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: • To reduce the volume of wastes produced to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.5.1)	Cooling and brine water discharges will not impact the conservation values of nearby AMPs. See **Appendix 1** for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Ramsar wetlands (Section 5.5.4)	Cooling and brine water discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.5.6)	Cooling and brine water discharges will not intersect any TECs.
	NIWs (Section 5.5.8)	Cooling and brine water discharges will not intersect any NIWs.

	Nationally threatened and migratory species (Section 5.4)	Cooling and brine water discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	Cooling and brine water discharges will not impact the conservation values of nearby AMPs. 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 (vessel) records. • Chemical inventories.		

7.7 IMPACT 7 – Routine Discharges - Bilge Water and Deck Drainage

7.7.1 Hazard

Bilge tanks on the vessels receive fluids from closed deck drainage and machinery spaces that may contain contaminants such as oil, detergents, solvents, chemicals and solid waste. An oily water separator (OWS) then treats 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, 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 capturing trace quantities of contaminants such as oil, grease and detergents, or a chemical (e.g., hydraulic fluids, lubricating oils) or hydrocarbon spill or leak washed overboard.

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 around the discharge point;
- Acute toxicity to marine fauna through ingestion of contaminated water in a small mixing zone.

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; 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 a very small mixing zone (as per the EMBA).

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 of off specification water, toxicity impacts may occur, though this is only likely in a highly localised mixing zone (meaning that few individuals would be exposed).

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 7.44 presents the impact assessment for the discharge of bilge water and deck drainage.

Table 7.44. Impact assessment for the discharge of bilge water and deck drainage

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	Intermittent during vessel operations.
Level of certainty of impacts	HIGH – the impacts of oily water discharges to the ocean 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 (inherent)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
Bilge water discharges comply with MARPOL Annex I requirements.	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.	IOPP certificate is current.
	The OWS is maintained in accordance with the vessel PMS.	PMS records verify that the OWS is maintained to schedule.
	The OWS is calibrated in accordance with the vessel PMS to ensure the 15 ppm OIW limit is met.	PMS records verify that the OWS is calibrated to schedule.
No whole residual bilge oil is discharged overboard.	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.
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.	Training records verify that vessel crews receive spill response training.
	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.	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.
Impact Consequence (residual)		
Minor		
Demonstration of ALARP		

A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.

Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about bilge water and deck drainage discharges.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The performance standards outlined in this EP align with the requirements of: • *Navigation Act* 2012 (Cth): o Chapter 4 (Prevention of Pollution). o AMSA Marine Order 91 (Marine Pollution Prevention - oil). • *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth): o Part II (Prevention of pollution by oil). o Part III (Prevention of pollution by noxious substances).	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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	The EPS listed in this table meet these guidelines for offshore activities with regard to:

	Exploration and Production (European Commission, 2019)	• Management of drain water (item 24). The BAT are met for vessel operations with regard to 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 have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met 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)	Guidelines met 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: • To reduce the risk of release of substances into the marine environment to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.5.1)	Bilge water and deck drainage discharges will not impact the conservation values of nearby AMPs. See **Appendix 1** for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Ramsar wetlands (Section 5.5.4)	Bilge water and deck drainage discharges will not intersect any Ramsar wetlands.
	TECs (Section 5.5.6)	Bilge water and deck drainage discharges will not intersect any TECs.
	NIWs (Section 5.5.8)	Bilge water and deck drainage discharges will not intersect any NIWs.
	Nationally threatened and migratory species (Section 5.4)	Bilge water and deck drainage discharges will not have any significant impacts on threated or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	Bilge water and deck drainage 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.
- IOPP certificate.
- Oil Record Book.
- Crew training records.
- Inspection and checklist records.
- P&IDs.
- SDS (for deck cleaning agents).
- Incident reports.
- SMPEP.

7.8 IMPACT 8 – Seabed Disturbance

7.8.1 Hazard

The only activity that will result in seabed disturbance is the deployment and retrieval of several underwater sound loggers on the seabed (that will measure ambient sound before or after the MSS, and sound in the water column and particle motion at the seabed during the MSS, see Section 8.19).

The loggers comprise a bottom plate that is in contact with the seabed (typically no more than 1 m x 1 m in size) and is likely to include a small anchor (generally in the form of dumbbells, ~20 kg) and associated short anchor line (~100 m long).

The sound loggers do not contain chemicals or hydraulic fluids, and batteries are stored in a pressure housing, so there is no risk of hazard substances being released from the sound loggers.

Other activities that may result in seabed disturbance but are not assessed because the events were determined as not credible are vessel grounding (deep waters with no emergent features), lost objects such as streamers (SRDs attached) and anchoring (will not occur in survey area).

7.8.2 Known and potential environmental impacts

The known and potential environmental impacts of this localised seabed disturbance are:

- Temporary and localised turbidity of water near the seabed during deployment and retrieval; and
- Displacement of a small area of seabed habitat by the bottom plates and anchors.

7.8.3 EMBA

The EMBA for seabed disturbance will be in the immediate vicinity of each sound logger (a few metres).

In addition to the quality of the receiving waters, receptors that may occur within this EMBA, either as residents or migrants, are:

- Plankton;
- Demersal fish; and
- Benthic invertebrates.

7.8.4 Evaluation of Environmental Impact

Water turbidity

Turbidity occurs when seabed sediments are stirred up and is likely to result from deployment/retrieval of the sound logger bottom plate assembly, weights and ground line. The sediments mapped in the survey area are classified as fine, medium, coarse and very coarse sands (see Figure 5.7), so these sediments will rapidly suspend in the water column when disturbed.

Given the small size of the disturbed area (1 m^2 for the bottom plate, <1 m^2 for the anchor and < 1m^2 for the ground line), the turbidity created will result in a small plume of disturbed sediments that are within the limits of natural variability when considering the turbidity created by ocean bottom currents. Benthic fauna living in sediment (endobenthos) or on sediment (epibenthos) may be temporarily displaced by this turbidity.

Surveys of seabed disturbance from anchoring activities indicate that recovery of benthic fauna in soft sediment substrates (such as those that dominates the survey area) occurs between 6 to 12 months after the disturbance was created (URS, 2001). The anchor depression acts as a trap for marine detritus and sand, which will quickly fill and be recolonised by benthic organisms (Currie and Isaac, 2005). The area impacted by small anchors that barely penetrate the seabed will not pose a threat to seabed habitats or fauna communities.

Displacement of seabed habitat

The sound logger base plates and anchors will temporarily smother benthic habitat and fauna in very small isolated locations. There are no mapped areas of seabed sensitivity in the survey area (e.g., rocky reefs, sponge gardens, canyons, etc). In the context of the abundance of similar habitat surrounding the logger locations, benthic fauna will rapidly return to recolonise these disturbed sites, resulting in no long-term impacts.

7.8.5 Impact Assessment

Table 7.45 presents the impact assessment for seabed disturbance.

Table 7.45. Impact assessment for seabed disturbance

Summary		
Summary of impacts	Localised and temporary water turbidity near the seabed. Localised and temporary seabed habitat smothering.	
Extent of impacts	Localised – a few metres at each sound logger location.	
Duration of impacts	Temporary – duration of the survey.	
Level of certainty of impacts	HIGH – the impacts of disturbance to seabed sediments 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 (inherent)		
Minor		
Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria

Deployment and retrieval of the sound loggers results in no permanent seabed habitat damage.	Geographic coordinates are noted for the locations of the deployed sound loggers in order to facilitate ease of relocating for later retrieval.	Geographic coordinates are noted for the locations of the deployed sound loggers.

Impact Consequence (residual)		
Minor		
Demonstration of ALARP		
A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.		
Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about bilge water and deck drainage discharges.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	There is no legislation associated with seabed disturbance for the purposes of temporary sound logger deployment.	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 marine use (physical disturbance) in Section 4.3.2 of the guidelines: • Consider sensitive marine habitats. • Reduce footprint.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	There is no guidance in these guidelines regarding seabed disturbance.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards 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 is no guidance in these guidelines regarding seabed disturbance.

	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	There is no guidance in these guidelines regarding seabed disturbance.
	APPEA CoEP (2008)	The EPS listed in this table meet the following offshore geophysical survey objectives: • To reduce the impacts to benthic communities to ALARP and to an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.5.1)	Seabed disturbance in the survey area will not impact the conservation values of nearby AMPs. See **Appendix 1** for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Ramsar wetlands (Section 5.5.4)	Seabed disturbance in the survey area will not impact any Ramsar wetlands.
	TECs (Section 5.5.6)	Seabed disturbance in the survey area will not impact any TECs.
	NIWs (Section 5.5.8)	Seabed disturbance in the survey area will not impact any NIWs.
	Nationally threatened and migratory species (Section 5.4)	Seabed disturbance in the survey area will not impact any threated or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	Seabed disturbance in the survey area will not impact 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		
• Sound logger locations (geographic coordinates).		

The following sections assess environmental risks (i.e., from unplanned events that may happen), presented pictorially in Figure 7.11.

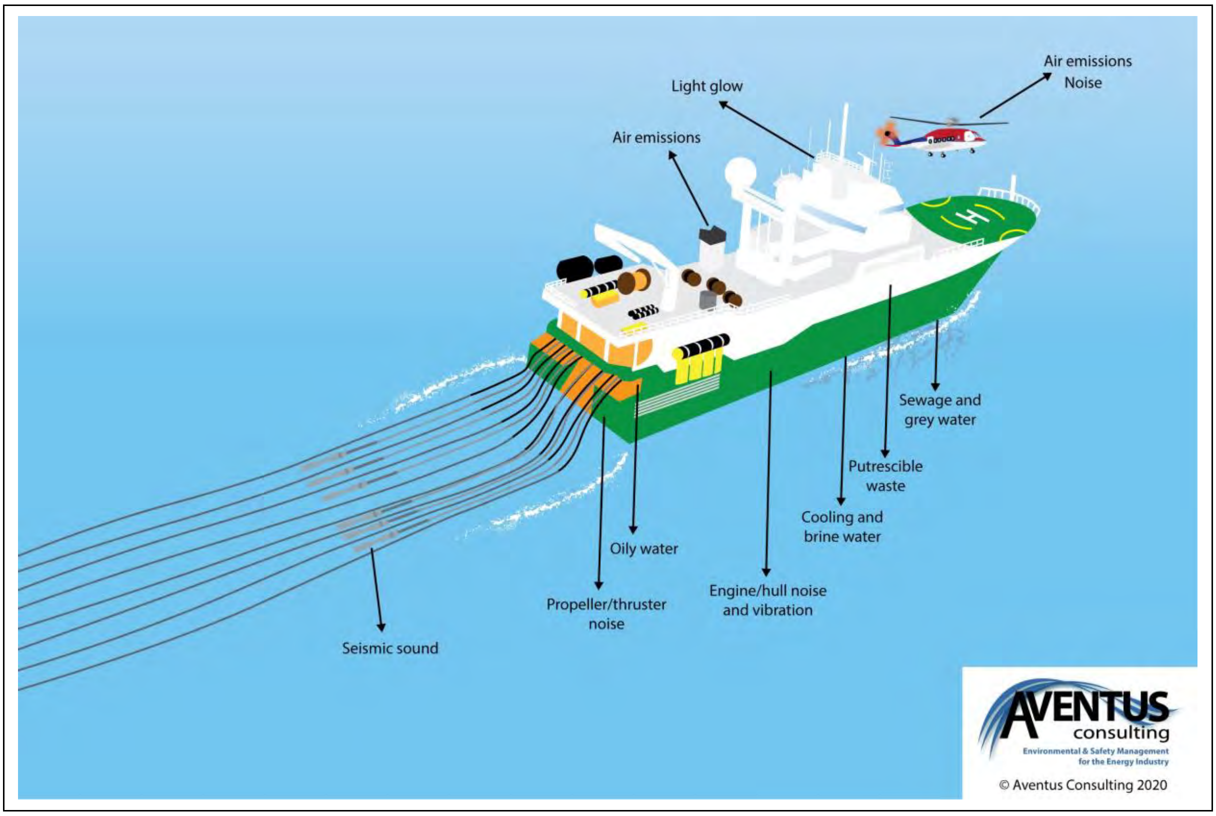


Figure 7.11. Simplified pictorial representation of risks that may arise from the survey

7.9 RISK 1 – Displacement of or Interference with Third-party Vessels

7.9.1 Hazard

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 commercial fishing vessels and merchant vessels.

Note, this section deals with interference in a socio-economic sense; collision hazards (and subsequent MDO spill impacts) are addressed in Section 7.12.

7.9.2 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; and
- Damage to or loss of fishing equipment and/or loss of commercial fish catches.

7.9.3 EMBA

The EMBA for the displacement or interference with third-party vessels is anywhere within the operational area (wherever vessel movements occur), and more specifically the immediate around the two intersecting vessels.

Receptors in the EMBA include:

- Passenger ferries;

- Commercial fishing vessels;
- Recreational vessels (e.g., yachts); and
- Merchant vessels.

7.9.4 Evaluation of environmental risks

Displacement of third-party vessels

The presence of the survey vessel (with trailing equipment) (and to a lesser extent, the support vessels) will temporarily exclude other users of the marine environment in order to protect the streamers. The operational intersects the 'Spirit of Tasmania' ferry route and merchant shipping routes (see Section 5.7.7 and Figure 5.52). Given the inability of the survey vessel to take sudden evasive action with streamers trailing, it is likely that the support vessels would engage the merchant vessel to change course. This is likely to result in a negligible increase in travel time and fuel cost for the merchant vessels, but in the content of an entire journey, this is considered to be of minor consequence.

The consequence of displacing other users, such as commercial and/or recreational fishers, is considered minor given the sparse use of the area by fishers (see Section 5.7.6).

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 vessel and the low speed or stationary nature of the support 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 within 6 nm (11 km) of the survey vessel for the duration of the survey so as to avoid damage to the towed equipment (principally airguns and streamers). 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.

7.9.5 Risk Assessment

Table 7.46 presents the risk assessment for displacement or interference with third-party vessels.

Table 7.46. Risk assessment for displacement or interference with third-party vessels.

Summary	
Summary of impacts	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 impacts	Highly localised (immediately around vessels).

Duration of impacts	Short-term (minutes for a third-party vessel detour) to long-term (vessel collision).		
Level of certainty of impacts	HIGH – the impacts associated with vessel collisions 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 (inherent)			
Risk	Likelihood	Consequence	Risk rating
Displacement	Almost certain	Minor	Medium
Interference	Possible	Moderate	Medium
Environmental Controls and Performance Measurement			
EPO	EPS	Measurement criteria	
No incidents or complaints of spatial conflict with third-party vessels or fishing equipment.	Beach 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.	
	The AHO will be notified of survey activities at least 30 days 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.	
	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.	
	Constant communication between the survey vessel and support vessels is maintained to ensure that the support vessels are patrolling the safety exclusion zone (defined as a 6 nm [11 km] radius around the survey vessel and streamers) at all times.	Daily operations reports verify that the support vessels are patrolling the safety exclusion zone.	

	The tailbuoys on the seismic streamers will have flashing lights and radar reflectors so they are visible to other marine users. The survey vessel(s) will display the appropriate lights and day shapes for a vessel with restricted ability to manoeuvre during survey operations.	Visual confirmation (and associated completed checklists) verifies that these measures are in place during survey acquisition.
	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) at all times 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.
Vessel-to-vessel collisions are managed in accordance with vessel-specific emergency procedures.	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.
	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.

Impact Consequence (residual)

Risk	Likelihood	Consequence	Risk rating
Displacement	Unlikely	Minor	Low
Interference	Highly unlikely	Moderate	Low

Demonstration of ALARP

A 'minor' residual impact consequence is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.

Demonstration of Acceptability

Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. A summary of relevant engagement with stakeholders regarding displacement or interference with third-party vessels is presented in Chapter 4.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The EPS outlined in this table align with the requirements of: • OPGGS Act 2006 (Cth). o 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). • *Navigation Act* 2012 (Cth). o Chapter 6 (Safety of navigation), particularly Part 3 (Prevention of collisions). o AMSA Marine Orders Part 21 (Safety of Navigation and Emergency Procedures). o AMSA Marine Orders Part 27 (Safety of Navigation and Radio Equipment).	

	o AMSA Marine Order Part 30 (Prevention of Collisions).	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards 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 specifically regarding physical presence for marine seismic survey vessels.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013).	Guidelines met 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: • To 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.
Environmental context	MNES	
	AMPs (Section 5.5.1)	This hazard will not intersect nearby AMPs. See **Appendix 1** for additional detail regarding the impacts of routine activities on the management aims of these AMPs.
	Ramsar wetlands (Section 5.5.4)	This hazard will not intersect any Ramsar wetlands.
	TECs (Section 5.5.6)	This hazard will not intersect any TECs.

	NIWs (Section 5.5.8)	This hazard will not intersect any NIWs.
	Nationally threatened and migratory species (Section 5.4)	This hazard will not have any impacts on threatened or migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	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/ 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

- Continuous bridge monitoring.

Record Keeping

- Stakeholder consultation communication records.
- Notice to Mariners.
- Auscoast warnings.
- Bridge communication logs.
- Crew qualifications.
- Incident reports.

7.10 RISK 2 - Accidental Discharge of Waste to the Ocean

7.10.1 Hazard

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, waste, chemicals and fuel, 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.

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 or crane operator error:

- 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.

7.10.2 Potential environmental risks

The risks of the release of hazardous and non-hazardous materials and waste to the ocean are:

- Marine pollution (littler and a temporary and localised reduction in water quality);
- Acute toxicity to marine fauna through ingestion or absorption;
- Injury and entanglement of individual animals (such as seabirds and seals); and
- Localised (and normally temporary) smothering or pollution of benthic habitats.

7.10.3 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; 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 four turtle species (loggerhead, green, leatherback and hawksbill);
- Eight albatross species and three petrel species;
- Other birds (flesh-footed shearwater, southern fairy prion);
- Australian fur-seal;
- Indian Ocean bottlenose dolphin; and
- The SRW, PBW, humpback, sei, pygmy right and killer whales.

7.10.4 Evaluation of Environmental Risks

Non-hazardous Materials and Waste

If discharged overboard, non-hazardous 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 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 skip 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. 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. Seabed substrates can rapidly recover from temporary and localised impacts.

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 chemical 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 temporary and localised. The absence of particularly sensitive seabed habitats and the widespread nature of the sandy seabed present in the activity area further limits the extent of potential impacts.

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 is likely to result in a small area of 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.

All hazardous waste is disposed of at appropriately licensed facilities, by licenced contractors, so impacts such as illegal dumping or disposal to an unauthorised onshore landfill that is not lined are highly unlikely to result from the survey.

7.10.5 Risk Assessment

Table 7.47 presents the risk assessment for the accidental disposal of hazardous and non-hazardous materials and waste.

Table 7.47. Risk assessment for the unplanned discharge of solid or hazardous waste to the marine environment.

<table>
<tr><th colspan="3">Summary</th></tr>
<tr><td>Summary of risk</td><td colspan="2">Marine pollution (litter and a temporary and localised reduction in water quality), injury and entanglement of individual animals (such as seabirds and seals) and smothering or pollution of benthic habitats.</td></tr>
<tr><td>Extent of risks</td><td colspan="2">Non-buoyant waste may sink to the seabed near where it was lost. Buoyant waste may float long distances with ocean currents and winds.</td></tr>
<tr><td>Duration of risks</td><td colspan="2">Short-term to long-term, depending on the type of waste and location.</td></tr>
<tr><td>Level of certainty of risk</td><td colspan="2">HIGH – the effects of inappropriate waste discharges are well known.</td></tr>
<tr><td>Risk 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">Risk Assessment (inherent)</th></tr>
<tr><td>Likelihood</td><td>Consequence</td><td>Risk rating</td></tr>
<tr><td>Possible</td><td>Moderate</td><td>Medium</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 rowspan="5">No unplanned release of hazardous or non-hazardous solid wastes or materials.</td><td>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.</td><td>A GMP is in place, readily available on board and kept current.</td></tr>
<tr><td rowspan="4">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.</td><td>GMP is available and current.</td></tr>
<tr><td>Inspections verify that waste is stored and handled according to its waste classification.</td></tr>
<tr><td>Inspections verify that waste receptacles are properly located, sized, labelled, covered and secured for the waste they hold.</td></tr>
<tr><td>A licensed shore-based waste contract is in place for the management of onshore waste transport and disposal.</td></tr>
</table>

	• Correct segregation of solid and hazardous wastes.	
	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.
	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.
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 deployment of streamer and source equipment so that damage to (and potential loss of) equipment caused by rough seas is avoided.	Daily reports record weather conditions and verify that streamers are not deployed during rough seas.
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 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.
	The crane handling and transfer procedure is in place and implemented by crane operators (and others, such as dogmen) to prevent dropped objects.	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.
	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 PTW.	PTW records verify that crane transfers of bulk chemicals and hydrocarbons are undertaken in accordance with the procedure.

Risk Assessment (residual)		
Likelihood	Consequence	Risk rating
Highly unlikely	Moderate	Low

Demonstration of ALARP

A 'low' residual risk rating is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.

Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about accidental waste releases.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The performance standards outlined in this EP align with the requirements of: • *Navigation Act* 2012 (Cth): o Chapter 4 (Prevention of Pollution). o Marine Orders Part 47. o Marine Orders Part 94 (Marine pollution prevention – packaged harmful substances). o Marine Orders Part 95 (Marine pollution prevention – garbage). • *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 (Cth): o Part III (Prevention of pollution by noxious substances). o Part IIIA (Prevention of pollution by packaged harmful substances). o Part IIIC (Prevention of pollution by garbage).	

Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 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.
	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: • 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.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met 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)	Guidelines met with regard to: • Section 8.5 (Waste management): Measures for managing waste are addressed through the performance standards, mainly through the requirement for a GMP. • Section 8.6 (Hazardous materials): Stipulations that fuel and oils are stored in appropriate areas are addressed in the performance standards.
	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 as low as reasonably practical 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.

<table>
<tr><td rowspan="11">Environmental context</td><td colspan="2">MNES</td></tr>
<tr><td>AMPs
(Section 5.5.1)</td><td>The unplanned discharge of solid or hazardous waste is highly unlikely to intersect nearby AMPs.
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.</td></tr>
<tr><td>Ramsar wetlands
(Section 5.5.4)</td><td>The unplanned discharge of solid or hazardous waste is highly unlikely to reach Ramsar wetlands.</td></tr>
<tr><td>TECs
(Section 5.5.6)</td><td>The unplanned discharge of solid or hazardous waste is highly unlikely to reach any TECs.</td></tr>
<tr><td>NIWs
(Section 5.5.8)</td><td>The unplanned discharge of solid or hazardous waste is highly unlikely to reach any NIWs.</td></tr>
<tr><td>Nationally threatened and migratory species
(Section 5.4)</td><td>The unplanned discharge of solid or hazardous waste is highly unlikely to have any impacts on threated or migratory species.</td></tr>
<tr><td colspan="2">Other matters</td></tr>
<tr><td>State marine parks
(Sections 5.5.9 & 5.5.10)</td><td>The unplanned discharge of solid or hazardous 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.</td></tr>
<tr><td>Species Conservation Advice/ Recovery Plans/
Threat Abatement Plans</td><td>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.</td></tr>
<tr><td>ESD principles</td><td colspan="2">The EIA presented throughout this EP demonstrates that ESD principles (a), (b), (c) and (d) are met (noting that principle (e) is not relevant).</td></tr>
<tr><td colspan="3">Environmental Monitoring</td></tr>
<tr><td colspan="3">• Waste tracking.</td></tr>
</table>

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.

7.11 RISK 3 – Vessel Collision with Megafauna

7.11.1 Hazard

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, this being cetaceans and pinnipeds.

7.11.2 Potential environmental risks

The risks of vessel strike with megafauna are:

- Injury; and
- Death.

7.11.3 EMBA

The EMBA for megafauna vessel strike or entanglement with streamers is the immediate area around the vessel and towed streamers.

Receptors most at risk within this EMBA are:

- Cetaceans (whales and dolphins); and
- Pinnipeds (fur-seals).

7.11.4 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).

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 (see Section 5.4.5).
- 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 5.4.5).
- 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 operational 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 survey area, they will be travelling very slowly or will be stationery, so the risk associated with fast moving vessels is eliminated for this activity.

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 an almost negligible risk of this occurring to megafauna with tethered ROVs as the tethers are likely to break under the weight of entanglement. The Australian and New Zealand fur-seals are highly agile species that haul themselves onto rocks and platform jackets. As such, it is likely that they will be able to avoid towed equipment and are unlikely to become entangled within them.

The survey vessel will be travelling at a maximum of about 4.5 knots (8.3 km/hr) while acquiring seismic data (with the support vessels generally travelling at a similar speed or remaining stationary for long periods), thus minimising the risk of injury to megafauna. 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, and the lack of a defined migration route for pygmy blue whales in central Bass Strait makes it even more 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 about 75 m).

7.11.5 Risk Assessment

Table 7.48 presents the risk assessment for vessel collision with megafauna.

Table 7.48. Risk assessment for vessel collision with megafauna

Summary	
Summary of risks	Injury or death of cetaceans and/or pinnipeds.
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 (inherent)			
Risk	Likelihood	Consequence	Risk rating
Individual animal	Unlikely	Moderate	Medium
Population level	Unlikely	Minor	Low

Environmental Controls and Performance Measurement		
EPO	EPS	Measurement criteria
No injury or death of megafauna as a result of vessel strike or entanglement with subsea equipment.	Through constant bridge 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. • 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.	Daily operations reports note when cetaceans and pinnipeds were sighted and what actions were taken to avoid collision or entanglement.
	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	Risk rating
Individual animal	Highly unlikely	Moderate	Low
Population level	Highly unlikely	Minor	Low

Demonstration of ALARP

A 'low' residual risk rating is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.

Demonstration of Acceptability

Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about collisions with megafauna.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The performance standards outlined in this EP align with the requirements of: • *EPBC Act* 1999 (Cth): o Section 199 (failing to notify taking of listed species or listed ecological community). • EPBC Regulations 2000 (Cth): o Part 8 (Interacting with cetaceans and whale watching). o AMSA Marine Notice 2016/15 – Minimising the risk of collisions with cetaceans.	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 3.4) have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013)	Guidelines met 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: • To 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 Cetaceans and other Marine Megafauna (DoEE, 2017).	The EPS listed in this table are aligned with objective 3 of this strategy, which is to reduce the likelihood and severity of megafauna vessel collisions.
Environmental context	MNES	
	AMPs (Section 5.5.1)	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.
	Ramsar wetlands (Section 5.5.4)	The risk of collisions with megafauna does not have any effect on Ramsar wetlands.
	TECs (Section 5.5.6)	The risk of collisions with megafauna does not have any effect on TECs.
	NIWs (Section 5.5.8)	The risk of collisions with megafauna does not have any effect on NIWs.
	Nationally threatened and migratory species (Section 5.4)	The low speed of the source and support vessels, along with the temporary nature of the survey, 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 5.5.9 & 5.5.10)	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.

7.12 RISK 4 - Introduction and Establishment of Invasive Marine Species

7.12.1 Hazards

The 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 containing foreign species; 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 source and support vessels undertaking inspection and maintenance activities 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 one 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.

7.12.2 Potential environment risks

The risks of IMS introduction (assuming their survival, colonisation and spread) include:

- Reduction in native marine species diversity and abundance;

- Displacement of native marine species;
- Depletion of commercial fish stocks (and associated socio-economic effects); and
- Changes to conservation values of protected areas.

7.12.3 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.

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 fish.

7.12.4 Evaluation of Environmental Risks

Successful IMS invasion requires the following three steps:

1. Colonisation and establishment of the marine pest on a vector (e.g., vessel hull) in a donor region (e.g., home port).
2. Survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g., activity area).
3. 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 intake pipes. 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 Table 7.16 and will begin with a pre-qualification undertaken by the new vessel contractor prior to charter in order to determine that its biofouling and ballast water controls meet the requirements of this EP.

7.12.5 Risk Assessment

Table 7.49 presents the risk assessment for the introduction of IMS.

Table 7.49. Risk assessment for the introduction of IMS

<table>
<tr><th colspan="3">Summary</th></tr>
<tr><td>Summary of risks</td><td colspan="2">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.</td></tr>
<tr><td>Extent of risk</td><td colspan="2">Localised (isolated locations if there is no spread) to widespread (if colonisation and spread occurs).</td></tr>
<tr><td>Duration of risk</td><td colspan="2">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).</td></tr>
<tr><td>Level of certainty of risk</td><td colspan="2">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.</td></tr>
<tr><td>Risk 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">Risk Assessment (inherent)</th></tr>
<tr><td>Likelihood</td><td>Consequence</td><td>Risk rating</td></tr>
<tr><td>Unlikely</td><td>Major</td><td>Medium</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>Vessels used to undertake the survey do not introduce IMS.</td><td>A pre-qualification is undertaken for all new vessel contractors against Beach's Introduced Marine Species Management Plan ((IMSMP) S4000AH719916) prior to charter to ensure biofouling and ballast water controls meet these EP requirements. The requirements of the IMSMP are outlined herein.</td><td>Vessel contractor pre-qualification audit report verifies the vessel meets the requirements outlined in the IMSMP.</td></tr>
<tr><td colspan="3">Biofouling</td></tr>
<tr><td rowspan="3">Vessels do not introduce IMS to the operational area.</td><td>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.</td><td>Biofouling assessment report prior to mobilising to site confirms acceptability to enter operational area.</td></tr>
<tr><td>Vessels >400 gross tonnes carry a current International Anti-fouling System (IAFS) Certificate that is complaint with Marine Order Part 98 (Anti-fouling Systems).</td><td>IAFS Certificate is available and current.</td></tr>
<tr><td>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 ensuring that vessels:</td><td>Vessel contractor Biofouling Management Plan and Biofouling Record Book are available and current.</td></tr>
</table>

	• 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.	
	An IMS risk assessment is undertaken based on the following: • Inspecting the IAFS certificate to ensure currency. • Reviewing recent vessel inspection/audit reports to ensure that the risk of IMS introduction is low. • Reviewing recent ports of call to determine the IMS risk of those ports. • Determining the need for in-water cleaning and/or re-application of anti-fouling paint if neither has been done recently in line with anti-fouling and in-water cleaning guidelines (DoA/DoE, 2015). • Implementing the biofouling guidance provided in Part 5 of the Offshore Installation Biosecurity Guideline (DAWR, 2019, v1.3).	IMS risk assessment document verifies that the biofouling risk evaluation took place and that the IMS risk is 'low.'
Immersible equipment (does not introduce IMS to the operational area.	Immersible equipment is cleaned (e.g., biofouling is removed from airguns and streamers) prior to initial use in the operational area.	Records are available to verify that immersible equipment was cleaned prior to use.
Ballast water		

Internationally-sourced vessels discharge only low risk ballast water.	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).
	  o If intending to discharge internationally-sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival.
	  o 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 ePAR is available and signed off by DAWR.

Vessels only discharge low risk ballast water.	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:*	As above, except for the BWR.

	• *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.*	
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 DAWR immediately (contact details in Section 8.9).	Incident report notes that contact was made with the DAWR regarding non-compliant ballast water discharges.

Risk Assessment (residual)		
Likelihood	Consequence	Risk rating
Highly unlikely	Major	Medium

Demonstration of ALARP

A 'medium' residual risk rating is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required.

Demonstration of Acceptability		
Internal context	Policy compliance	Beach Environmental Policy objectives are met through implementation of this EP.
	OEMS compliance	Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS have been met during the planning phase of this activity and can be met during the implementation phase of this activity.
Stakeholder engagement (Chapter 4)	Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS. Stakeholders have not raised concerns about the introduction and establishment of IMS.	
Legislative context (see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)	The performance standards outlined in this EP align with the requirements of: • *Biosecurity Act* 2015 (Cth): o Chapter 4 (Managing biosecurity risk). o Chapter 5, Part 3 (Management of discharge of ballast water). • *Protection of the Sea (Harmful Anti-fouling Systems) Act* 2006 (Cth): o Part 2 (Application or use of harmful anti-fouling systems). o Part 3 (Anti-fouling certificates and anti-fouling declarations). o Marine Order 98 (Marine pollution – anti-fouling systems).	
Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 have been considered (and adopted where practicable) in the development of performance standards 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: • To reduce the risk of introduction of marine pests to ALARP and to an acceptable level. • To reduce the impacts to benthic communities to ALARP and to an acceptable level.
	IMS-specific	
	Australian Ballast Water Management Requirements (DAWR, 2020, v8)	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 5.5.1)	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.
	Ramsar wetlands (Section 5.5.4)	The risk of introducing IMS is highly unlikely to affect Ramsar wetlands.

	TECs (Section 5.5.6)	The risk of introducing IMS is highly unlikely to affect TECs.
	NIWs (Section 5.5.8)	The risk of introducing IMS is highly unlikely to affect NIWs.
	Nationally threatened and migratory species (Section 5.4)	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 5.5.9 & 5.5.10)	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.
- DAWR-signed ePARs.

7.13 RISK 5 – MDO Release

7.13.1 Hazard

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.

DNV (2011) indicates that for the period 1982-2010, there were no spills over 1 tonne (1 m^3) for offshore vessels caused by collisions or fuel transfers.

MDO properties

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 C_{11}-C_{28} 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 IOPC Fund definition (i.e., greater than 5% boiling above 370°C) (Table 7.50).
- 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 MDO 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 crude 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, Beach commissioned RPS to undertake OSTM using the scenario of a release of 280 m^3 of MDO at a random location within the operational area for a duration of 6 hours (RPS, 2020), using the MDO properties outlined in Table 7.51. Table 7.52 outlines the key OSTM inputs for the MDO spill scenario.

Table 7.50. 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 7.51. Summary of the MDO spill OSTM inputs.

Characteristic	Details
Density (kg/m^3)	829 at 25°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 7.52. Summary of the MDO spill OSTM inputs.

Parameter	Details
Oil Type	MDO
Total spill volume	280 m^3
Release type	Sea surface
Release duration	6 hours
Release rate	46.66 m^3/hr
Simulation duration	20 days
Number of simulations	200
Surface oil concentration thresholds (g/m^2)	1 g/m^2 – low exposure 10 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

Exposure Values

Exposure Values

The outputs of the OSTM are used to assess the environmental risk if a credible hydrocarbon spill scenario occurred, by defining which areas of the marine environment could be exposed to hydrocarbon concentrations that exceed exposure values that may result in impact to sensitive receptors. The degree of impact will depend on the sensitivity of the biota contacted, the duration of the exposure and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon.

The modelling considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks:

- Surface hydrocarbons;
- Entrained hydrocarbons;
- Dissolved hydrocarbons; and
- Shoreline accumulated hydrocarbons.

The modelling used defined hydrocarbon exposure values, as relevant for risk assessment and oil spill planning, for the various hydrocarbon phases. To ensure conservatism in the environmental assessment process, the exposure values applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Exposure values applied for surface, entrained, dissolved and shoreline accumulated hydrocarbons used in the modelling study are summarised in Table 7.52. The adopted exposure values are based primarily on the exposure values defined in NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019).

Spill Location

For this assessment, 100 random spill locations were chosen within the operational area, resulting in 2.5-8 km spacing between simulated release sites.

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. Beach has used this guidance in determining the volume to be modelled for this study. Given that the marine seismic vessel for this survey has yet to be contracted, the exact volume of MDO to be carried cannot be provided. However, of the survey vessel contractors that have tendered for the work, the largest single fuel tank has been determined to be 280 m^3. The *MV Geo Coral* recently undertook an MSS in Bass Strait and its largest fuel tank is 286 m^3. In early 2018, the CarbonNet Pelican 3DMSS used the *Polarcus Naila* vessel, and its largest fuel tank is 278 m^3. As such, a spill volume of 280 m^3 is an accurate figure to use for this OSTM.

Sea Surface Results

A summary of the sea surface OSTM results for the MDO spill scenario is presented in Table 7.53 and illustrated in Figure 7.12. Figure 7.13 presents the spill simulation with the largest extent of sea surface hydrocarbons. The sea surface OSTM results indicate that low exposure contact may be made with the Beagle and Boags AMPs. Weathering results for this MDO spill scenario are illustrated in Figure 7.14, indicating that evaporation accounts for half of the MDO weathering and this occurs rapidly.

Table 7.54 presents the probability of exposure from sea surface hydrocarbons under the MDO spill scenario.

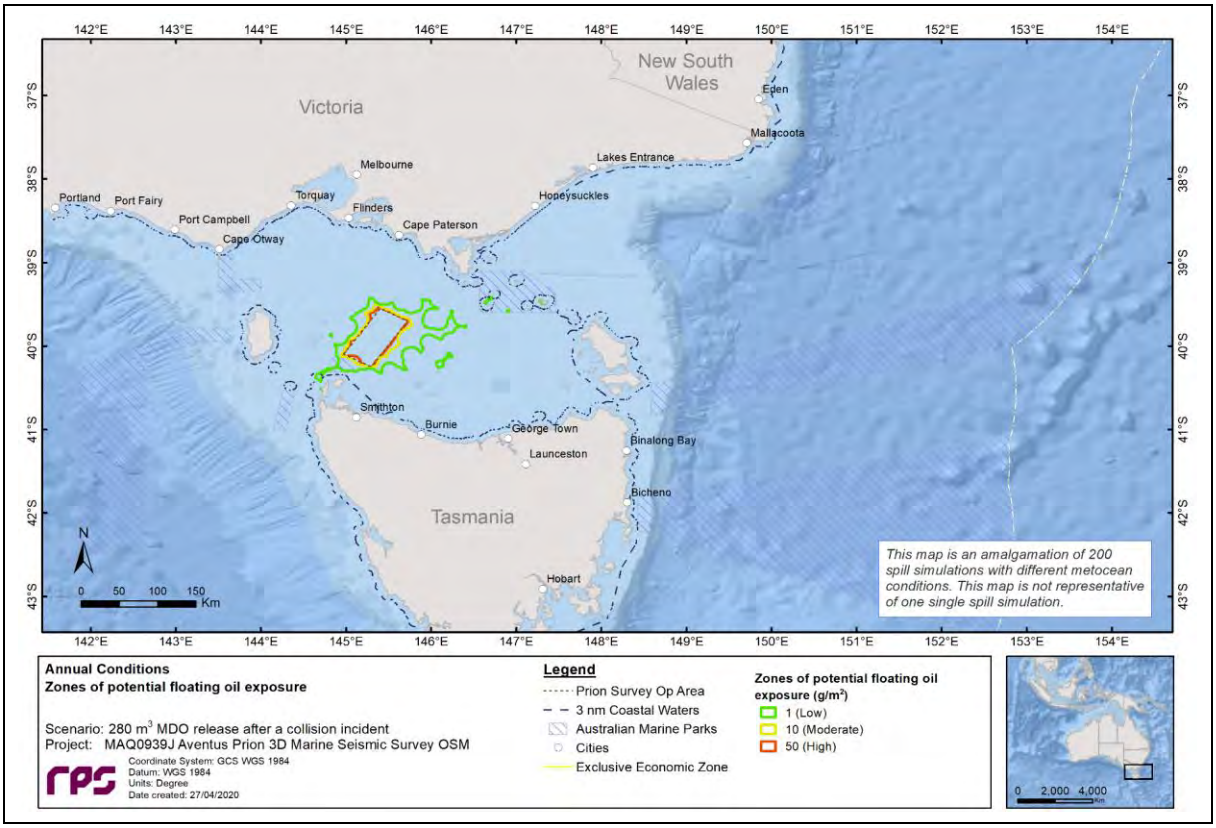


Figure 7.12. Zones of potential exposure on the sea surface in the event of a 280 m^3 surface release of MDO over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

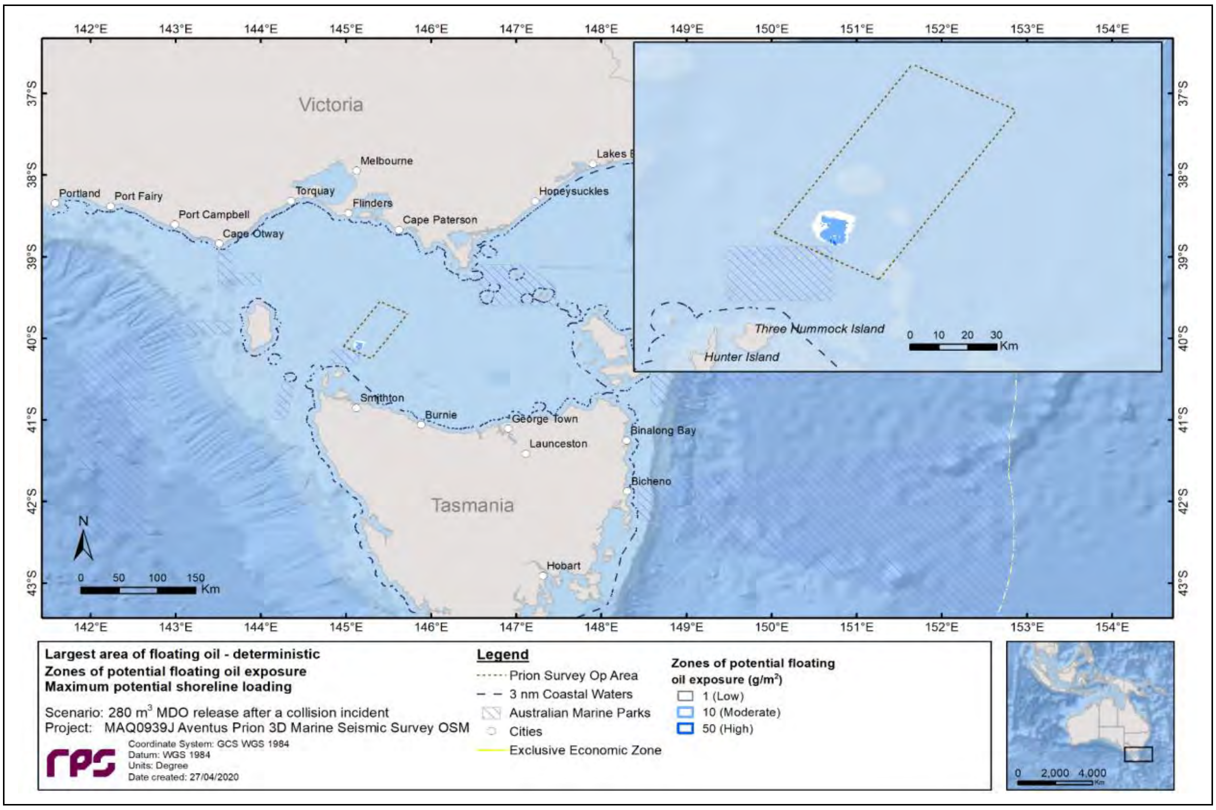


Figure 7.13. Largest extent of sea surface hydrocarbon 'swept area' from a single spill simulation based on 280 m^3 surface release of MDO over 6 hours tracked for 20 days, starting on the 15th of November 2013.

Table 7.52. Summary of the sea surface results for the MDO spill scenario

Distance and direction	Zones of potential sea surface exposure		
	Low (1-10 g/m^2)	Moderate (10-50 g/m^2)	High (>50 g/m^2)
Maximum distance from centre of operational area	176.1 km	44.4 km	41.7 km
Direction	East-northeast	North	North

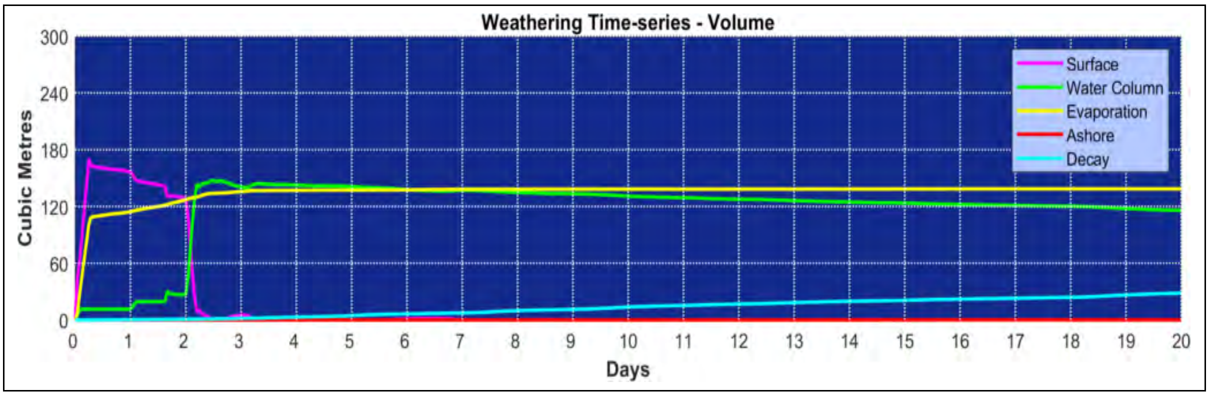


Figure 7.14. Predicted weathering and fate of MDO for the largest swept area based on a 280 m^3 surface release of MDO over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

Table 7.53. Probability of exposure to sea surface waters from a 280 m^3 MDO release over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

Receptor	Probability (%) of floating oil exposure			Minimum time before floating oil exposure (hours)		
	Low	Mod	High	Low	Mod	High
Protected areas						
Beagle AMP	1	NC	NC	92	NC	NC
Kent Group NP	0.5	NC	NC	160	NC	NC
Nearshore waters						
Albatross Island	0.5	NC	NC	24	NC	NC
Curtis Island	0.5	NC	NC	83	NC	NC
Hunter Island	0.5	NC	NC	88	NC	NC
Kent Island Group	0.5	NC	NC	160	NC	NC

NC = no contact

Shoreline Results

A summary of the shoreline OSTM results for the scenario is presented in Table 7.54. The maximum potential shoreline loading results for this scenario are illustrated in Figure 7.15. The shoreline OSTM results presented in Table 7.55 indicate that contact would be made with the shorelines of Albatross Island, Curtis Island, Hogan Island Group, Hunter Island and Kent Island Group.

Table 7.54. Summary of the shoreline contact results above 10 g/m^2 in the event of a 280 m^3 MDO spill over 6 hours and tracked for 20 days during annual conditions

Shoreline statistics		Results
Maximum probability of contact to any shoreline		3%
Absolute minimum time to shore		25 hours
Maximum volume of hydrocarbons ashore		3.5 m^3
Average volume of hydrocarbons ashore		3.2 m^3
10 g/m^2 loading	Maximum shoreline length	5.5 km
	Average shoreline length	4.7 km
100 g/m^2 loading	Maximum shoreline length	1.3 km
	Average shoreline length	1.0 km
1,000 g/m^2	Maximum shoreline length	-
	Average shoreline length	-

Dashed line indicates that the threshold concentration was not reached

Table 7.55. Probability of exposure to shoreline hydrocarbon loading from a 280 m³ MDO release over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

Receptor (shoreline segment)	Probability (%) of exposure on shorelines			Minimum time before shoreline oil accumulation (hours)		
	Low	Mod	High	Low	Mod	High
Shorelines						
Albatross Island	1	NC	NC	25	NC	NC
Curtis Island	1	1	NC	76	91	NC
Hogan Island Group	1	1	NC	100	114	NC
Hunter Island	1	1	NC	46	90	NC
Kent Island Group	1	1	Nc	140	162	NC

NC = no contact

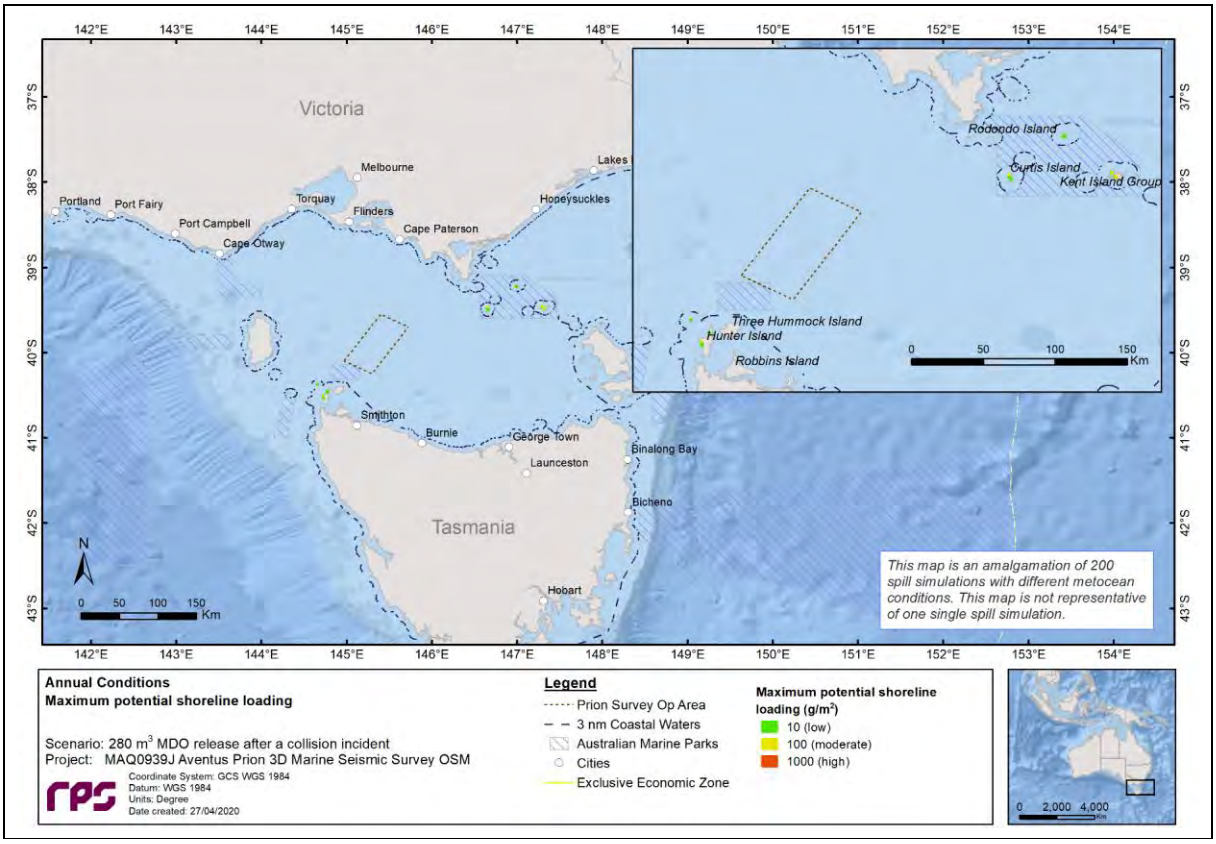


Figure 7.15. Maximum potential shoreline loading in the event of a 280 m³ surface release of MDO over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

Entrained Hydrocarbon Results

Figure 7.16 illustrates the zones of potential entrained hydrocarbon exposure at 0-10 m and >10 m below the sea surface, indicating that the maximum distance travelled from the centre of the operational area is 674 km predominantly in an east direction for low exposure hydrocarbons and up to 308 km in a predominantly east-northeast direction for high exposure entrained hydrocarbons.

There is no contact with entrained hydrocarbons at any threshold in waters below a depth of 10 m from the sea surface. A summary of the entrained MDO OSTM results is presented in Table 7.56.

Table 7.56. Probability of exposure to protected area from entrained MDO based on a 280 m^3 release over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

Receptor (shoreline segment)	0-10 m below sea surface			>10 m below sea surface		
	Max. exposure to entrained hydrocarbons (ppb)	Probability (%) of exposure to entrained hydrocarbons		Max. exposure to entrained hydrocarbons (ppb)	Probability (%) of exposure to entrained hydrocarbons	
		Low	High		Low	High
AMPs						
Apollo	65	2.5	NC	NC	NC	NC
Beagle	295	17.5	3.0	NC	NC	NC
East Gippsland	48	2.5	NC	NC	NC	NC
Flinders	31	0.5	NC	NC	NC	NC
Franklin	251	6	1	NC	NC	NC
Zeehan	53	0.5	NC	NC	NC	NC
KEFs						
Big Horseshoe Canyon	40	1.5	NC	NC	NC	NC
Upwelling East of Eden	71	5	NC	NC	NC	NC
West Tasmania Canyons	95	2.5	NC	NC	NC	NC
State marine parks						
Kent Group NP	161	12.5	0.5	NC	NC	NC
Bunurong MNP	38	1	NC	NC	NC	NC
Cape Howe MNP	12	0.5	NC	NC	NC	NC
Point Hicks MNP	50	2.5	NC	NC	NC	NC
Wilsons Promontory MNP	102	2.5	0.5	NC	NC	NC
Corner Inlet Marine and Coastal Park	12	0.5	NC	NC	NC	NC
Nooramunga Marine and Coastal Park	40	0.5	NC	NC	NC	NC
Wilsons Promontory MP	21	0.5	NC	NC	NC	NC
Wilsons Promontory MR	32	1	NC	NC	NC	NC
Chappell Islands Nature Reserve	17	1.5	NC	NC	NC	NC
Ramsar wetlands						
Corner Inlet Ramsar site	40	0.5	NC	NC	NC	NC
Lavinia Ramsar site	64	1.5	NC	NC	NC	NC

NC = no contact

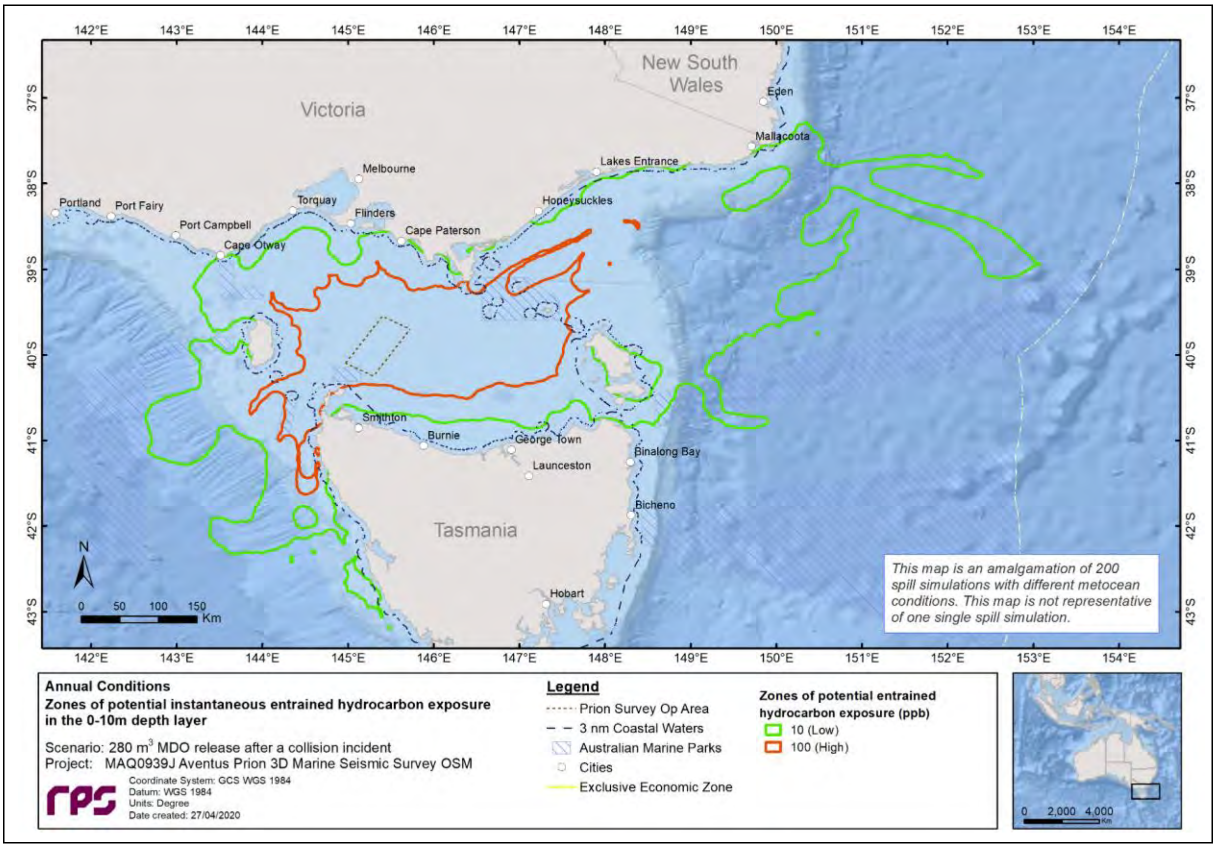


Figure 7.16. Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 280 m^3 surface release of MDO over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

Dissolved Hydrocarbons Results

Table 7.57 summarises the OSTM results for dissolved hydrocarbons. Figure 7.17 illustrates the zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface, indicating that the maximum distance travelled from the centre of the operational area is 346 km predominantly in a east-northeast direction for low exposure dissolved hydrocarbons and up to 113 km in a southwest direction for moderate exposure dissolved hydrocarbons, with no exposure to high exposure dissolved hydrocarbons.

Figure 7.18 and Figure 7.19 present the dissolved hydrocarbon exposure predicted to occur in the 10-20 m and 20-30 m depth layers. Note, the areas exposed to dissolved hydrocarbons in the 10-20 m and 20-30 m depth layers is greatly reduced in comparison to the 0-10 m depth layer.

Table 7.57. Probability of exposure to receptors from dissolved MDO based on a 280 m^3 release over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

Receptor (shoreline segment)	0-10 m below sea surface				>10 m below sea surface			
	Max. exposure to dissolved aromatics (ppb)	Probability (%) of exposure to dissolved aromatics			Max. exposure to dissolved aromatics (ppb)	Probability (%) of exposure to dissolved aromatics		
		Low	Mod	High		Low	Mod	High
AMPs								
Beagle	36	1	NC	NC	NC	NC	NC	NC
Franklin	18	0.5	NC	NC	NC	NC	NC	NC
KEFs								
Upwelling East of Eden	11	0.5	NC	NC	NC	NC	NC	NC
State parks								
Kent Group NP	20	0.5	NC	NC	NC	NC	NC	NC

NC = no contact

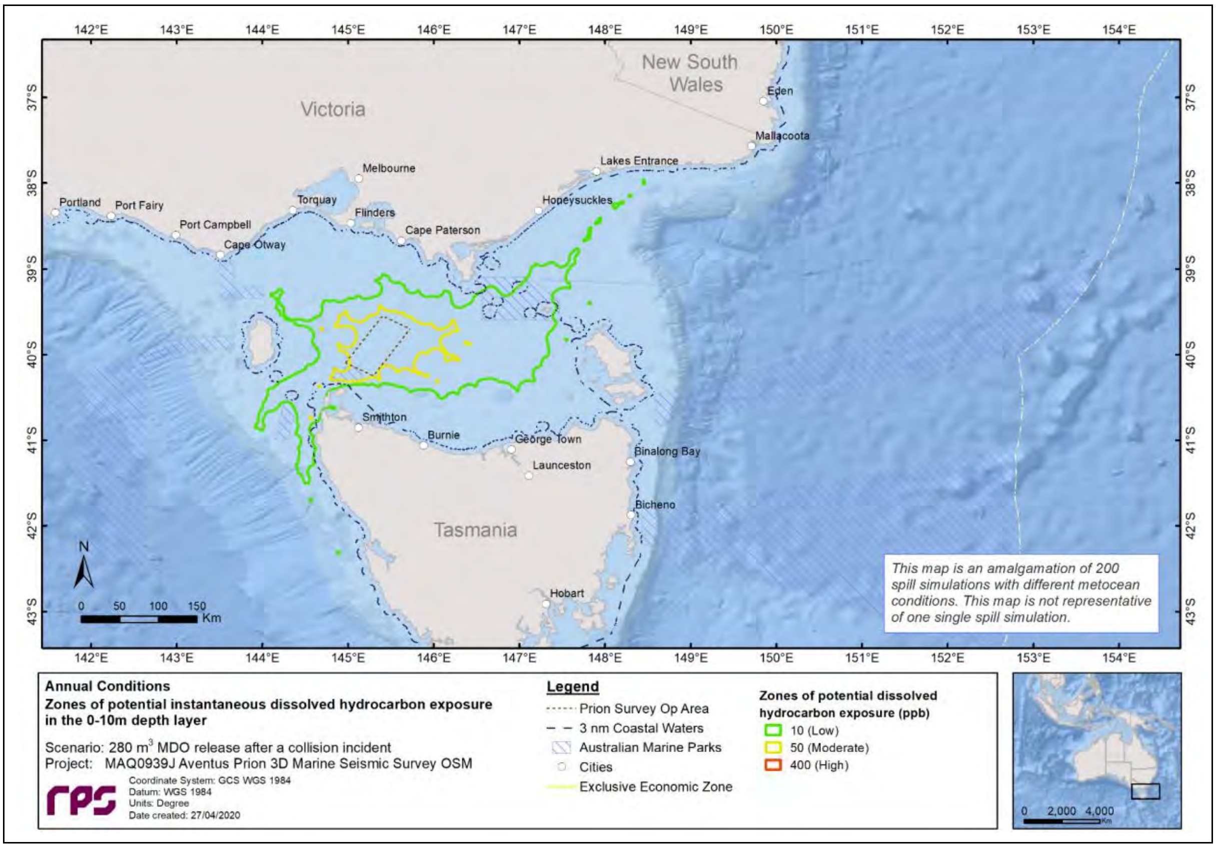


Figure 7.17. Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 280 m^3 surface release of MDO over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

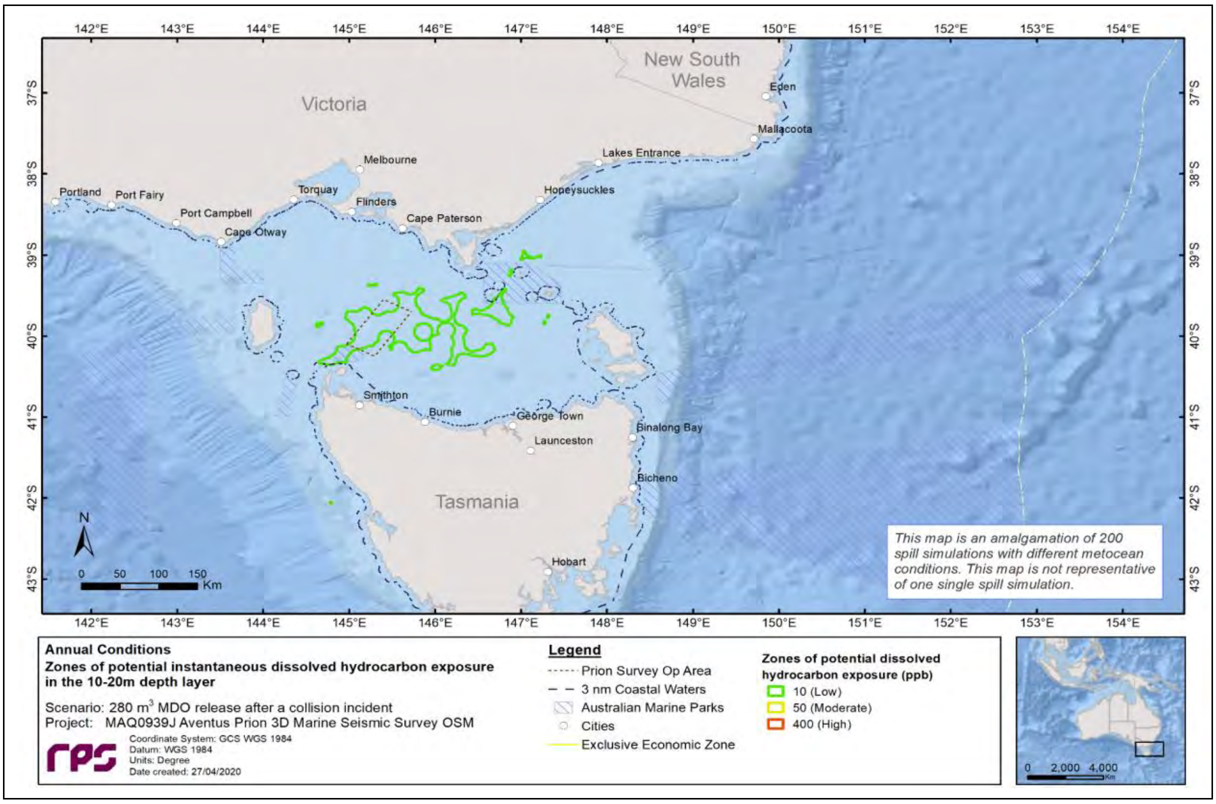


Figure 7.18. Zones of potential dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 280 m^3 surface release of MDO over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

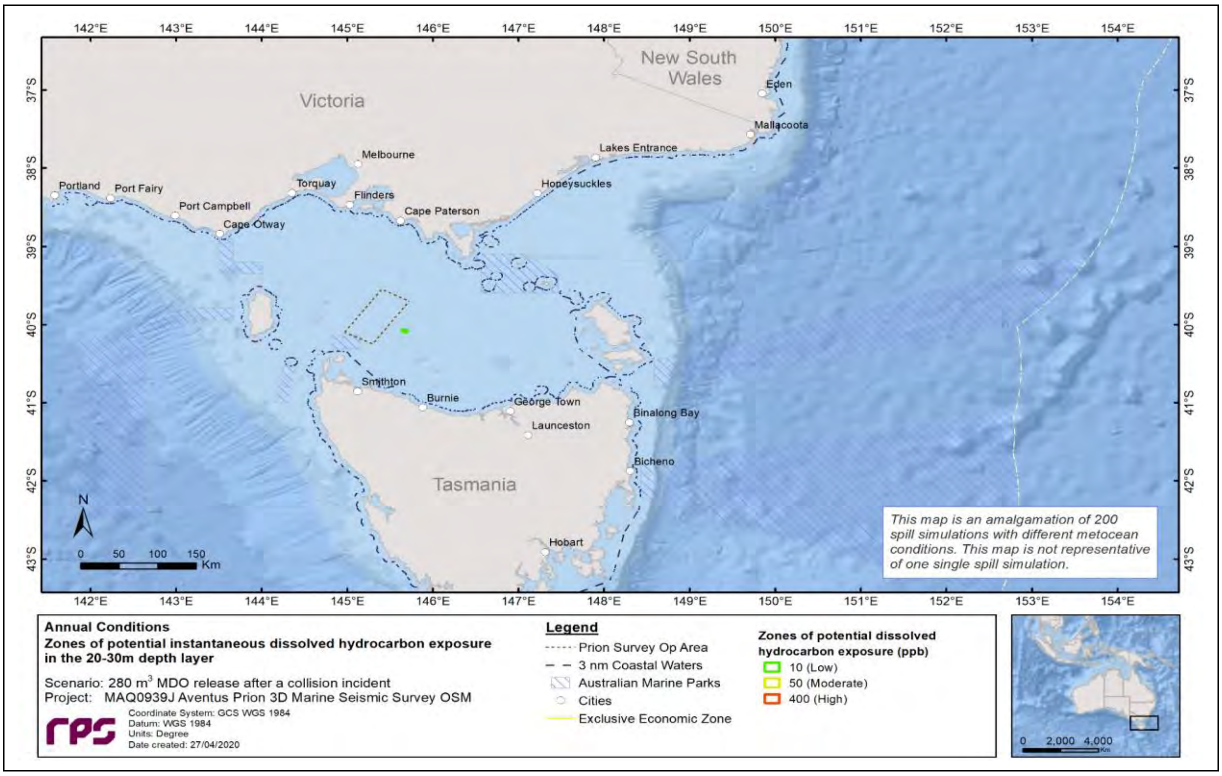


Figure 7.19. Zones of potential dissolved hydrocarbon exposure at 20-30 m below the sea surface in the event of a 280 m^3 surface release of MDO over 6 hours and tracked for 20 days based on 200 spill trajectories during annual conditions

7.13.2 Potential environmental risks

The known and potential impacts of an MDO spill are:

- 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
- Changes to the functions, interests or activities of other users (e.g., commercial fisheries).

7.13.3 EMBA

The EMBA for a 280 m^3 spill of MDO (sea surface, shoreline, entrained and dissolved aromatics) is illustrated in Figure 7.12, Figure 7.15, Figure 7.16 and Figure 7.17. Receptors most at risk within this EMBA, whether resident or migratory, are:

- Plankton;
- Fish;
- Cetaceans;
- Pinnipeds;
- Avifauna; and
- Shoreline habitats.

7.13.4 Evaluation of Environmental Risk

Vessel collisions are a low probability event in open ocean areas without restricted navigation, and shipping traffic around the survey area is low (see Figure 5.52). Higher commercial and recreational vessel traffic occurs in and around ports and harbours, which is therefore where the greatest risk of collision occurs. While undertaking the survey, the source and support vessels will be operating at low speeds, reducing the risk of collision with third-party vessels.

Criteria for the sensitivity of receptors that may be affected by an MDO spill are presented earlier in Table 7.58. The impacts of the MDO spill scenario on key environmental receptors in the spill EMBA are described in Table 7.59 to Table 7.69.

Table 7.58 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 7.59. Potential risk of MDO release on benthic assemblages

General sensitivity to oiling – benthic assemblages	
Sensitivity rating of benthic species and communities:	Low
A description of benthic fauna in the EMBA is provided in:	Section 5.4.1

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).

Surveys undertaken after the Montara well blowout in the Timor Sea in 2009 found no obvious visual signs of major disturbance at Barracouta and Vulcan 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.

Recovery of benthic habitats exposed to entrained hydrocarbons would be expected to return to background water quality 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 consequence from an MDO spill			
Sea Surface	**Water column - dissolved phase**	**Water column – entrained phase**	**Shoreline**
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 modelled exposure to the high threshold for dissolved hydrocarbons. At the low threshold exposure to dissolved hydrocarbons, ecological impacts are unlikely. In nearshore waters (0-10 m) where there is interaction with the benthic environment, there is a 0.5% probability of moderate threshold exposure at Albatross Island. At the moderate threshold, sub-lethal impacts to benthic fauna may occur as described above. Due to the limited extent of dissolved hydrocarbons at the moderate threshold in nearshore benthic environments, the consequence to benthic fauna or habitats from an MDO spill is **minor**.	There are areas of low exposure entrained hydrocarbons in the nearshore benthic zone on the northwest coast of Tasmania, on the east coast of King Island, between Phillip Island and the Honeysuckles and on the western coast of Flinders Island and Cape Barren Island. This concentration is not considered to impart ecological impact, rather this threshold is more suited to establishing the planning area for scientific monitoring (RPS, 2020). Thus, the area intersected by this threshold is considered outside the adverse exposure zone when considering benthic assemblages. The consequence to benthic fauna or habitats exposed to hydrocarbons at the low threshold is **negligible.** There are some areas of high exposure to entrained hydrocarbons in the nearshore benthic zone on the northwest coast of Tasmania, on the southern tip of Wilsons	The low threshold (10 g/m^2) for shoreline accumulation applied to the OSTM represents the trigger for socio-economic impact including the temporary closure of beaches to recreation or fishing (RPS, 2020). As such, the moderate threshold (100 g/m^2) has been applied as the minimum threshold to define ecological impact (French *et al.,* 1996; French-McCay, 2009). There is a 1% probability of contact with moderate threshold exposure to shorelines at Curtis Island, Hogan Island Group, Hunter Island and Kent Island Group. The maximum length of shoreline predicted to be contacted at or above the moderate threshold is 1.3 km. The high threshold (1000 g/m^2) for shoreline loading, which is associated with higher potential for ecological impact, was not reached during the 200 simulations of

		Promontory and among the islands of the Hogan Group and Kent Group. Settlement of high threshold entrained MDO in the benthic layer is unlikely due to the properties of the MDO. As such, the consequence of a hydrocarbon spill on benthic assemblages is **minor**.	the scenario undertaken in the modelling (RPS, 2020). Intertidal benthic species would be exposed to MDO (albeit weathered) along limited sections of shorelines on small islands in Bass Strait. Resident fauna such as worms, molluscs and crustaceans may suffer sub-lethal and lethal impacts where hydrocarbon loadings penetrate into the sediments and persist. While MDO penetrates porous sediments (e.g., sand) quickly, it is also washed off quickly (and weathered within sediments) by waves (NOAA, 2012), thus minimising impacts to intertidal fauna. Similarly, the exposed rock cliffs and intertidal platforms present on the small islands will facilitate weathering of the hydrocarbons through wave action pounding on the rocks). Therefore, the consequence of an MDO spill on benthic assemblages is **minor**.

Table 7.60. Potential risk of MDO release from vessel 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 5.4.3	
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 entrained and dissolved hydrocarbons, as well as to surface hydrocarbons if present 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 hydrocarbons within the water column can affect light qualities and the ability of macrophytes to photosynthesise.			
Potential consequence from an MDO spill			
Sea surface	**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. There are no areas of moderate or high threshold sea surface hydrocarbons in the nearshore environment. The nature of the spill in this scenario (occurring in central	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	The Giant Kelp Forest TEC may be intersected by areas of high concentration entrained hydrocarbons around the northwest coast of Tasmania, Flinders Island, Kent Group Island and Hogan Group Islands but only in the 0-10 m depth layer. These areas may be impacted by entrained hydrocarbons.	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.

Bass Strait waters >20 m deep) means the consequence to macroalgal communities is **minor**.	communities, there is a possibility of moderate threshold exposure at Albatross Island. Due to the low concentrations and physical properties of the hydrocarbons and the well-mixed nature of the waters of the EMBA, ecological impact to macroalgae communities by hydrocarbons is considered highly unlikely, particularly in high-energy nearshore environments. Thus, the consequence to macroalgal communities from an MDO spill is **minor**.	However, due to the limited temporal extent at which these concentrations persist, along with the well-mixed nature of Bass Strait, the consequence of an MDO spill to macroalgal communities is **minor**.	Areas of predicted moderate shoreline loading are limited to offshore rocky shore islands in Bass Strait. 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 the MDO spill 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 5.5.6) 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 7.61. 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 5.4.2

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 consequence from an MDO spill		
Sea Surface	**Water column**	**Shoreline**
Plankton found in open water of the EMBA is expected to be widely represented in wider Bass Strait. 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 surface, dissolved and entrained hydrocarbons. Once background water quality conditions are 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. The consequence of an MDO spill on plankton populations is **minor**.		Not applicable.

Table 7.62. 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 5.4.7

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 high 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 7.32 '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).

During most of their lives, squid are widely distributed, however, when squid reach maturity at 1-2 years, they move inshore to spawn in large numbers and then die after spawning. Where large numbers of squid spawn in small areas, the population could be impacted by the reduction in successful spawn. As squid are generally abundant and reach sexual maturity rapidly, recovery is expected to be rapid (1-2 years) (Minerals Management Service, 1983).

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 consequence from an MDO spill		
Sea Surface	**Water column**	**Shoreline**
There is a small area in which moderate exposure (44.4 km) and high exposure (41.7 km) threshold hydrocarbons travel from the operational area on 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, however the maximum distance of moderate exposure threshold from the release site (representing the point at which harmful effects may be encountered) represents a relatively small area of the sea surface in comparison to the wider Bass Strait. Because the majority of fish tend to remain in the mid-pelagic zone, they are not likely to come into contact with surface hydrocarbons, so the consequence of an MDO spill is **minor**.	Impacts to fish from exposure to hydrocarbons in the water column is likely to be spatially and temporally limited. The OSTM indicates that exposure to high threshold entrained hydrocarbons (i.e., the concentration at which biological impact may occur) is predicted to occur up to a maximum distance of 308 km east-northeast from the operational area. This concentration represents the possibility of sub-lethal impacts to exposed fish species in the affected area. NOAA (2013) and ITOPF (2011a) state that hydrocarbon spills in open water are so rapidly diluted that fish kills are rarely observed. In addition, due to the properties of MDO, there are no hydrocarbons predicted below 10 m water depth. Fish such as the great white shark, shortfin mako and porbeagle shark spend most of their time in the water column (rather than surface waters), meaning they are more likely to be exposed to entrained and dissolved hydrocarbons than surface hydrocarbons. As highly mobile species, they are unlikely to remain in one area for a long period of time, minimising the risk that they would be exposed to toxic levels of hydrocarbons. Due to Bass Strait's generally well-mixed waters, and the high and rapid rate of MDO weathering, the consequence of an MDO spill on for fish is restricted to the top 10 m of water and is **minor** at a population level.	Not applicable

Table 7.63. 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 5.4.5

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 hydrocarbons, 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 whale 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 consequence from an MDO spill		
Sea Surface	**Water column**	**Shoreline**
There is a small area in which moderate exposure (44.4 km) and high exposure (41.7 km) threshold hydrocarbons travel from the operational area on the sea surface. This area overlaps the foraging BIA for pygmy blue whales and known core range of southern right whales. There is a chance that pygmy blue and southern right whales may be present in the EMBA depending on the time of year that a spill occurs. If present, these species (and other cetaceans) may be exposed to hydrocarbons in the manner described in Table 7.26. If large quantities of zooplankton exposed to the spill were ingested, chronic toxicity impacts to some individual cetaceans may occur. Biological consequences of physical contact with localised areas of high concentrations (maximum 41.7 km from the operational area) of hydrocarbons at the sea surface are unlikely to lead to any long-term population impacts. Evaporation of the hydrocarbons is expected to occur rapidly in this scenario with ~115 m^3 of the modelled 280 m^3 evaporating within 1 day of the spill occurring, thus reducing the duration of the hydrocarbons persisting on the sea surface. In comparison to the range of the BIAs of the whale species identified, the duration and extent of sea surface hydrocarbons is negligible and does not represent a long-term threat at the population level of cetaceans migrating or foraging in the EMBA. Therefore, the consequence to cetacean populations from an MDO spill is **minor**.	Impacts to cetaceans are likely to be limited to the areas of high exposure to entrained hydrocarbons. This area is predicted to be limited to central Bass Strait and only within the 0-10 m depth layer. This area overlaps the forging BIA for pygmy blue whales and known core range of southern right whales. About 42% of the MDO is expected to remain in the water column after 20 days. The pygmy blue whale BIA is for 'known foraging' and the BIA for southern right whales is for 'known core range'. The generally low exposure threshold for entrained and low to moderate exposure for dissolved hydrocarbons encountered in the EMBA are unlikely to pose a significant threat at the population level to cetaceans given that they are likely to be migrating through the region and not undertaking critical activities such as feeding and breeding and therefore unlikely to accumulate toxic levels of hydrocarbons. Therefore, the consequence to cetacean populations from an MDO spill is **minor**.	Not applicable.

This hydrocarbon spill scenario will not have a 'significant' impact on threatened cetacean species (see Section 5.4.5) 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' (Figure 7.13) 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 7.64. Potential risk of MDO release on pinnipeds

General sensitivity to oiling – pinnipeds	
Sensitivity rating of pinnipeds:	High
A description of pinnipeds in the EMBA is provided in:	Section 5.4.6

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 consequence from an MDO spill		
Sea Surface	**Water column**	**Shoreline**
The foraging range for New Zealand fur-seals 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, 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 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. The zones of dissolved hydrocarbons meeting the moderate threshold and entrained hydrocarbons meeting the high threshold in a single spill are 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 is unlikely to be habitat critical	Moderate and high concentrations do not reach shorelines where seals are likely to be entering and exiting the water and low threshold shoreline loading is unlikely to impart ecological harm. Therefore, the consequence of an MDO spill on pinniped species is **minor**.

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**.	to their survival. Because of this, the consequence to fur-seals from an MDO spill is **minor**.

Table 7.65. Potential risk of MDO release on marine reptiles

General sensitivity to oiling – marine reptiles	
Sensitivity rating of marine reptiles:	Medium
A description of marine reptiles in the EMBA is provided in:	Section 5.4.8

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:

1. Internally – eating or swallowing oil, consuming prey containing oil-based chemicals, or inhaling of volatile oil related compounds; and
2. 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 consequence from an MDO spill		
Sea Surface	**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 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 7.66. 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 5.4.4

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. 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). 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).

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).

<table>
<tr><th colspan="3">Potential consequence from an MDO spill</th></tr>
<tr><th>Sea Surface</th><th>Water column</th><th>Shoreline</th></tr>
<tr><td>The threatened bird species likely to occur in the EMBA, such as albatross and petrels, forage over an extensive area and are distributed over a wide geographic area.

Seabirds rafting, resting, diving or feeding at sea have the potential to come into contact with moderate to high exposure levels of MDO on the sea surface. These concentrations are generally considered detrimental to birds because of ingestion from preening of contaminated feathers, loss of thermal protection and hypothermia from matted feathers.

However, rapid weathering will limit the duration of toxicity impacts. Sea surface MDO is predicted to have weathered completed after 3 days.

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 from an MDO spill is minor.</td><td>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 wider Bass Strait 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 from an MDO spill is minor.</td><td>The average length of shoreline predicted to be exposed to MDO that may have ecological impacts to birds (100 g/m^2) is 1 km, with an average volume of 3.2 m^3.

These sections of coastline, located on Hogan Island, Curtis Island, Hunter Island and the Kent Island Group, comprises mostly rocky shores that do not provide suitable habitat for beach nesting species such as hooded plovers, terns, snipes and sandpipers. MDO is unlikely to persist on the surface of these rocky shores that are exposed to high energy wave action in Bass Strait.

Shorebirds foraging for food in intertidal areas or along the high tide mark and splash zone may encounter weathered hydrocarbons that may be brought back to nests. Hydrocarbon entering the sandy nests of hooded plovers, terns or other bird species (in areas not exposed to shoreline loading) is likely to percolate through the sand and not accumulate in the feathers of adults or young. Toxicity effects from ingestion of contaminated prey caught in the intertidal zone or from direct exposure or transport back to nests are unlikely to occur, as the volatile components are likely to have weathered prior to stranding.

The populations of shorebird species within the EMBA have a wide geographic range, meaning that impacts to individuals or a population at one location will not necessarily extend to populations at other un-impacted locations.

Due to isolated areas of moderate shoreline loading, the consequence of an MDO spill to shorebird species is moderate.</td></tr>
<tr><td colspan="3">This hydrocarbon spill scenario will not have a ‘significant’ impact on migratory shorebird species (see Section 5.4.4) 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:</td></tr>
<tr><td>• Loss of habitat.</td><td colspan="2">The sandy beaches of the EMBA will not be lost in the event of an MDO spill.</td></tr>
<tr><td>• Degradation of habitat leading to a substantial reduction in migratory shorebird numbers.</td><td colspan="2">Shoreline quality will temporarily decrease but given the behaviour of MDO and nature of the shoreline, there will be no long-term degradation.</td></tr>
</table>

• 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 5.4.4) 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 survey 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	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

becoming established in the endangered or critically endangered species' habitat.	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 7.67. 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 5.3.7

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 consequence 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. Shorelines that may be exposed to low and moderate threshold loading are located on offshore islands in Bass Strait, the largest of which is Hunter Island. In general, these islands are sparsely inhabited or uninhabited. Therefore, socio-economic and environmental consequences from shoreline loading are **minor**. No MDO shoreline loading at the high threshold is predicted in the OSTM. Intersection with the Western Tasmanian Aboriginal Cultural Landscape by low threshold entrained hydrocarbons will not result in any impacts to the values of this landscape, given that these are terrestrial values, shoreward of the intertidal zone.

Table 7.68. 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 rocky shores in the EMBA is provided in:	Section 5.3.7

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 consequence 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 1% probability of moderate shoreline loading on the Curtis Island, Hogan Island Group, Hunter Island and Kent Island Group coasts. Much of this coastline is comprised of rocky shores with cliffs, shore platforms and pebble/boulder beaches. 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 7.69. Potential risk of MDO spill on commercial fisheries

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 5.7.6

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, 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 AFMA, the VFA and/or DPIPWE (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 of income 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 consequence from MDO release			
Fishery	**Surface oiling**	**Water column**	**Shoreline**
General	A short-term fishing exclusion zone may be implemented by AFMA, the VFA and/or DPIPWE. 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 smaller areas at the moderate dissolved and high entrained exposure thresholds. Note, the high exposure threshold for dissolved hydrocarbons was not reached. 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 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, some of which are included within the EMBA. Where the EMBA intersects moored fishing vessels, some staining or coasting of vessel hulls may occur.
Victorian fisheries (those known to fish within the EMBA)			
Scallop	No impacts due to their benthic habitat.	The area overlapped by the EMBA represents 57% of the area available to the fishery. Hydrocarbons are not expected to accumulate among benthic sediments in areas fished for scallops. A temporary closure of the area affected by hydrocarbons may be implemented. Therefore, this is expected to be of **minor** consequence to the overall function of the fishery, its catch species and its future viability.	As per 'general'.
Abalone	No impacts due to their benthic habitat.	The area overlapped by the EMBA represents 56% of the area available to the fishery. The most heavily fished areas of the fishery are located off the east coast of Victoria. Much of the fishery is exposed to areas of low threshold entrained hydrocarbons, which will not result in sub-lethal or lethal impacts to the target species. A temporary closure of the area affected by hydrocarbons may be implemented. This is expected to be of **minor** consequence to the overall function of the fishery, its catch species and its future viability.	As per 'general'.

Rock lobster	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 area overlapped by the EMBA represents 56% of the area available to the fishery. The OSTM indicates the maximum extent of high exposure of the benthic layer to entrained hydrocarbons occurs in the nearshore environment at the southern tip of Wilsons Promontory and Cape Otway. Low exposure entrained hydrocarbons intersect large areas of the fishery, which will not result in sub-lethal or lethal impacts to the target species. 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, its catch species and its future viability.	As per 'general'.
Giant crab	There is a low risk of 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 area overlapped by the EMBA represents 56% of the area available to the fishery. The OSTM indicates the maximum extent of high exposure of the benthic layer to entrained hydrocarbons occurs in the nearshore environment at the southern tip of Wilsons Promontory and Cape Otway. Low exposure entrained hydrocarbons intersect large areas of the fishery, which will not result in sub-lethal or lethal impacts to the target species. 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, its catch species and its future viability.	As per 'general'.
Wrasse	No impacts due to their pelagic habitat.	The area overlapped by the EMBA represents 57% of the area available to the fishery. Low exposure to entrained and dissolved hydrocarbons intersect large areas of the wrasse fishery, which will not result in sub-lethal or lethal impacts to the target species. 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	As per 'general'.

		hydrocarbons. This is expected to be of **minor** consequence to the overall function of the fishery, its catch species and its future viability.	
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 some areas of the available fishing grounds are exposed to low threshold entrained MDO. 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, its catch species and its future viability.	As per 'general'.
Ocean access			As per 'general'.
Tasmanian fisheries (those known to fish within the EMBA)			
Scalefish	No impacts due to their pelagic habitat.	A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an 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.	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 impact on the overall function of the fishery, its catch species or its future viability. Therefore, the short- or long-term consequence to the fishery or its catch species is **minor**.	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.	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 impact on the	As per 'general.'

	This is expected to be of **minor** consequence to the fishery.	overall function of the fishery, its catch species or its future viability. Therefore, the short- or long-term consequence to the fishery or its catch species is **minor**.	
Octopus	No impacts due to their benthic and pelagic habitat. There is a low risk of octopus 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.	A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an 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.	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.	A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an 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.'
Commonwealth fisheries (those known to fish within the EMBA)			
Scallop	No impact due to their benthic habitat.	The area overlapped by the EMBA represents 68% of the area available to the fishery. Hydrocarbons are not expected to accumulate among benthic sediments in the EMBA due to the significant mixing of waters and dilution of the high and 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.	Not applicable.

	However, a temporary closure of the area affected by hydrocarbons may be implemented until background water quality levels return to pre-spill conditions. Given the proximity of recent fishing effort to the survey area, the consequence of a hydrocarbon spill and potential closure of grounds adjacent the spill would be of **moderate** consequence to the fishery.	
Southern squid jig	The area overlapped by the EMBA represents 6.7% of the area available to the fishery. The most heavily fished areas of the fishery are located off the west coast of Victoria and east coast of Tasmania, which are not exposed to hydrocarbons. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an impact on the overall function of the fishery, its catch species or its future viability. Therefore, the consequence of the MDO spill is therefore **minor**.	Not applicable.
SESS – gillnet and shark hook sector	The area overlapped by the EMBA represents 11.9% of the area available to the fishery. The most heavily fished areas of the fishery are located off the east coast of Victoria and north coast of Flinders Island, which are not exposed to surface oil and exposed to low exposure thresholds for entrained hydrocarbons, which will not result in sub-lethal or toxicity impacts to target species. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an impact on the overall function of the fishery, its catch species or its future viability. Therefore, the consequence of the MDO spill is therefore **minor**.	Not applicable.
SESS – Commonwealth trawl sector	The area overlapped by the EMBA represents 14.5% of the area available to the fishery. The most heavily fished areas of the fishery are located on the continental slope off the east coast of Victoria, southwest Victoria and the west and east coasts of Tasmania. These areas are not exposed to surface oil and exposed to low exposure thresholds for entrained hydrocarbons, which will not result in sub-lethal or lethal impacts to target species. A temporary closure of the area affected by hydrocarbons may be implemented. This is not expected to have an impact on the overall function of the fishery, its catch species or its future viability. Therefore, the consequence of the MDO spill is therefore **minor**.	Not applicable.
SESS - scalefish hook sector	The area overlapped by the EMBA represents 7.1% of the area available to the fishery. 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. A temporary closure of the area affected by hydrocarbons may be implemented This is not expected to have an impact on the overall function of the fishery, its catch species or its future viability. Therefore, the consequence of the MDO spill is therefore **minor**.	Not applicable.

7.13.5 Risk assessment

Table 7.70 presents the risk assessment for an MDO spill.

Table 7.70. Risk assessment for an MDO spill

Summary			
Summary of risks	Localised and temporary reduction in water quality. Potential toxicity impacts to marine life. Temporary fisheries closures.		
Extent of risks	EMBA is defined in Figures 7.14, 7.16, 7.17 and 7.18.		
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 (inherent)			
Receptor	Consequence	Likelihood	Risk rating
Benthic fauna	Minor	Highly unlikely	Low
Macroalgal communities	Minor	Highly unlikely	Low
Plankton	Minor	Highly unlikely	Low
Pelagic fish	Minor	Highly unlikely	Low
Cetaceans	Minor	Highly unlikely	Low
Pinnipeds	Minor	Highly unlikely	Low
Marine reptiles	Minor	Highly unlikely	Low
Seabirds	Minor	Highly unlikely	Low
Shorebirds	Moderate	Highly unlikely	Low
Sandy beaches	Minor	Highly unlikely	Low
Rocky shores	Minor	Highly unlikely	Low
Commercial fisheries	Minor	Highly unlikely	Low
Public amenity (beaches, recreational fishing)	Serious	Highly unlikely	Medium
Desalination plant	Major	Highly unlikely	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.			
Preparedness			

No MDO is spilled at sea during refuelling activities.	No vessel refuelling is undertaken at sea (this will be done in port.	Bunker log verifies that refuelling was undertaken in port.
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 contracted to Beach: • Comply with the requirements of: o *Navigation Act* 2012 (Cth), Chapter 3, Part 3 (Seaworthiness of vessels). o Marine Order 21 (Safety and emergency arrangements). o Marine Order 30 (Prevention of Collisions). o 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.	Vessel audit/assurance reports (prepared or commissioned by Beach) verify that vessels contracted to Beach meet legislative safety requirements.
	For vessels undertaking work along the pipeline, AMSA and DJPR (EMD) are notified within two weeks of the commencement of the activity so that Notices to Mariners can be generated.	Notice/s to Mariners are available for pipeline-related inspection and maintenance activities.
	Beach 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 Beach made contact with relevant stakeholders about the timing and location of the MSS.
Vessel crews are prepared to respond to a spill.	Vessels have approved SMPEPs (or equivalent appropriate to class) 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.
	Vessel crews are trained in spill response techniques in accordance with their SMPEP.	Training records verify that crews are trained in spill response.
	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.
	Prior to the survey commencing, a desktop oil spill response exercise is conducted to test the interfaces between the Beach OPEP, ERP and vessel contractor SMPEP.	Oil spill response exercise spreadsheet verifies that exercises have been undertaken.
Emergency response		
Vessel crews promptly respond to a spill.	An OPEP and ERP are in place and tested annually in desktop exercises by those	The OPEP and ERP are current.
		OPEP and ERP training schedule is available and remains live.

	nominated in the plans to be part of the response strategies.	The 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 and ERP exercise reports verify that exercises have been undertaken.
	The Vessel Master will authorise actions in accordance with the vessel-specific SMPEP (or equivalent according to class).	Daily operations reports verify that the SMPEP was implemented.
	The Prion MSS OPEP is implemented to limit the release of a Level 2 or 3 MDO spill.	Daily operations reports verify that the OPEP was implemented.
Recording and reporting		
Beach and regulatory authorities are promptly made of aware of near-misses and spills.	All incidents of spatial conflict with other marine users will be reported in the Beach incident register (CMO).	The CMO is current.
	Beach will report the 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 spill.	Beach will undertake operational and scientific monitoring in accordance with the OSMP.	Daily operations reports and overall study reports verify that the OSMP was implemented.

Risk Assessment (residual)			
Receptor	Consequence	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	Minor	Remote	Low
Sandy beaches	Minor	Remote	Low
Commercial fisheries	Minor	Remote	Low
Public amenity (beaches, recreational fishing)	Serious	Remote	Low
Desalination plant	Serious	Remote	Low

Demonstration of ALARP

<table>
<tr><td colspan="3">A 'low' residual risk rating is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required. However, because this hazard has a Decision Context of 'B', an ALARP analysis is presented below.</td></tr>
<tr><td colspan="3">Good practice</td></tr>
<tr><td>Avoid/Eliminate</td><td colspan="2">The potential for a vessel collision leading to a MDO spill cannot be eliminated completely.
However, eliminating the need to refuel on location removes one of the more credible sources of an MDO spill.</td></tr>
<tr><td>Change the likelihood

Change the consequence</td><td colspan="2">Power that could be used as a substitute to MDO, such as solar or wind power or biofuels, are not commercially proven in vessels. MDO is a substitute for HFO, which would have greater environmental impacts if spilled.
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.</td></tr>
<tr><td>Reduce the risk</td><td colspan="2">Vessel specific SMPEPs are in place and are implemented.
The Prion MSS ERP and OPEP are implemented in the event of a Level 2 or 3 spill.</td></tr>
<tr><td colspan="3">Engineering risk assessment</td></tr>
<tr><td colspan="3">The OSTM undertaken for the MDO spill scenario is an engineering risk assessment and supports the development of the EPS listed in this table.</td></tr>
<tr><td colspan="3">Cost benefit analysis</td></tr>
<tr><td colspan="3">Not applicable for an impact decision framework context of 'B'.</td></tr>
<tr><td colspan="3">Demonstration of Acceptability</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>Beach Environmental Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>OEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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>Stakeholder engagement (Chapter 4)</td><td colspan="2">The Prion MSS SEP is implemented to ensure that stakeholders are aware of operational issues.
There have been no concerns expressed regarding MDO spills.</td></tr>
<tr><td>Legislative context
(see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)</td><td colspan="2">The performance standards outlined in this EP align with the requirements of:
• Navigation Act 2012 (Cth):
o Chapter 4 (Prevention of Pollution).
• OPGGS Act 2006 (Cth):
o Section 572A-F (Polluter pays for escape of petroleum).
• OPGGS(E):
o Part 3 (Incidents, reports and records).
• Protection of the Sea (Prevention of Pollution by Ships) Act 1983 (Cth):
o Section 11A (SOPEP).</td></tr>
<tr><td rowspan="2">Industry practice
(see Sections 2.7 & 2.8 for descriptions)</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 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.</td></tr>
</table>

	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 Prion MSS.
	Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met 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)	Guidelines met 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: • To reduce the risk of any unplanned release of material into the marine environment to ALARP and an acceptable level.
Environmental context	MNES	
	AMPs (Section 5.5.1)	The MDO EMBA intersects the following AMPs: • Apollo; • Beagle; • East Gippsland; • Flinders; • Franklin; and • Zeehan. These AMPs have the following relevant conservation values: - Benthic assemblages - Cetaceans - Seabirds - Pinnipeds - White shark As addressed in Tables 7.59 to 7.66, the consequence of an MDO spill on these conservation values is minor and unlikely 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.
	Ramsar wetlands	There is no contact from high threshold entrained or dissolved hydrocarbons with Ramsar sites. There is a 0.5%

	(Section 5.5.4)	probability of low exposure entrained MDO intersecting small portions of the Corner Inlet Ramsar site and 1.5% probability of low exposure entrained MDO with the Lavinia Ramsar site. At this exposure concentration, the conservation values of these wetlands will not be affected in the long-term.
	TECs (Section 5.5.6)	Entrained hydrocarbons at the low threshold of exposure may intersect the Giant Kelp Forests of South East Australia on the north western coast of Tasmania and the west coast of Flinders Island. At this exposure level, there will be no significant impacts to giant kelp populations, as detailed in Table 7.60. Entrained hydrocarbons at the high threshold of exposure may intersect the Giant Kelp Forests of South East Australia TEC among the Kent Island Group, the Hunter Island Group and north western Tasmania. Even at this concentration, there are unlikely to be significant impacts on this TEC, as detailed in Table 7.60. Entrained hydrocarbons at the low threshold of exposure may intersect the subtropical and temperate coastal saltmarsh TEC located at the Nooramunga Marine and Coastal Park in Victoria. At this exposure level, there will be no long-term impacts to this TEC.
	NIWs (Section 5.5.8)	The EMBA (low threshold entrained phase hydrocarbons) is predicted to potentially intersect the following NIWs: • Lavinia; • Western Port; • Corner Inlet; • Snowy River; • Sydenham Inlet Wetlands; • Tamboon Inlet Wetlands; • Thurra River; and • Benedore River. Low threshold entrained hydrocarbons are not predicted to have toxicological impacts on the waterbird species that these sites are important for. There are no NIWs that are intersected by high threshold entrained phase hydrocarbons.
	Nationally threatened and migratory species (Section 5.4)	Some nationally threatened species and migratory species have the potential to be present in the MDO spill EMBA, particularly within their BIAs, but as evaluated in the previous tables in this section, the consequence to individuals or populations of threatened and migratory species are mostly minor.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	The MDO EMBA intersects the following state marine parks: • Bunurong MP/MNP; • Wilsons Promontory MP/MNP. • Cape Howe MNP; • Point Hicks MNP; • Corner Inlet MCP; • Nooramunga MCP;

		• Chappell Islands NR; and • Kent Group NP. See **Appendix 1** for additional detail regarding the impacts of non-routine activities on the management aims of these 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 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		
Vessels		
• Vessel assurance reports. • Notices to Mariners. • Stakeholder consultation correspondence and register. • SMPEPs. • OPEP. • ERP.	• Crew training records. • Bunkering procedure. • Bunkering PTWs, JSAs, inspection checklists. • Oil spill response exercise records. • Inspection/audit reports. • Incident reports.	

7.14 RISK 6 - Hydrocarbon Spill Response Activities

This section assesses the environmental and socio-economic risks associated with the MDO spill response strategies. 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.

Table 7.71 summarises the feasibility and effectiveness of the strategies available to respond to a Level 2 or 3 MDO spill, and whether they will be adopted. Only those that will be adopted are risk assessed in this section.

Table 7.71. Prion 3DMSS MDO spill response options

Response option	Feasibility and effectiveness analysis	Adopt?
Source control	**Effectiveness** Implementing the vessel-specific SMPEP is the preferred manner 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

Response option	Feasibility and effectiveness analysis	Adopt?
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
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
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 '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.	No
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/m^2), 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/m^2) 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
Protection and Deflection	**Effectiveness** The high volatility of MDO creates inherent safety risks when attempting to use protection and deflection booms. 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.	No

Response option	Feasibility and effectiveness analysis	Adopt?
	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 allowing for natural degradation.	
Shoreline clean-up	**Effectiveness** MDO is highly volatile and will evaporate rapidly even after making shoreline contact. MDO also quickly infiltrates sand, where it is then remobilised by wave action (reworking) until it has naturally degraded. This quick infiltration through sediments makes it very difficult to recover without also recovering vast amounts of shoreline sediments. **Feasibility** 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 1.3 km. Environmental impacts are likely to be higher when implementing this response technique compared to the natural degradation.	No
Oiled Wildlife Response (OWR)	**Effectiveness** Because MDO evaporates and disperses rapidly, most fauna are unlikely to be exposed to sub-lethal or lethal hydrocarbon concentrations that warrant wildlife capture and treatment, especially at the sea surface. **Feasibility** The relative proximity of the Phillip Island wildlife rescue centre to the affected shoreline makes an OWR response feasible. However, more wildlife harm could occur (during the handling and treatment process) using this response technique compared to allowing for natural cleaning. 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

Table 7.71 indicates that only the following responses may be used to respond to a hydrocarbon spill:

- Source control;
- Monitor and evaluate; and
- Assisted natural dispersion.

The risks associated with these response techniques is discussed in this section.

7.14.1 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.

7.14.2 Availability

Monitor and Evaluate

Beach (through its membership with AMOSC), the DJPR (Emergency Management Branch, EMB) and DPIPWE (EPA Tasmania) maintain operational monitoring capability as outlined in Table 7.72.

Table 7.72. Resources available for monitoring and evaluation

<table>
<tr><th>Resource required</th><th>Beach resources</th><th>DJPR (EMB) resources</th><th>DPIPWE (EPA Tasmania resources)</th></tr>
<tr><td>Aviation</td><td>Beach will activate its contract with AMOSC to access helicopter and/or fixed aircraft to assist in spill monitoring.</td><td>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.</td><td rowspan="2">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 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.</td></tr>
<tr><td>Trained observers</td><td>Beach 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.</td><td>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.</td></tr>
<tr><td>Vessel-based observations</td><td colspan="3">Vessels of opportunity (VoO) based in ports nearest to the survey area, such as San Remo and Queenscliff would be engaged as required. VoO from ports slightly further afield, such as Geelong, Barry Beach (in Corner Inlet) Lakes Entrance and Stanley would also be considered.</td></tr>
</table>

Resource required	Beach resources	DJPR (EMB) resources	DPIPWE (EPA Tasmania resources)
OSTM	Beach 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.

7.14.3 Hazards

The hazards associated with each of these 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.

7.14.4 Impacts and Risks of the Response Activities

The impacts and risks associated with these 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.

7.14.5 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 in some shorelines of the EMBA. As an example, the eggs of hooded plovers (that nest only on sandy beaches) have small eggs that are very well camouflaged, so they are easily trodden on by accident. If the incubating adult is scared off the nest by passers-by, the eggs may literally bake in the sun, or become too cold in the cool weather. Either way, it kills the chick developing in the egg, and the egg will not hatch. Similarly, when people disturb a chick, it quickly runs into the sand dunes and hides. While it is running, the chick uses up valuable energy, and while it is hiding it is unable to feed (they usually forage at the water's edge), so that a chick that is forced to run and hide throughout the day could easily starve (Birdlife Australia, 2016). 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 (likely 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.

7.14.6 Environmental Impact and Risk Assessment

Table 7.73 presents the risk assessment for hydrocarbon spill response activities

Table 7.73. Risk assessment for hydrocarbon spill response activities

Summary			
Summary of risks	Disturbance to marine and shoreline fauna.		
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 (inherent)			
Receptor	Likelihood	Consequence	Risk rating
Fauna disturbance	Possible	Minor	Medium
Fauna injury	Possible	Minor	Medium
Fauna death	Unlikely	Minor	Low

EPO	EPS	Measurement criteria
Preparedness		
Source control Beach and its vessel contractors are operationally ready to respond to a spill.	Vessels contracted to Beach have a current SMPEP (or as appropriate to class) in place.	Inspection/audit records verify current SMPEPs in place.
Monitor and evaluate Beach maintains capability to implement hydrocarbon spill monitoring and response in a Level 2 or 3 spill event.	Access to operational response capabilities is maintained through the survey vessel paying the required shipping levy and Beach 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 equipment to ensure it is always ready to respond rapidly.	AMSA response capabilities are maintained in a manner that permits them to respond to spills rapidly (noted in annual reports).
	Beach undertakes a desktop drill prior to the survey commencing in order to test internal and external spill response communications.	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 contacted 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, protection and deflection Monitoring activities are undertaken in a manner that protects sensitive fauna and habitat.	Helicopters 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	Likelihood	Consequence	Risk rating
Fauna disturbance	Unlikely	Minor	Low
Fauna injury	Unlikely	Minor	Low
Fauna death	Highly unlikely	Minor	Low

Demonstration of ALARP

A 'low' residual risk rating is considered to be ALARP and a 'lower order' impact. An ALARP analysis is therefore not required. 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 an MDO spill, including in the context of the OSTM undertaken for the Prion MSS. This should be taken into account into 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 Beach personnel to monitor and respond to the reduces the likelihood and

<table>
<tr><td>Change the consequence</td><td colspan="2">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.</td></tr>
<tr><td>Reduce the risk</td><td colspan="2">A pre-survey desktop exercise will be undertaken to ensure Beach and vessel contractors 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.
Beach's contract with AMOSC reduces the risk of delays in instigating response measures (over and beyond those of AMSA).</td></tr>
<tr><td colspan="3">Engineering risk assessment</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">Cost benefit analysis</td></tr>
<tr><td colspan="3">Not applicable for an impact decision framework context of 'B'.</td></tr>
<tr><td colspan="3">Demonstration of Acceptability</td></tr>
<tr><td rowspan="2">Internal context</td><td>Policy compliance</td><td>Beach Environmental Policy objectives are met through implementation of this EP.</td></tr>
<tr><td>OEMS compliance</td><td>Chapter 8 describes the EP implementation strategy employed for this activity. It is demonstrated that all the standards in the OEMS 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>Stakeholder engagement (Chapter 4)</td><td colspan="2">Beach has undertaken open and honest communications with all stakeholders, and actively involved stakeholders known to have concerns with MSS.
Stakeholders have not raised concerns about hydrocarbon spill response activities.</td></tr>
<tr><td>Legislative context
(see Sections 2.2, 2.3 & 2.4 for descriptions of relevant legislation)</td><td colspan="2">The performance standards outlined in this EP align with the requirements of:
• OPGGS Act 2006 (Cth) and OPGGS(E) (Cth):
o Part 6.2 – directs the polluter to take actions in response to an incident and to clean up and monitor impacts.
o Regulation 13(5) (Risk assessment undertaken to demonstrate ALARP).
• EPBC Regulations 2000 (Cth):
o Part 8 (Interacting with cetaceans and whale watching).
• 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 (Tas).
• Environmental Management and Pollution Control Act 1994 (Tas).
• Emergency Management Act 2006 (Tas).</td></tr>
</table>

Industry practice (see Sections 2.7 & 2.8 for descriptions)	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 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.
	Best Available Techniques Guidance Document on Upstream Hydrocarbon Exploration and Production (European Commission, 2019)	No guidance is provided regarding oil spill response activities, other than having a spill contingency plan in place. An OPEP is in place for the Prion MSS.
	Effective planning for managing environmental risk associated with geophysical and other imaging surveys (Nowacek & Southall, 2016)	The four practices outlined in this document have been considered (and adopted where practicable) in the development of performance standards for this EP and the survey design in general.
	Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development (World Bank Group, 2015)	Guidelines met with regard to: • Sections 76-79 (Spill response planning): A spill response plan should be prepared.
	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 Pla.
	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 Beach 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).	
Environmental context	MNES	
	AMPs (Section 5.5.1)	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.
	Ramsar wetlands (Section 5.5.4)	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 Ramsar wetlands.
	TECs (Section 5.5.6)	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 5.5.8)	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 5.4)	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 impacts on threatened and migratory species.
	Other matters	
	State marine parks (Sections 5.5.9 & 5.5.10)	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. See **Appendix 2** for additional detail regarding the impacts of non-routine activities on the management aims of threatened species plans. Land, 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.

8. Implementation Strategy

Regulation 14 of the OPGGS(E)R requires that the EP must contain an implementation strategy for the activity.

The Beach Operations Excellence Management System (OEMS) will be used to govern the Prion 3DMSS. The OEMS provides guidance on how Beach will meet the requirements of its Environmental Policy (see Figure 2.1). The Beach OEMS has been developed considering Australian/New Zealand Standard ISO 14001:2016 Environmental Management Systems. The OEMS is an integrated management system and includes all HSE management elements and procedures.

The Implementation Strategy described in this section provides a summary of the OEMS elements and how they will be applied to effectively implement the control measures detailed in this EP. Specifically, it describes:

- The OEMS;
- Environment-specific roles and responsibilities;
- Arrangements for monitoring, review and reporting of environmental performance;
- Preparedness for emergencies; and
- Arrangements for ongoing consultation.

8.1 Operations Excellence Management System

The Prion 3D MSS will be undertaken in accordance with the Beach OEMS. The OEMS documents the Environmental Policy, 11 OEMS Elements, HSE Procedures and the key HSE processes and requirements for activities where Beach is the titleholder. It provides a management framework for achieving the requirements in a systematic way but allows flexibility to achieve this in a manner that best suits the business. The OEMS has been developed based on the IOGP Operating Management System Framework and is aligned with the requirements of recognised international and national standards including:

- ISO 14001 (Environmental Management);
- ISO 31000 (Risk Management); and
- ISO 45001 (Occupational Health and Safety Management Systems).

At the core of the OEMS are 11 elements and associated standards that detail specific performance requirements that incorporate all the requirements for the implementation of the Environmental Policy (provided in Figure 2.1) and management of potential HSE impacts and risks (Table 8.1 and Figure 8.1). The Elements, via the nominated expectations, sponsor 30 Beach OEMS Standards, which provide more granular minimum compliance rule sets under which the company operates. At the business level, the system is complemented by asset and site procedures and plans such as this EP.

Whilst Beach is the titleholder for the activity, the survey contractor maintains operational control of the vessel as per the requirements of their management system. The application of OEMS Elements and Standards relevant to the MSS are described in the following sections.

Table 8.1. Beach OEMS Elements and Standards

Element		Standard
1	Partners, Leadership and Authority	Leadership Standard
		Technical Authority Standard
		Joint Venture Management Standard
2	Financial Management and Business Planning	Integrated Planning Standard
		Phase Gate Standard
		Hydrocarbon Resource Estimation and Reporting Standard
		Finance Management Standard
3	Information Management and Legal Requirements	Regulatory Compliance Standard
		Document Management Standard
		Information Management Standard
4	People, Capability and Health	Training and Competency Standard
		Health Management Standard
5	Contracts and Procurement	Contracts and Procurement Standard
		Transport and Logistics Standard
6	Asset Management	Asset Management Standard
		Maintenance Management Standard
		Well Integrity Management Standard
		Well Construction Management Standard
		Project Management Standard
7	Operational Control	Operational Integrity Standard
		Process Safety Standard
		Management of Change Standard
8	Risk Management and Hazard Control	Risk Management Standard
		Safe Systems of Work
		Emergency and Security Management Standard
9	Incident Management	Incident Management Standard
10	Environment and Community	Environment Management Standard
		Community Engagement Standard
11	Assurance and Reporting	Sustainability Standard
		Assurance Standard

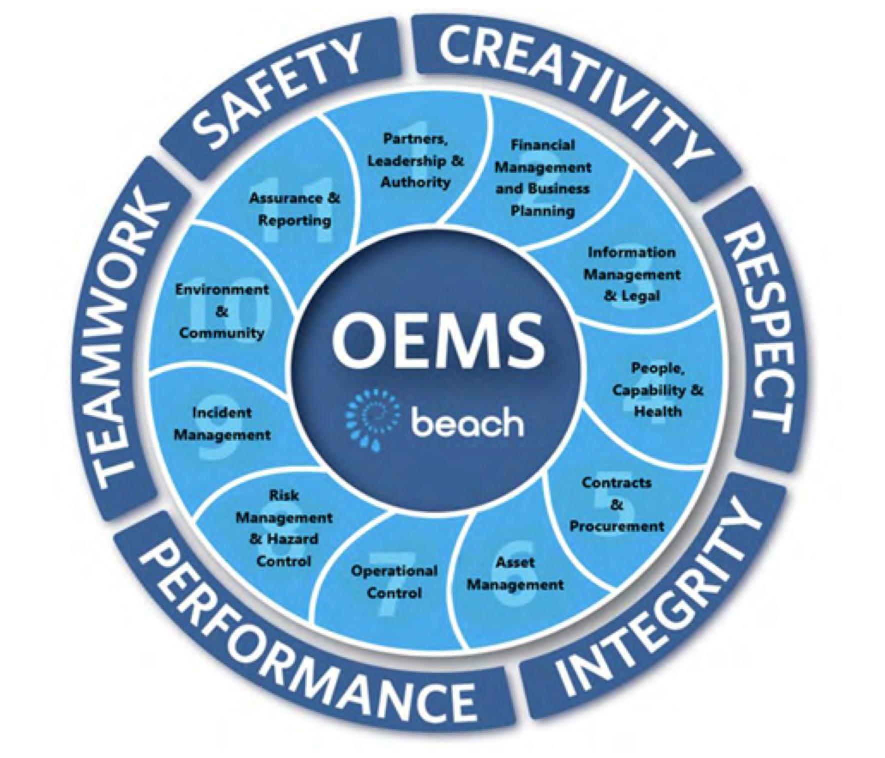


Figure 8.1. The Beach OEMS

8.2 Element 1 – Partners, Leadership and Authority

Element 1 focuses on ensuring the organisation is equipped, structured and supported to ensure a healthy, efficient and successful company. Communications with internal and external bodies, including joint venture partners, is essential to delivering successful projects and operations. The leadership styles and actions demonstrated within Beach will influence the performance of all staff and contractors. Clear levels of authority are necessary to remove organisational ambiguity and to support effective decision making.

There are three standards (see Table 8.1) and 11 outcomes to be delivered under this element.

To this effect, Beach's Environment Policy provides a clear commitment to conduct its operations in an environmentally responsible and sustainable manner.

Demonstratable compliance with this EP is a key commitment for Beach. This will be managed through the use of a commitments register to track all EP commitments through to completion.

The Beach CEO has the ultimate responsibility for ensuring that Beach has the appropriate organisation in place to meet the commitments established within this EP. The Beach Survey Project Manager and Principal Environmental Advisor (offshore), have the responsibility and delegated authority to ensure that adequate and appropriate resources are allocated to comply with the OEMS and this EP.

The organisation structure for the Prion 3DMSS is illustrated in Figure 8.2 and the roles and responsibilities of key project members are summarised in Table 8.2.

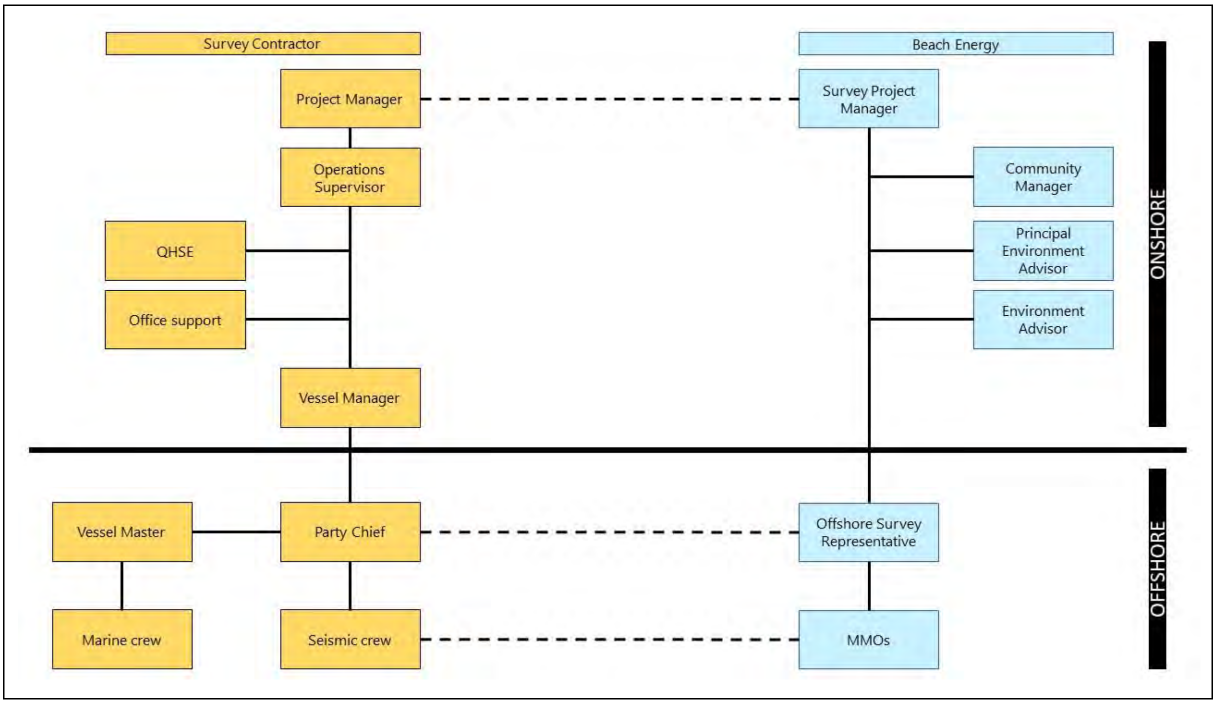


Figure 8.2. Prion MSS organisation chart

Table 8.2. Prion MSS roles and key environmental responsibilities

Role	Key environmental responsibilities
Onshore	
Beach Chief Executive Officer	Ensures: • Beach 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 OEMS continues to meet the evolving needs of the organisation.
Beach Survey Project Manager	Ensures: • Compliance with regulatory and other requirements and this EP. • Records associated with the activity are maintained as per Section 8.4.2. • Personnel who have specific responsibilities pertaining to the implementation of this EP or OPEP 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 8.8.1. • Incidents are managed and reported as per Section 8.10.1. • The EP environmental performance report is submitted to NOPSEMA not within three months of activity completion. • 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 8.8.1. • Oil spill response arrangements for the activity are tested as per Chapter 9. • Ensure audits and inspections are undertaken in accordance with Section 8.12.

Role	Key environmental responsibilities
Beach Principal Environment Advisor (offshore)	Ensures: • Environmental and regulatory requirements are communicated to those who have specific responsibilities pertaining to the implementation of this EP or OPEP. • The environmental component of the activity induction is prepared and presented. • Environmental incidents are reported and managed as per Section 8.10. • The monthly and end-of-activity EP environmental performance report are prepared and submitted. • Any new or changed environmental impact or risk or a change that may impact the EP is reviewed and documented as per Section 8.12. • That audits and inspections are undertaken as detailed in Section 8.12 and any actions from non-conformances or improvement suggestions tracked. • Reviews and revisions to the EP are made as per the requirements in Section 8.12.
Beach Community Manager	Ensures: • Stakeholder consultation for the activity is undertaken in a timely and thorough manner. • Objections or claims raised by stakeholders are recorded and reported to the Survey Project Manager and Principal Environmental Advisor (offshore). • A stakeholder consultation log is maintained. • Stakeholder issues are addressed.
Offshore	
Beach Offshore Representative	Ensures: • The activity is carried out in accordance with regulatory requirements and this EP. • Vessel personnel participate in the activity induction. • Vessel personnel are competent to fulfil their designated role. • HSE issues are communicated via mechanisms such as the daily report, daily pre-start meetings and weekly HSE meeting. • New or increased environmental impacts or risks are managed via the MoC process detailed in Section 8.8.1. • Environmental incidents are reported and investigated as per Section 8.12. • Emissions and discharges identified in Section 8.12 are recorded and reported in the end-of-activity EP performance report. • The Survey Project 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 8.12. • Weekly HSE vessel inspections as detailed in Section 8.12 are undertaken to ensure ongoing compliance with the EP.
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 Beach Offshore Representative within required timeframes as per Section 8.10. • Emissions and discharges identified in Section 8.12 are recorded and provided to the Beach Offshore Representative. • The Beach 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 8.12. • Oil spill response arrangements are in place and tested as per the vessel's SMPEP. • General and hazardous wastes are backloaded to port for disposal to a licenced waste facility.

Role	Key environmental responsibilities
Party Chief	Ensures: • That procedures and work instructions required for seismic operations are known, understood and followed by all vessel personnel. • Toolbox meetings are conducted. • Working codes and practices are implemented for all survey operations in accordance with industry standards.
MMOs	Ensure: • That vessel crew are briefed about their role in supporting the MMOs to fulfil their duties. • That the EPBC Policy Statement 2.1 procedures and additional controls detailed in Section 7.1.5 and Section 7.11.5 are implemented throughout the survey. • A daily log of cetacean sightings is maintained. • That continuous liaison is maintained with the Party Chief and Beach Offshore Representative regarding MMO implementation issues. • An end-of-survey MMO report is prepared for submission to DAWE.
Vessel personnel	All vessel crew are responsible for: • Completing the Beach 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 in letter and in spirit. • 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.

This element recognises that a systematic risk-based approach to HSE management is in place as an integral part of leadership and planning, and that HSE goals and targets must be established and measured. A philosophy of continuous improvement is applied to all Beach operations.

Targets for environmental performance of the MSS are detailed throughout Chapter 7 of this EP. The EPO and EPS have been established to ensure that the impacts of planned activities and the risks of unplanned events are managed to ALARP and to an acceptable level.

Additionally, the EPO and EPS emerging from this Implementation Strategy are summarised in Section 8.13.

8.3 Element 2 – Financial Management and Business Planning

Element 2 seeks to ensure robust and achievable business plans are developed and supported by a consistent and realistic understanding of facility constraints. It drives robust analysis and accountable decision-making to deliver assets that maximise lifecycle value, providing clear cost control throughout the life of an asset.

There are four standards (see Table 8.1) and ten outcomes to be delivered under this element.

This EP does not cover the risks involved in financial management and impact on the Prion 3DMSS. The relevant impacts of financial and business planning risks are managed under the other OEMS elements described in this chapter.

8.4 Element 3 – Information Management and Legal

Element 3 describes the measures Beach must take to ensure ongoing compliance with regulatory and legal obligations in order to protect the Company's value and reputation, and to maintain Beach's licences to operate.

Beach's ability to safely perform its duties in line with its legal obligations relies on robust management of documents and information.

There are three standards (see Table 8.1) and seven outcomes to be delivered under this element. The standards relevant to the implementation of this EP are described below.

8.4.1 Standard 3.1 – Regulatory Compliance Standard

Standard 3.1 describes the responsibilities of each stakeholder and the processes for identifying, maintaining, managing and reporting Beach's regulatory compliance obligations. The Standard details the minimum requirements of a system to ensure effective Regulator engagement can be maintained across all its activities including permissioning, project execution, operating and reporting.

Chapter 2 of this EP details the key environmental legislation applicable to the MSS. The acceptability discussion for each hazard assessed in Chapter 7 specifically details the legislation pertaining to each hazard.

8.4.2 Standard 3.2 – Document Management Standard

Standard 3.2 specifies the minimum requirements to ensure that all Beach documents and records are managed in alignment with legal, regulatory and stakeholder requirements. It requires documents to be classified, developed, authorised, published, stored, accessed, reviewed and disposed consistently and in a manner that complies with company and statutory obligations. The document management system will clearly support the safe and efficient operations of the Company.

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 Beach document control system ('BoardWalk') for a minimum of five years. These records will be made available to regulators in electronic or printed form upon request.

8.4.3 Standard 3.3 – Information Management Standard

Standard 3.3 ensures that Beach implements appropriate Information Management practices to ensure information is managed as a corporate asset, enabling it to be exploited to support corporate objectives as well as satisfying Beach's legal and stakeholder requirements.

8.5 Element 4 – People, Capability and Health

Element 4 focuses on ensuring the people within the business are fully equipped with the competencies required to perform their assigned duties and are physically and mentally prepared. This element is important in protecting workers' health and is closely aligned with Standard 8.1 (Risk Management) and Standard 8.2 (Safe Systems of Work).

There are two standards (see Table 8.1) and four outcomes to be delivered under this element. Standard 4.1 is discussed below, noting that the health management standard is not relevant to the EP.

8.5.1 Standard 4.1 – Training and Competency Standard

Standard 4.1 describes the minimum company requirements to ensure peoples training requirements are identified and meet the tasks they are required to perform, and that verification of competency is carried out where necessary. The Standard defines the responsibilities for ensuring suitable training programmes are available and for ensuring peoples levels of capability are maintained at the required level.

Each employee or contractor with responsibilities pertaining to the implementation of this EP shall have the appropriate competencies to fulfil their designated role.

To ensure that personnel are aware of the EP requirements for the activity, all vessel personnel will complete a project-specific environmental induction. Records of completion of the induction will be recorded and maintained. 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 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 shall be made aware of their responsibilities, and the specific control measures required to maintain environmental performance and legislative compliance.

The Beach Offshore Representative is responsible for delivering the induction, or facilitating it if presented by another member of the project team.

The survey contractor will conduct their own company and vessel-specific inductions independently of the project-specific HSE induction.

This element also includes the management of HSE risks to personnel associated within the working environment and encourages a healthy lifestyle for its employees and provides formal programs to promote health and fitness.. These are not related to the implementation of the EP and are not addressed here.

The Survey Project Manager has responsibility for ensuring that systems are in place to facilitate the communication of HSE issues to survey and vessel crew. This is typically via the daily operations meeting and weekly HSE meetings.

8.5.2 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 Beach 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.

8.5.3 Communications

The Vessel Master, Party Chief and Beach 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 8.3 outlines the key meetings that will take place onshore and offshore during survey acquisition.

Table 8.3. Project communications

Meeting	Frequency	Attendees
Onshore		
Beach project team	Daily	All team members
Offshore		
Operations (including cetacean strategy)	Daily	Beach onshore project team, department heads, Beach 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

8.6 Element 5 – Contracts and Procurement

Element 5 addresses the acquiring of external services and materials, and the transportation of those materials. It ensures Beach's business interests are met while maintaining compliance with all legal obligations and retaining HSE performance as the top priority. Element 5 also documents requirements for management of land transport risks.

There are two standards (see Table 8.1) and four outcomes to be delivered under this element.

Section 3.5.1 details how the vessel contractor will be assessed to ensure they have the capabilities and competencies to implement the control measures identified in Chapter 7. Training and competency of contractor personal engaged to work on the activity shall be managed in accordance with the contractor's HSEMS (or equivalent).

8.7 Element 6 – Asset Management

The focus of Element 6 is the design, build and operation of assets. The underpinning standards reflect the importance of inherent safety in design, recognising that hazards and risk are to be reduced to ALARP in the design phase of an asset. The standards define the minimum requirement for the monitoring and assurance processes that support the ongoing safe and reliable management of an asset throughout its lifecycle. Element 6 draws heavily on the principles of process safety and is closely aligned with Elements 7 (Operational Control) and Element 8 (Risk Management).

There are five standards (see Table 8.1) and eight outcomes to be delivered under this element.

These standards are not of particular relevance to activities where Beach has no operational control of a facility (in this case, the survey vessel). Nevertheless, plant and equipment that have been identified as a control measure for the purposed 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 Prion 3DMSS, Beach will ensure that the contractor maintains all plant and equipment in good working order.

8.8 Element 7 – Operational Control

Element 7 focuses on the definition of parameters, practices and procedures required to ensure adequate controls and safe execution of work at operating assets. It deals with the ongoing management of barrier integrity throughout asset lifecycle, ensuring good process safety practices are consistently deployed, and that facility changes manage holistic risk.

There are three standards (see Table 8.1) and ten outcomes to be delivered under this element. The standard of relevance to this EP is briefly discussed below.

8.8.1 Standard 7.3 – Management of Change Standard

Standard 7.3 defines the minimum planning and implementation requirements for technical and organisational change at Beach. It details the requirement for holistic assessment of the change, the requirement for consultation with stakeholder's dependent upon the nature of the change, and the need for clear accountability for the change. Risk associated with change is mitigated by ensuring change is appropriately approved, effectively implemented, formally assured and closed out upon completion. Any changes must be classified as either temporary or permanent.

The intent of the MoC Standard 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 MoC Standard 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 (called 'Stature'), 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 the Beach Environment Team to determine whether the MoC review process is triggered.

Where risk and hazard review processes nominated in Section 8.9 identify a change in hazards, controls or risk (compared to those described and assessed in Chapter 7), and triggers a regulatory requirement to revise this EP, the revision shall be defined, endorsed, completed and communicated in accordance with the MoC Standard.

8.9 Element 8 – Risk Management and Hazard Control

The identification, assessment and treatment of risk is central to maintaining control of assets. Element 8 defines the means by which Beach manages all types of risk to the business. This element includes general risk management, the Safe Systems of Work by which site activities are controlled and executed, and the emergency and security arrangements in place to protect the Company from unplanned events or the attempts of others to do harm to the business.

There are three standards (see Table 8.1) and seven outcomes to be delivered under this element. The standards of relevance to this EP are briefly discussed below.

8.9.1 Standard 8.1 – Risk Management Standard

Standard 8.1 defines Beach's requirements to mitigate and manage risk at all levels within the business. It defines the Risk Management Framework for identifying, understanding, managing and reporting risks. The framework defines the documents, training, tools and templates to be used, and the accountabilities to be applied in support of effective risk management. Risks to people, the environment, Beach's reputation, financial position and any legal risks are assessed through the framework. The Standard defines the purpose and use of risk assessments and risk registers. The environmental risk management framework applied to the Prion 3DMSS is described in Chapter 6 and applied to all the hazards assessed in Chapter 7 of this EP.

As described in Section 8.12, Beach will undertake a review of this EP if required in order to ensure that any changes to the activity, controls, regulatory requirements and information from research, stakeholders, industry bodies or any other sources to inform the EP are assessed using the risk management tools nominated. The review will ensure that the environmental impacts and risks of the activity continue to be reduced to ALARP and an acceptable level.

If revision of this EP is trigged though a change in risk or controls, the revision process shall be managed in accordance with the MoC process outlined in Section 8.8.1.

8.9.2 Standard 8.3 – Emergency and Security Management Standard

Standard 8.3 defines the minimum performance requirements to effectively manage credible emergency and security events, and to enable an efficient recovery to normal operations following such an event. The Standard defines the prevention, preparedness, response and recovery principles to be applied, the organisational structures to support emergency and security measures, and the training and testing protocols that must be in place to assure Beach maintains a state of readiness.

The emergency response framework to be applied to the Prion 3DMSS is outlined below.

Emergency Response Framework

The Beach Crisis and Emergency Management Framework consists of a tiered structure whereby the severity of the emergency triggers the activation of emergency management levels. The emergency response framework contains three tiers based on the severity of the potential impact, as outlined in Figure 8.3. This framework is described in the Beach Emergency Management Plan (EMP) (CDN/ID 128025990).

The responsibilities of the Emergency Response Team (ERT), Emergency Management Team (EMT) and Crisis Management Team (CMT) are outlined in Table 8.4.

The key emergency response arrangements for the Prion 3DMSS are outlined herein.

Emergency Response Plan

Beach will prepare a bridging ERP that bridges to the emergency response measures in the survey contractor's vessel-specific ERP to ensure that all emergency management functions are accounted for.

The Bridging ERP will describe the emergency roles and responsibilities for those on the vessel and outline the actions to be taken for potential activity-specific scenarios (e.g., loss of containment, vessel collision, fire, man overboard, fatality, etc). The Bridging ERP will define the communication requirements to notify both the company and external bodies of the incident so as to obtain assistance where needed and to fulfil reporting obligations.

The Bridging ERP will be supported by the Beach EMP. The EMP provides the standard mechanism for the EMT to operate from and includes guidance on effective decision-making for emergency events, identification, assessment and escalation of events and provides training and exercise requirements. The EMP provides information on reporting relationships for command, control and communications, together with interfaces to emergency services specialist response groups, statutory authorities and other external bodies. The roles and responsibilities are detailed for onshore and offshore personnel involved in an emergency, including the response teams, onshore support teams, visitors, contractors and employees. The EMP details the emergency escalation protocol depending on the nature of the emergency.

Associated with the EMP are the Emergency Response Duty Roster and Contact Lists. These documents constitute a suite of emergency response documents that form the basis for Beach's response to an emergency situation.

Where a third-party contractor (TPC) company is required to work under its own HSE management system while on the survey vessel, the Bridging ERP will detail the clear reporting lines between the TPC representatives and Beach personnel.

Table 8.4. Responsibilities of the Beach crisis and emergency management teams

Team	Base	Responsibilities
CMT	Adelaide head office	• Strategic management of Beach's response and recovery efforts in accordance with the Crisis Management Plan. • Provide overall direction, strategic decision-making as well as providing corporate protection and support to activated response teams. • Activate the CMT if required.
EMT	Melbourne office (or Adelaide office, depending on roster)	• Provide operational management support to the ERT to contain and control the incident. • Implement the Business Continuity Plan. • Liaise with external stakeholders in accordance with the Bridging ERP. • Regulatory reporting.
ERT	Survey vessel	• Respond to the emergency in accordance with the site-specific ERP (e.g., SMPEP).

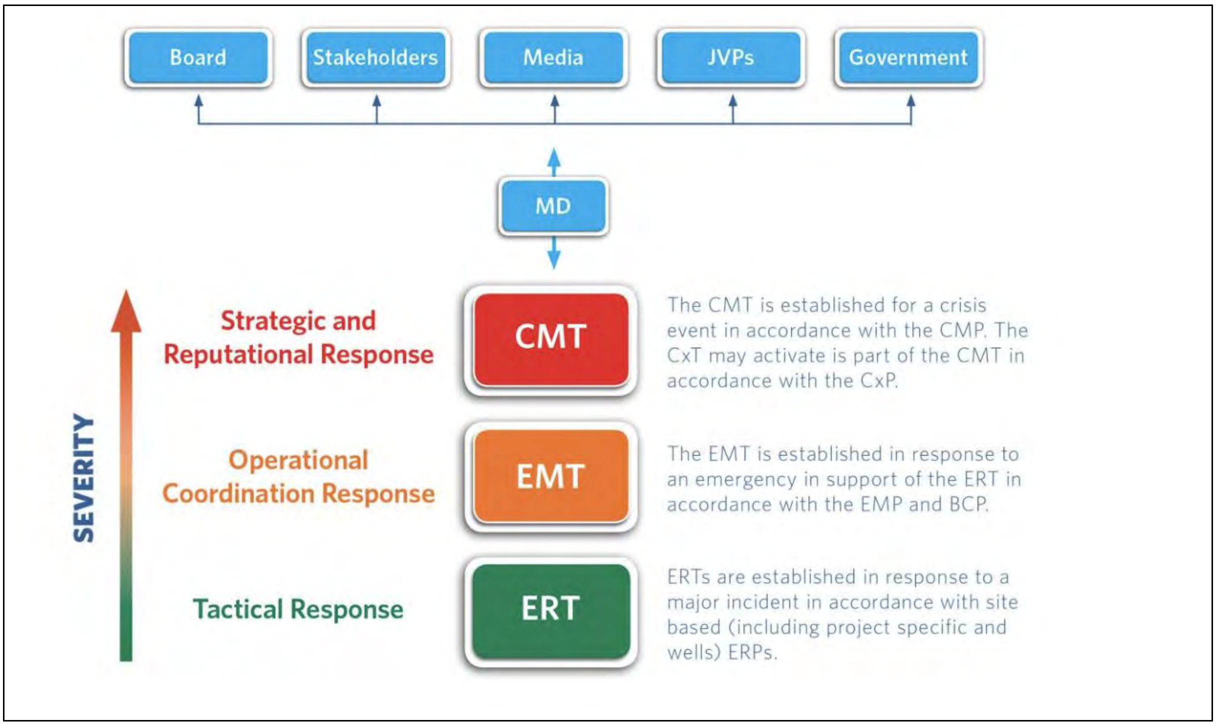


Figure 8.3. Beach Crisis and Emergency Management Framework

Prior to commencing the survey, office and vessel-based personnel will participate in a survey-specific desktop emergency response exercise to test the emergency response arrangements. 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, and the outcomes will be communicated to participants. Actions will be recorded and tracked to completion. This emergency response exercise may be combined with a test of spill response arrangements (see Section 9.4).

8.9.3 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 Beach 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.

8.10 Element 9 – Incident Management

Element 9 defines how Beach classifies, investigates, reports and learns from incidents An incident is any unplanned event or change that results in potential or actual adverse effects or consequences to people, the environment, assets, reputation, or the community.

There is one standard (see Table 8.1) and five outcomes to be delivered under this element, with the standard discussed below.

8.10.1 Standard 9.1 – Incident Management Standard

Standard 9.1 defines the requirement for incident reporting and subsequent investigation requirements. It ensures that incident classification is applied consistently across the company, and that the appropriate level of investigation and approval authority is implemented. The standard describes the requirement for identifying and assigning remedial actions, and for communicating key learnings throughout the business. As such, the standard also defines the requirement for adequate training for those persons involved in performing investigations.

The incident management standard requires that all HSE incidents, including near misses, are reported, investigated and analysed to ensure that preventive actions are taken and learnings are shared throughout the organisation.

Incident reports and corrective actions are managed using the CMO Incident Management System.

The recordable and reportable incident types are described in this section.

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, are prepared by the Beach Principal Environment Advisor (offshore) 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 8.5 summarises the recordable incident reporting requirements.

Table 8.5. Recordable incident reporting details

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.	NOPSEMA – submissions@nopsema.gov.au

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 Beach Environmental Risk Matrix, Beach interprets 'moderate to significant' environmental damage to be those hazards identified through the EIA and ERA process (see Chapter 7) as having an inherent or residual impact consequence of 'serious (3)' or greater. Impacts and risks with these ratings (as outlined throughout Chapter 7) are:

- Risk 4 – Introduction of IMS; and
- Risk 6 – MDO release.

Table 8.6 presents the reportable incident reporting requirements.

Table 8.6. 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	• NOPSEMA – 1300 674 472

Timing	Requirements	Contact
	• The corrective action that have been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	
	For a Level 1, 2 or 3 hydrocarbon 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
	For a Level 2 or 3 hydrocarbon spill only.	• Watersure – 03 5671 9041
	Oiled wildlife	• DELWP – 1300 134 444 (24 hrs) • DPIPWE - 03 6165 4599
	Suspected or confirmed IMS introduction	• DELWP – 136 186 (24 hrs) • DAWE - 1800 803 772 (general enquiries)
	Injury or death of EPBC Act-listed or FFG Act-listed fauna (e.g., vessel collision)	• DELWP – 1300 134 444 (24 hrs) • DAWE – 1800 803 772 • Whale and dolphin emergency hotline – 1300 136 017 • AGL marine response unit – 1300 245 678
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

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 Beach CMO Incident Management System.

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.

8.11 Element 10 – Environment and Community

Element 10 focuses on the measures the organisation must take to ensure that it upholds its reputation as a responsible and ethical company and continues its open and transparent engagements with its communities and stakeholders. Beach operates in environmentally sensitive areas, in close proximity to communities, with potential impacts on stakeholders. Beach has an obligation to ensure that potential impacts from its activities are clearly identified, minimised to ALARP and mitigated where there is an economic loss to a stakeholder directly impacted by Beach activities.

There are two standards (see Table 8.1) and three outcomes to be delivered under this element, with the standards discussed below.

8.11.1 Standard 10.1 – Environment Management Standard

Standard 10.1 ensures that Beach implements appropriate plans and procedures to conduct its operations in an environmentally responsible and sustainable manner. The standard defines the requirement to assess environmental impacts and risks that may result from the company's operations and for site-specific management plans to protect the environment from harm. The standard covers land disturbance, reinstatement and rehabilitation activities, and defines obligations for management of biodiversity, water systems, air quality, noise and vibration, amenities and waste.

This EP provides the key means of satisfying this HSEMS standard. The key environmental management issues for this activity are:

- Marine mammal observations;
- Scallop impact survey;
- Underwater sound validation; and
- Managing IMS risks.

These issues are discussed below.

Marine Mammal Observations

Competent MMOs will be hired for the survey. At least one Lead MMO will be present on the survey vessel at all times, with MMO trainees and/or bridge crew used where additional experienced MMOs cannot be sourced.

The MMO(s) will provide an information session to all vessel crew 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.

A daily cetacean strategy meeting involving the MMOs, Beach 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.

In accordance with Part A of EPBC Policy Statement 2.1, the cetacean sighting data report will be submitted to DAWE within three months of MSS completion.

Scallop Impact Survey

Background

Beach has assessed the scientific literature and STLM findings and believes the impact to scallop fishing is ALARP and acceptable. In addition, Beach has assessed fishing catch and effort history, has consulted with the scallop industry and in response to feedback, has reduced the MSS area. Notwithstanding Beach's assessment, in response to industry concerns regarding potential future impacts to scallop catches, Beach has committed to carrying out a scallop impact survey (SIS), which will be conducted by Fishwell Consulting (Fishwell), who also carry out scallop stock assessment research for AFMA and are well regarded by the scallop industry.

This section describes the environmental monitoring requirements of the proposed SIS.

Purpose

The purpose of the SIS is to determine whether the Prion 3DMSS impacts relative biomass of scallops on beds in the immediate vicinity of the acquisition area. The SIS will employ methodologies analogous to scallop stock assessment surveys, thereby aiming to provide assurance to the fishing industry on the approach.

Timing

The pre-MSS SIS will aim to take place about four weeks prior to the MSS (subject to change based on logistics and weather). It is anticipated that the post-MSS SIS will take place within 3-6 months after the completion of the MSS. This timing is based on the results of the Day et al (2016) study (see Section 7.1).

The ultimate timing of the post-Prion MSS SIS will be determined after consultation with BSSIA and SFAT, with regard to guidance from Fishwell, relevant science, vessel availability and sea state conditions.

Proposed methodology

Preliminary advice from Fishwell on the design of the SIS is included below. The final design will be tabled for consultation with BSSIA and SFAT, prior to commencement.

A BACI experimental design is proposed, which allows for robust tests of environmental impacts in real world situations. BACI designs involve environmental measurements taken from impact sites (subjected to the disturbance and potentially affected by it) and control sites, which are physically similar to the impact sites but not subject to the disturbance. BACI designs are a robust impact assessment tool because they provide strong evidence for the disturbance event as the cause of impact and allow for the estimation of the magnitude of environmental change caused by the disturbance. Given this, a BACI experimental design is proposed to test the hypothesis put forward by fishers in the BSCZSF that relative scallop biomass and densities are impacted by the Prion 3DMSS.

The proven method of using towed scallop dredges to sample scallop beds will be used in the BACI experiment. One or more commercial scallop vessels will be used to undertake a random stratified survey of scallop beds with an independent observer onboard to collect all of the necessary survey data. Appropriate survey sites will be both within the acquisition area (impact sites) and outside the acquisition area (control sites) and will be determined as part of the survey design with input from Beach, BSSIA and SFAT.

Within each site, up to 25 random tow locations will be surveyed. To be considered a valid tow, the vessel must dredge within 100 m of the tow location provided. A Lotek LAT1400-64kb temperature-depth logger will be attached to the dredge at the start of the first tow, and set to record an observation every two minutes. Tow locations will be geo-referenced using geographic information systems (GIS).

A suitably experienced and qualified independent observer will be on board the vessel to ensure the survey design is followed.

Consultation with the scallop fishing sector

Beach is committed to open and ongoing consultation with the scallop fishing sector. Beach will maintain in communications with BSSIA and SFAT before, during and after the Prion 3DMSS regarding:

- The final design, locations and timings of the SIS;
- The SIS findings, before and after the Prion 3DMSS (to be presented at a discussion forum to Beach, BSSIA and SFAT by Fishwell); and
- Assessment of economic impacts, should the post-Prion 3DMSS SIS determine there were impacts to scallops and such impacts will cause a direct economic loss to any commercial scallop fisher.

In the event that Beach, BSSIA and SFAT cannot reach agreement through the process above, Beach will act promptly to establish a Scallop Advisory Panel whose objective will be to facilitate constructive engagement among the members and work towards solutions acceptable to Beach, BSSIA and SFAT.

Beach proposes the panel participants include (subject to availability) members from Beach, BSSIA, SFAT, AFMA, Fishwell and Geoscience Australia. Other potential participants may emerge during detailed planning for such a panel. Should some of the proposed members not be available, Beach will consult with BSSIA and SFAT to identify alternative representatives who will bring relevant knowledge and experience to help meet the objectives of the panel.

Underwater Sound Validation

Purpose

As part of its contribution to the wider scientific body of knowledge around MSS and to determine the accuracy of STLM predictions regarding the extent of potential impacts to the commercial scallop fishery from the Prion 3DMSS and any future MSS over scallop fishing grounds (and thus aim to provide more certainty to the commercial fishing industry), Beach proposes to undertake underwater sound and particle motion validation monitoring against the STLM prepared for the Prion 3DMSS.

Timing

Beach will contract a specialist consultancy to source, configure and deploy several underwater sound loggers within the proposed acquisition area at least a week prior to the MSS commencing in order to collect ambient ocean sound data. The loggers will then be left at the same locations for the duration of the MSS. If logistics don't allow for the loggers to be deployed in sufficient time ahead of the MSS to collect ambient underwater sound data, then they will remain in location for up to a week after the completion of the MSS to perform the same role.

Proposed methodology

The work will involve:

- Using a locally-based fishing vessel (or MSS support vessel) to deploy the loggers;
- Placing the loggers (autonomous multichannel acoustic recorders) on the seabed, noting that the base plate and/or weight/s used to keep the underwater sound loggers on site during the MSS (noting that there is no mapped sensitive habitat, such as rocky reef, occurring in the acquisition area that could be damaged by the base plates/weights);
- Deploying the loggers at locations within the acquisition area and the underwater sound EMBA for benthic invertebrates (i.e., greater than 8 m) in order to verify predictions of acceptability;
- Deploying the loggers at least a week prior to the survey commencing in order to record ambient underwater sound levels;
- Recording sound for the duration of the MSS;
- Recovering the loggers at the completion of the MSS (no equipment will remain on the seabed once the sound validation work is complete);
- Downloading and analysing the recovered data; and
- Summarising the data in a report that compares the underwater sound during the survey with predictions from the STLM, and with ambient sound levels recorded immediately prior to the MSS.

The underwater sound validation monitoring results will be reviewed by Beach and shared with the scallop fishers who have expressed concern about the potential effects of the Prion 3DMSS on the BSCZSF.

Beach Domestic IMS Biofouling Risk Assessment Process

Scope

All vessels and submersible equipment mobilised from international or domestic waters to undertake the activity within the survey area must complete the Beach Introduced Marine Species Management Plan (S4000AH719916) vessel risk assessment process and complete the associated checklist prior to the initial mobilisation into the survey area.

The Beach Introduced Marine Species Management Plan risk assessment process does not include an evaluation of potential risks associated with ballast water exchange given all vessel operators contracted to Beach must comply with the most recent version of the Australian Ballast Water Management Requirements (see Section 7.11.5).

Purpose

- Validate compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in the activity within the survey area;
- Identify the potential IMS risk profile of vessels and submersible equipment prior to deployment within the survey area;
- Identify potential deficiencies of IMS controls prior to entering the survey area;
- Identify additional controls to manage IMS risk; and
- Prevent the translocation and potential establishment of IMS into non-affected environments (either to or from the survey area).

Screening Assessment

Prior to the initial mobilisation of the vessel or submersible equipment to the survey area, a screening assessment must be undertaken considering:

- All relevant IMO and regulatory requirements under the *Australian Biosecurity Act* 2015 and/or relevant State legislation must be met;
- If mobilising from a high or uncertain risk area, the vessel/submersible equipment must have been within that area for fewer than 7 consecutive days or inspected and deemed low risk by an independent IMS expert, within 7 days of departure from the area;
- Vessels must have valid antifouling coatings based upon manufacturers specifications;
- Vessels must have a biofouling control treatment system in use for key internal seawater systems; and
- Vessels must have a Biofouling Management Plan and record book consistent with the IMO 2011 *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* (IMO Biofouling Guidelines).

Where relevant criteria have been met, no further management measures are required, and the vessel/submersible equipment may be deployed into the survey area.

Where relevant criteria have not been met, or there is uncertainty if these criteria have been met, Beach must engage an independent IMS expert to undertake a detailed biosecurity risk assessment, and the vessel/submersible equipment must be deemed low risk prior to mobilisation into the survey area.

<u>Basis of Detailed IMS Biofouling Risk Assessment</u>

The basis by which an independent IMS expert evaluates the risk profile of a vessel/submersible equipment includes:

- Age, type and condition of the vessel/submersible equipment;
- Previous cleaning and inspection undertaken and the outcomes of previous inspections;
- Assessment of internal niches with potential to harbour IMS;
- Vessel/equipment history since previous inspection;
- Origin of the vessel/submersible equipment including potential for exposure to IMS;
- Translocation risk based upon source location in relation to activity location – both in relation to the water depth/proximity to land at the point of origin and the potential survivorship of IMS from the point of origin to the survey area;
- Mobilisation method – whether dry or in-water (including duration of low-speed transit through high or uncertain risk areas);
- For vessels, the application, age and condition of antifouling coatings;
- Presence and condition of internal seawater treatment systems;
- Assessment of Biofouling Management Plan and record book against IMO Biofouling Guidelines; and
- Where deemed appropriate, undertake in-water inspections.

8.11.2 Standard 10.2 – Community Engagement Standard

Standard 10.2 defines the minimum requirements for the conduct of Beach and its staff within the community, and the commitments to plan and execute effective community engagement in the course of its business. Beach staff will conduct themselves as ambassadors for the company and engage positively and respectfully with the community.

The standard describes the obligation of the company to proactively engage with the community at the outset of any activity that may have an impact on that community, and to develop a stakeholder engagement plan to manage that engagement.

Stakeholder consultation specific to the Prion 3DMSS is described in Chapter 4 of the EP. Wherever possible, concerns expressed by stakeholders have been addressed throughout the EP.

8.12 Element 11 – Assurance and Reporting

Element 10 establishes that the company must apply the requirements of relevant policies, and the commitments detailed in the OEMS standards throughout its activities. An assurance process therefore exists to systematically quantify compliance with those commitments, and with the underlying procedures and systems. This Element also documents Beach's approach to sustainability and reporting company performance using established sustainability performance metrics.

There are two standards (see Table 8.1) and four outcomes to be delivered under this element, with the standards relevant to the Prion 3DMSS discussed below.

8.12.1 Standard 11.2 – Assurance Management Standard

Standard 11.2 describes the "Three Lines of Defence" assurance model employed by Beach to govern its activities and ensure compliance with its commitments and standards. The standard defines Beach's requirements for the establishment and management of risk-based assurance activities at all levels within the company. The assurance process establishes the adequacy and effectiveness of Beach's risk controls and quantifies the status of compliance against our obligations. It ensures the organisation proactively closes any gaps in performance so it can address those issues before harm is manifested. As such, the assurance programme identifies improvement opportunities in business processes and risk controls.

The Standard describes the need to have assurance plans across the business, and for the assurance activities to take place on multiple levels of the organisation. This approach collectively ensures the operational activities Beach perform are compliant with its procedures, standards and ultimately with governing policies and legislative obligations. The holistic results of the assurance programme are reportable to the Board and Committees.

The assurance methods that will be used to ensure compliance with the EPS in this EP are described in this section.

Emissions and Discharge Records

Beach maintains a quantitative record of emissions and discharges 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.

A summary of the environmental monitoring to be undertaken for the survey from all vessels is presented in Table 8.7.

Table 8.7. Summary of environmental monitoring

Aspect	Monitoring parameter	Frequency	Record
Impacts			
	MMO megafauna visual observations	Continuous during survey	MMO daily reports End-of-survey report

Aspect	Monitoring parameter	Frequency	Record
Underwater sound (see also Section 8.11.1)	Underwater sound validation monitoring	Prior to or after the survey (for ambient sound) and during the survey	Underwater sound validation monitoring report
	Scallop impact survey takes place	Prior to MSS (and after, as required)	Scallop impact survey report(s)
Atmospheric emissions	Fuel consumption	Tallied at end of survey from daily reports and/or bunker receipts	Emissions register
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	Operational monitoring in line with the OPEP and scientific monitoring in line with the OSMP (depending on spill volume)	As required	Incident reports

Routine Reporting and Notifications

Regulation 11A 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 8.8 outlines the routine reporting obligations that Beach will undertake with external organisations.

Table 8.8. 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 all other stakeholders in the stakeholder register with the survey commencement date.	Two weeks prior to survey starting.	Via email addresses managed by the Community Manager	11A
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

Requirement	Timing	Contact details	OPGGS(E) regulation
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 Community Manager	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

Environment Plan Review

A member of the Beach Environment Team 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 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 PMST for the EMBA 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 OEMS; and

- Changes to any of the relevant legislation.

The Environment Team provides advice to the Survey Project 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 Principle Environmental Advisor to conduct the review. The team may consist of representatives from the Community, Engineering, HSE, Operations or Supply Chain teams as required by the scope.

All personnel can propose changes to HSE documentation via a register located in the Document Management System. If a review of the EP is initiated, then any proposed changes held in the register will also be considered by the review team.

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 Community Manager.

Revisions Triggering EP Re-submission

Beach 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 submission 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. Beach 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 3.
  - 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 Prion MSS 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 Guideline *When to submit a proposed revision of an EP* (N04750-GL1705, Rev 1, January 2017).

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 risks and impacts 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.

Inspections and Audits

Various inspections and audits will be undertaken for the Prion 3DMSS using competent personnel, as outlined in Table 8.10.

Table 8.10. Summary of environmental inspections and audits

Type	When	Frequency	Vessel	Method	Details
HSE due diligence inspection	Post-award, pre-survey	Once	Survey vessel & support vessels	Desktop or in port/ during mobilisation	Focused on ensuring EPS can be met through review of relevant records and databases
EP compliance audit	Post-award, pre-survey	Once	Survey vessel	In person on board	A suitably experienced auditor will assess compliance against each EPS through interviews, observations and review of databases and records.
Ongoing informal inspections	During survey	Weekly	Survey vessel & support vessels	In person on board	Checklists provided by Beach to be completed by: • Survey vessel – Party Chief and/or Beach Offshore Representative • Support vessels – Vessel Master (or delegate)

Any non-compliances or opportunities for improvement identified at the time of an inspection or audit will be communicated to the relevant Beach and contractor personnel at the time of the inspection or audit. These are tracked in the Beach incident management system, 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 Beach Offshore Representative and verified by the Beach Principal Environmental Advisor (offshore) (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 8.3).

Regulatory Inspections

Under Part 5 of the OPGGS Act, NOPSEMA inspectors have the authority to enter Beach premises, including the survey vessel, to undertake monitoring or investigation against this EP.

Beach will cooperate fully with the regulator during such investigations.

End of Activity Performance Report

In accordance with the OPGGS(E) Regulation 14(2), Beach will submit an end-of-activity EP performance report to NOPSEMA within three months of completion of the Prion 3DMSS. Performance will be measured against the EPO and EPS outlined in Chapter 7. The information in the report will be based on the information collected during routine communications, inspections and audits, as outlined in this chapter.

8.13 Summary of Implementation Strategy Commitments

Table 8.11 summarises the commitments provided throughout this Implementation Strategy by assigning EPOs, EPS and measurement criteria to each commitment.

Table 8.11. Summary of Prion MSS implementation strategy commitments

Section	EPO	EPS	Measurement criteria
8.4.2	All records relevant to implementation of the EP are available for five years.	All records relevant to implementation of the EP are stored in 'BoardWalk'.	EP documents are readily accessible through BoardWalk.
8.5.1	Project personnel are trained and competent to fulfil their duties.	The LMS records and tracks core and critical HSE and technical compliance training.	Training records are readily accessible through the LMS.
		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.
8.5.1	Project personnel 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 vessels are inducted.
8.5.2 & 8.5.3	Project 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.
8.6 & 8.7	The survey vessel meets maritime standards and has in place the required MARPOL certifications.	Beach will undertake a due diligence inspection of the survey vessel to ensure it meets are required maritime standards and has all required environmental certifications (see also Section 3.5.1).	A due diligence inspection report is available and verifies that the vessel meets required maritime standards.
8.8.1	Changes to approved plans (including this EP), equipment, plant, standards or procedures are assessed through the MoC process.	Changes are documented in accordance with the MoC Directive.	MoC records are available in the Stature database.
8.9.1	The EP is reviewed for currency in light of any changes to the activity,	Beach Environment Team updates the EP as required.	The revision history of this EP is updated to record document changes.

	controls, legislation or relevant scientific research.		
8.9.2	Emergency response responsibilities are clearly defined.	A Bridging ERP will be prepared to link between Beach's EMP and the vessel contractor's vessel-specific ERP.	Bridging ERP is in place prior to the MSS commencing.
8.9.2	Vessel- and office-based personnel are familiar with their emergency response responsibilities.	All relevant vessel- and office-based personnel participate in emergency response (e.g., ERP and OPEP) training, drills and exercises.	Training records verify that emergency response exercises were undertaken.
8.10	Incident reports are issued to the regulators as required.	Recordable incidents reports are issued monthly to NOPSEMA as per Table 8.5.	Recordable and reportable incident reports and associated email correspondence is available to verify their issue to NOPSEMA (and other agencies, as required).
		Reportable incidents are reported to NOPSEMA in accordance with the timing requirements provided in Table 8.6.	
8.10	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 CMS incident management system.
8.12.1	Emissions and discharges from the vessels are recorded.	Emissions and discharges from the vessels, in line with Table 8.7, are recorded.	Monitoring records are available and align with the requirements in Table 8.7.
8.12.1	Regulatory agencies and stakeholders are aware of survey start and end.	Pre- and post-MSS notifications to regulatory agencies and stakeholders are issued as per Table 8.8.	Notification records verify issue.
8.12.1	This EP is reviewed and updated on an as-required basis.	This EP is reviewed and updated based on the triggers presented in Section 8.12.1 on an as-required basis.	A record of EP reviews and updates is available in BoardWalk.
			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.
8.12.1	EP compliance inspections and audits are undertaken for the MSS.	EP compliance is assessed pre-MSS and during the MSS by competent personnel.	Environmental inspection reports, completed checklists and audit report are available and verify compliance with this EP.
8.12.1	An end-of-activity EP performance report is submitted to NOPSEMA.	The end-of-activity EP performance report is issued to NOPSEMA within three months of completion of the MSS.	The end-of-activity EP performance report and associated email correspondence is available to verify its issue to NOPSEMA.

9. Oil Pollution Emergency Plan

The following OPEP provides an overview of Beach's arrangements for responding in a timely manner to an MDO spill during the Prion 3DMSS. The OPEP is presented as an EP chapter rather than a stand-alone document in recognition of the fact that the survey vessel is not classified as a 'facility' in Section 15 and Schedule 3 of the OPGGS Act 2006 because it:

- 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).

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 9.4 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 SMPEP.

In accordance with the Bridging ERP, the Vessel Master will notify the Beach EMT Leader of the emergency, with the EMT Leader acting as onshore liaison. Beach has insurance policies in place that will cover the costs of any clean-up or remediation activities following a spill, no matter the jurisdiction.

9.1 Oil Spill Response Arrangements

In order to encompass the nature and scale of the survey and respond to the identified worst case credible spill scenario, modelling of a loss of 280 m^3 of MDO has been undertaken and the risks assessed (Section 7.12). This OPEP has been developed based on the results of this modelling and encompasses multiple levels of planning and response capability. The spill scenario is considered to be very conservative because survey vessel tanks are never filled 100% full, fuel will have already been combusted to reach the survey location, there are no emergent features to collide into and vessel-to-vessel collision (resulting in a spill) is extremely rare.

The overall OPEP for the Prion 3DMSS comprises the following emergency plans:

- Vessel SMPEP – for spills contained on the vessel or spills overboard that can be managed by the vessel;
- Bridging ERP (described in Section 8.9.2);
- Beach EMP (described in Section 8.9.2);
- 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 Department of Jobs, Precincts and Regions (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 Environment Protection Authority (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), 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 or 3 spills). Guidance for spill classification, as noted in Part 5 of the NatPlan (AMSA, 2020) 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 across government and industry
Resources	From within one area (e.g., vessel)	Intrastate	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 within weeks	Significant impacts, recovery may take months, remediation required	Significant area of impacts, recovery may take months, remediation required

As stated in Section 2.5 of the NatPlan, maritime environmental emergencies have the potential to impact upon the interests of two or more Australian jurisdictions, where each jurisdiction has legitimate administrative and regulatory interests in the incident (for the Prion 3DMSS, this includes Victoria and/or Tasmania). 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. In the case of the Prion 3DMSS, AMSA would liaise with the Victorian DJPR and the Tasmanian EPA to determine which agency is best placed to take the lead.

In Commonwealth waters, initial spill response actions will be undertaken by the vessel with subsequent actions determined in consultation with regulatory authorities under the NatPlan. AMSA is the responsible Combat Agency for hydrocarbon spills from vessels in Commonwealth waters; upon notification of a Level 2 or 3 spill, AMSA will assume control of the incident.

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 IMT and/or the Beach ERT.

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. Beach will have a representative embedded within the joint team and provide feedback to the Beach EMT.

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, 2017).

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 greater than 400 gross tonnes. 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.

The Vessel Master is in charge of implementing the SMPEP and ensuring that all crew comply with the plan.

Vessel SMPEPs include vessel-specific procedures for managing a fuel spill. 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 an 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.

Priority actions in the event of an MDO spill are to:

1. Make the area safe;
2. Stop the leak (source control); and
3. 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 ERT 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 SOPEP and associated drills.

Beach will conduct a desktop SMPEP exercise prior to the Prion 3DMSS commencing (see Section 9.4).

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 net environmental benefit analysis (NEBA) to confirm the suitability of the strategic spill response NEBA (see Section 7.14). The operational NEBA would be jointly conducted between AMSA and Beach and will take into account 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, access, maintaining equipment deployments, waste management and weather conditions.

9.2.1 Preferred Spill Response

A number of response options have been assessed specific to the survey location, fuel type and spill modelling results, which are outlined in Section 7.14. These are:

- 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);
- Monitor and evaluate the trajectory and extent of the spill; and
- Assisted natural dispersion using propeller wash, if advised by the Control Agency that it is safe to do so.

Initial actions for source control are outlined in the vessel SMPEP and would be undertaken in consultation with the relevant Combat 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, monitor and evaluate 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.

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 Beach Offshore Survey Representative is responsible for advising the Beach Project Manager of the spill incident. The Beach Project Manager is then responsible for notifying NOPSEMA.

Regulatory notification arrangements are provided in Table 9.2. In addition to this, Beach will advise potentially affected stakeholders of the spill.

Table 9.2. MDO spill regulatory notifications for a Level 2 or 3 spill

Notification timing	Authority	Notification By	Contact Number	Details
Level 1				
ASAP	Beach PM	Vessel Master	TBA	Vessel to notify Beach 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	Beach PM	08 6461 7090	Beach 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/ Beach PM	03 8392 6934	Verbally notify DJPR and follow up with POLREP ASAP
ASAP- if spill affects Tas Waters	EPA Tasmania	AMSA/ Beach PM	03 6165 4599	Verbally notify EPA and follow up with POLREP ASAP
Within 2 hours	Type II Monitoring Service Provider (RPS)	Beach PM	08 9211 1111	Verbally notify service provider to initiate scientific monitoring if triggered (as outlined in Section 9.6.2).

Notification timing	Authority	Notification By	Contact Number	Details
Within 1 day	NOPTA	Beach PM	08 6+424 5317	Provide a verbal or written incident summary.
Within 3 days	NOPSEMA	Beach PM	08 6461 7090	Provide a written incident report form.
If MDO is travelling towards one or more AMPs				
ASAP	Director of National Parks	Beach PM	0419 293 465	Spill with potential to impact AMPs, 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 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.

<u>OPEP Review</u>

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 Prion 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.

Beach has insurance policies in place that will cover the costs of spill response and operational and scientific monitoring (see the following section).

9.6 Hydrocarbon Spill Monitoring

Beach will implement a monitoring program that reflects the scale and potential effects of the spill. To this effect, Beach has in place an Operational and Scientific Monitoring Program (OSMP) (CDN/ID S4100AH717908) that can be rapidly activated in the event of a large scale 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. Beach may, at the direction of the Control Agency, support Type I monitoring with on-the-water surveillance to:

- Determine the location and extent 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 Combat Agency (AMSA), via a POLREP/SITREP form, to allow for determination and planning of appropriate response actions under the NatPlan (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 any surface slicks;
- GPS tracking;
- Manual or computer predictions of oil trajectory and weathering; and
- GIS mapping.

Determining the location 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 Combat Agency. The information gathered from this initial monitoring will be passed on to the Combat Agency, via the POLREP form, but also via ongoing SITREP reports following the initial spill notification to AMSA RCC.

Beach will implement, assist with, or contribute to (including funding if required) any other Type I monitoring (e.g., computer OSTM) as directed by the Combat Agency.

9.6.2 Type II Scientific Monitoring

In consultation with the Control Agency, Beach is committed to scientific monitoring dependent on the circumstances of the spill, and the sensitivities at risk. Beach's OSMP describes the detailed arrangements and studies that could be activated upon request and agreement with AMSA. The OSMP ensures Beach 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 Beach's behalf (if initiation criteria are triggered).

The OSTM predicts that MDO is expected to undergo rapid evaporation once spilled. After 48 hours:

- Under calm winds (a constant 5 knots) - 41% has evaporated; and
- Under variable winds - 30% has evaporated.

The OSTM predicts that after 10 days:

- Under calm winds (a constant 5 knots) - 60% has evaporated and 40% remains floating; and
- Under variable winds - 30% has evaporated, MDO entrained in the water column will be 60% and MDO that has decayed in the water column will be 10%

Beach will work with AMSA and relevant stakeholders to develop and implement appropriate scientific monitoring. The aim of the scientific monitoring is to understand the environmental impacts of the spill and response activities on the marine environment, with a focus on relevant environmental and social 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 scientific monitoring may comprise some or all of the monitoring studies described in Table 9.3 and detailed in Section 5 of the Beach OSMP. As described previously, Beach will engage with AMSA to coordinate and review operational monitoring data. Operational monitoring may provide valuable surveillance and modelling data 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 evaluate 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.

Table 9.3 summarises Beach's OSMP scientific monitoring studies. If 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 Combat Agency and relevant stakeholders, Beach will activate its contract with its OSMP provider (RPS) to design and implement the appropriate scientific monitoring studies as outlined in the Beach OSMP. RPS has undertaken a wide range of relevant marine environmental monitoring studies in Australia and internationally and has the relevant skills, expertise and resources in place to provide scientific monitoring support. RPS prepares a monthly OSMP readiness review for Beach outlining the resources available to undertake OSMP requirements.

Initiation criteria for scientific monitoring studies are outlined throughout Section 5 of the Beach OSMP. Following Beach'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

Scientific Monitoring Study	Objectives	Initiation triggers	Termination criteria
SM01 Water quality impact assessment	Determine the impact to, and recovery of; offshore and intertidal water quality from oil exposure and/or any impacts to associated with response activities.	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the Study O2 has confirmed exposure to offshore or intertidal waters **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence.	• The EMT Environment Leader (or delegate) considers that: ◦ MDO concentrations in offshore waters have returned to within the expected natural dynamics of baseline state and/or control sites **or** ◦ MDO concentrations in offshore waters are below relevant ANZG (2018) 99% species protection levels or other applicable benchmark values **and** • The EMT Environment Leader (or delegate) considers that: ◦ Relevant water quality parameter concentrations in offshore waters have returned to within the expected natural dynamics of baseline state and/or control sites **or** ◦ Relevant water quality parameter concentrations in offshore waters are below relevant ANZG (2018) 99% species protection levels or other applicable benchmark values **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that water quality values within protected areas (i.e., AMPs, Ramsar wetlands or State marine protected areas) have not been impacted or have returned to within the expected natural dynamics of baseline state **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring
SM02 Sediment quality impact assessment	Determine the impact to, and recovery of, offshore, intertidal and shoreline sediment quality from oil exposure and/or any impacts associated with response activities.	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred and data from the Study O3 has confirmed exposure to shoreline sediments **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence.	• The EMT Environment Leader (or delegate) considers that: ◦ MDO concentrations in sediments have returned to within the expected natural dynamics of baseline state and/or control sites **or** ◦ MDO concentrations in sediments are below relevant ANZECC/ARMCANZ SQGV other applicable benchmark values **and** ◦ Relevant sediment quality parameter concentrations have returned to within the expected natural dynamics of baseline state and/or control sites **or** ◦ Relevant sediment quality parameter concentrations in are below relevant ANZECC/ARMCANZ SQGV other applicable benchmark values **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring.

Scientific Monitoring Study	Objectives	Initiation triggers	Termination criteria
SM03 Subtidal habitats impact assessment	Determine the impact to, and recovery of, subtidal habitats from oil exposure and/or any impacts associated with response activities.	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the OPEP Monitor and Evaluate response strategy or Study O2 or O3 indicates potential and/or actual exposure to near-bottom waters or sediments **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence.	• The EMT Environment Leader (or delegate) considers that disturbance parameters (e.g., species composition, percent cover) and health parameters (e.g., leaf condition) have returned to within the expected natural dynamics of baseline state and/or control sites **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that subtidal habitat quality values within protected areas (i.e., AMPs, Ramsar wetlands or State marine protected areas) have not been impacted or have returned to within the expected natural dynamics of baseline state **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring.
SM04 Intertidal and coastal habitats impact assessment	Determine the impact to, and recovery of, intertidal and coastal habitats from oil exposure and/or any impacts associated with response activities.	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the OPEP Monitor and Evaluate response strategy or Study O2 or O3 indicates potential and/or actual exposure to near-bottom waters or sediments **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence.	• The EMT Environment Leader (or delegate) considers that disturbance parameters (e.g., species composition, percent cover) and health parameters (e.g., leaf condition) have returned to within the expected natural dynamics of baseline state and/or control sites **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that intertidal habitat quality values within protected areas (i.e., Ramsar wetlands or State marine protected areas) have not been impacted or have returned to within the expected natural dynamics of baseline state **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring.
SM05 Marine fauna impact assessment	Determine the impact to, and recovery of, marine fauna from oil exposure and/or any impacts associated with response activities.	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the Study O4 has confirmed exposure to marine fauna **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence.	• The EMT Environment Leader (or delegate) considers that disturbance parameters (e.g. population size, breeding success) have returned to within the expected natural dynamics of baseline state and/or control sites **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that protected marine fauna (i.e. threatened or migratory species) have not been impacted or have returned to within the expected natural dynamics of baseline state (including any assessment against management requirements in Conservation Advices and/or Recovery Plans) **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring.
SM06 Fisheries impact assessment	Determine the presence of, and recovery from, oil taint in commercially or recreationally important fish species and/or	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from Study O6 has confirmed the presence of fishing tainting **or**	• The EMT Environment Leader (or delegate) considers that: ◦ Fish or shellfish show no presence of tissue taint **or** ◦ PAH levels in fish and shellfish tissue have returned to within the expected natural dynamics of baseline state and/or control sites **or**

Scientific Monitoring Study	Objectives	Initiation triggers	Termination criteria
	any impacts associated with response activities.	• Allegations of damage are received from commercial fisheries or government agencies **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence.	◦ PAH levels in fish and shellfish tissue are at or below regulatory levels of concern **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring.
SM07 Heritage and socio-economic impact assessment	Determine the impact to, and recovery of, heritage and socioeconomic features from oil exposure and/or any impacts associated with response activities.	• The EMT Environment Leader (or delegate) has confirmed that a Level 2 or Level 3 offshore oil spill has occurred **and** data from the OPEP Monitor and Evaluate response strategy or Study O2 or O3 indicates potential and/or actual exposure to known areas of heritage or socioeconomic features **or** • Allegations of damage are received from other users (e.g., tourism operators, heritage groups) or government agencies **or** • The EMT Environment Leader (or delegate) advises that either full or partial implementation of the study is to commence.	• The EMT Environment Leader (or delegate) considers that considers that disturbance parameters (e.g. hydrocarbon visibility and concentration, condition/quality, area usage levels) have returned to within the expected natural dynamics of baseline state and/or control sites **and** • The EMT Environment Leader (or delegate) in conjunction with relevant government agency, considers that heritage and/or socioeconomic features have not been impacted or have returned to within the expected natural dynamics of baseline state **and** • Agreement has been reached with the Statutory Authority relevant to the spill to terminate the monitoring.

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