3D OIL LIMITED

DORRIGO 3D MARINE SEISMIC SURVEY ENVIRONMENT PLAN

EXPLORATION PERMIT T/49P

REVISION 1:
APRIL 2019

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REVISION HISTORY

Revision	Issue Date	Revision Summary	Originator	Reviewer	Approver
0	30/01/19	Issued to NOPSEMA	LC	DB	NN

APPROVALS

This Dorrigo 3D Marine Seismic Survey Environment Plan has been approved by 3D Oil Limited for the Exploration Permit T/49P during 2019.

NAME	SIGNATURE	DATE
David Briguglio Exploration Manager		30 January 2019

DISTRIBUTION LIST

No:	Recipient
1	3D Oil Project Manager
2	3D Oil Senior Geophysicist
3	Seismic Contractor Project Manager
4	Seismic Contractor Party Manager
5	3D Oil (Offshore) Representative
6	Vessel Master – Seismic Vessel
7	Vessel Master – Scout/Chase Boat
8	Vessel Master – Support Vessel
9	Marine Environment Protection Division - AMSA

HEALTH, SAFETY & ENVIRONMENT POLICY

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Health, Safety & Environment Policy

3D Oil Limited is committed to hydrocarbon development which maximizes shareholder value and delivers Health, Safety & Environmental (HSE) outcomes which:

- Minimize environmental and community impacts;
- Maximize resource utilization; and
- Provides a safe and healthy workplace for all 3D Oil personnel.

To achieve these outcomes, 3D Oil will implement and maintain effective management systems which will:

- Systematically identify HSE hazards and where possible, eliminate the hazard or implement controls to manage the risk to as low as reasonably practicable (ALARP);
- Comply with all applicable legislation and apply responsible standards where legislated standards do not exist;
- Implement HSE monitoring programs and measure progress through program HSE targets and objectives;
- Continuously improve HSE outcomes through incident management, inspection, audit and review processes;
- Provide necessary resources, information and training to allow 3D Oil personnel to fulfill their HSE responsibilities;
- Consult openly with all relevant internal and external stakeholders who have an interest in 3D Oil's activities;
- Engage service contract organizations who manage HSE performance in a manner consistent with this policy;
- Develop, maintain and test 3D Oil's ability to respond effectively to emergencies; and
- Foster a corporate culture of respect, open communication and engagement between all personnel to achieve our HSE outcomes.

This policy applies to all 3D Oil personnel, including contractors, engaged on 3D Oil activities.

Primary responsibility for implementation of the HSE Policy lies with 3D Oil's Managing Director and management team.

Delivery of HSE outcomes is both an individual and shared responsibility of all 3D Oil personnel within the workplace.

Noel Newell
Managing Director – 3D Oil
January 2018

ACRONYMS

Acronym	Definition
ACAP	Agreement on the Conservation of Albatrosses and Petrels
AFMA	Australian Fisheries Management Authority
AHS	Australian Hydrographic Service
ALARP	As Low as Reasonably Practicable
AMMC	Australian Marine Mammal Centre
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Producers and Exploration Association
BIA	Biologically Important Area
BOEM	Bureau of Ocean Energy Management
BOM	Bureau of Meteorology
CA	Control Agency
CFA	Commonwealth Fishing Association
CoEP	Code of Environmental Practice
CMP	Commonwealth Marine Reserve
CPUE	Catch per Unit Effort
CSIRO	Commonwealth Scientific & Industrial Research Organisation
CTS	Commonwealth Trawl Sector
DAWR	Department of Agriculture, Water and Resources
DNP	Director of National Parks
DPIPWE	Department of Primary Industries, Parks, Water and the Environment
EIA	Environmental Impact Assessment
EIAPP	Engine International Air Pollution Prevention (Certificate)
EMBA	Environment that may be affected
EP	Environment Plan
EPA	Environment Protection Authority
EPBC	Environment Protection and Biodiversity Conservation (Act)
EPO	Environmental Performance Outcome
EPS	Environmental Performance Standard
ERA	Environmental Risk Assessment
ERG	Emergency Response Group
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESD	Ecologically Sustainable Development
EVA	Eligible Voluntary Agreement
FLO	Fishing Liaison Officer
FPSO	Floating Production Storage Offloading
FRDC	Fishing Research and Development Corporation
GAB	Great Australian Bight

Acronym	Definition
GABTS	Great Australian Bight Trawl Sector
GHG	Greenhouse Gas
GHTS	Gillnet Hook and Trap Sector
GMDSS	Global maritime Distress Safety System
GPS	Global Positioning System
HF	High Frequency
HFC	High Frequency Cetacean
HSEMS	Health Safety Environment Management System
HSEQ	Health Safety Environment Quality
Hz	Hertz
IAFS	International anti-fouling system (certificate)
IAGC	International Association of Geophysical Consultants
IAPP	International Air Pollution Prevention (certificate)
IGAE	Intergovermental Agreement on the Environment
IMCRA	Intergrated Marine and Coastal Regionalisation of Australia
IMAS	Institute for Marine and Antarctic Studies
IMS	Invasive Marine Species
IOPP	International Oill Pollution Prevention (certificate)
IPIECA	International Petroleum Industry Environmental Conservation Association
ISPP	International Sewage Pollution Prevention (Cetrificate)
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
JSEA	Job Safety and Environmental Analysis
KEF	Key Ecological Feature
KIRDO	King Island Regional Development Organisation
LC50	Lethal Concentration (50% population)
LF	Low Frequency
LFC	Low Frequency Cetacean
MCMPR	Ministerial Council on Minerals and Petroleum Resources
MD	Managing Director
MDO/MGO	Marine Diesel Oil/Marine Gas Oil
MF	Mid-frequency
MFC	Mid-frequency cetaceans
MFO	Marine Fauna Observer
MMSCF	Million standard cubic feet
MNES	Matter of National Environmental Significance
MoC	Management of Change
MRT	Mineral Resources Tasmania
MSS	Marine Seismic Survey

Acronym	Definition
NATPLAN	National Plan for Maritime Environmental Emergencies
NCVA	National Conservation Values Atlas
NEBA	Net Environmental Benefits Assessment
NMFS	National Marine and Fisheries Service
NOO	National Oceans Office
NOPSEMA	National Offhsore Petroleum Safety & Environmental Management Authority
NOPTA	National Offshore Petroleum Title Administrator
OA	Operational Area
OGP	Oil and Gas Producers (Association)
OIW	Oil-in-water
OPGGSA	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OPGGSER	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPEP	Oil Pollution Emergency Plan
OSMP	Operational & Scientific Monitoring Plan
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response
PK	Peak
PMST	Protected Matters Search Tool
PNEC	Predicted No Effects Concentration
PWS	Parks & Wildlife Service (Tasmania)
SA	Statutory Authority
SCAT	Shoreline Cleanup Assessment Technique
SD	Standard Deviation
SDS	Safety Data Sheet
SEL	Sound Energy Level
SESSF	Southeast Shark & Scalefish Fishery
SETFIA	South-east Trawl Fishing Industry Association
SEWPC	(Department) of Sustainability Environment Water Population and Communities
SIV	Seafood Industry Victoria
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
SRL	Southern Rock Lobster
SRW	Southern Right Whale
SSF	Sustainable Shark Fishing (Inc)
SSIA	Southern Shark Industry Alliance
SSV	Sound Source Verification
STP	Sewerage Treatment Plant
STWC	Standards of Training and Watchkeeping for Seafarers
TACC	Total Allowable Commercial Catch

Acronym	Definition
TAP	Threat Abatement Plan
TASPLAN	Tasmanian Oil Spill Contingency Plan
TEC	Threatened Ecological Community
TJ	Terrajoule
TRLFA	Tasmanian Rock Lobster Fishing Association
TSIC	Tasmanian Seafood Industry Council
TSSC	Threatened Species Scientific Committee
UHF	Ultra high frequency
UXO	Unexploded ordinances
VFA	Victorian Fishing Authority
VHF	Very High Frequency
VM	Vessel Manager
WTO	World Trade Organisation

1 INTRODUCTION

1.1 Background

3D Oil T49P Pty Ltd ('3D Oil') is proposing to undertake the Dorrigo 3D Marine Seismic Survey (MSS) in the Commonwealth waters of the Otway Basin, Tasmania. The closest operational boundary of the MSS is located approximately 18 km west of King Island (Tas.) and 56 km south of Cape Otway (Vic).

The objectives of this Environment Plan (EP) are to demonstrate:

- Compliance with all applicable legislation;
- The titleholder understands how the proposed petroleum activity will interact with the environment;
- The environmental and other marine user impacts for routine and incident events associated with the petroleum activity have been identified and the risks have been reduced to a level which is low as reasonably practicable (ALARP) and to acceptable levels;
- Environmental performance outcomes (EPOs), environment performance standards (EPSs) and measurement criteria are in place to measure environmental performance of the titleholders associated with the activity;
- Consultation has been undertaken with 'relevant' persons to understand possible activity impacts and identify mitigation measures (as far as possible); and
- There is systematic implementation of controls (i.e. management system strategies) and continued assessment of new hazards and risk throughout the activity to manage environmental impacts and risks associated with the activity.

1.2 Environment Plan Scope and Structure

In accordance with Regulation 4(1) of the *Offshore Petroleum and Greenhouse Gas (Environment) Regulations 2009* (OPGGS(E)R), this EP applies to a defined 'petroleum activity'. This activity Is defined as the proposed Dorrigo 3D MSS in the Exploration Permit Area T/49P. The MSS is expected to take up to 35 days to complete between 1st September to 31st October 2019.

Following this introduction, this EP describes the following:

- **Section 2** provides a description of the location of the petroleum activity, the equipment to be used during the seismic survey and the survey location;
- **Section 3** provides a summary of the legislative framework and relevant legislation applicable to the MSS activity;
- **Section 4** provides details of the consultation undertaken with stakeholders for the petroleum activity;
- **Section 5** provides a summary of the existing natural, social, cultural and economic environment in the MSS area;
- **Section 6** details the risk assessment process adopted within this EP;
- **Section 7** identifies aspects of the petroleum activity which potentially impact the physical and social environment, provides the environmental management strategies to control the environmental impact and risk to acceptable and ALARP conditions. It also details the EPOs, EPSs and measurement criteria for the survey; and
- **Section 8** details the implementation strategies to be followed during the survey to ensure environmental impacts and risk is managed and environmental management systems to identify roles and responsibilities, practices, processes and resources used to manage the

environmental aspects of the survey (e.g. consultation, training, inspection, audit, review and monitoring activities).

1.3 Proponent

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

3D Oil's focus on exploration on the South East coast of Australia led to the award of the T/49P exploration permit in the highly prospective Otway Basin. A broad set of 2D data of varying vintages exists across the permit has allowed preliminary mapping of a number of large structures across the permit. A least two of these, Whalebone and Flanagan are large enough (on current mapping) to contain a combined volume of greater than 5 TCF of gas in place. Recent developments in the gas market on the south east coast of Australia has justified 3D Oil's focus in this region.

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

1.4 Nominated Titleholder and Liaison Person

3D Oil T49P Pty Ltd ('3D Oil'), a fully-owned subsidiary of 3D Oil Limited, is the titleholder nominated to undertake eligible voluntary actions (EVAs) under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Section 775C) in Exploration Permit T/P49 located in the Commonwealth waters of the Otway Basin.

In accordance with the OPGGS(E)R Regulation 18(2) details of the titleholder and liaison person for this EP are provided in **Table 1-1**. Any changes to the Titleholder, Liaison Person or Company contact details will be advised by the 3D Oil Managing Director (MD) to NOPSEMA and NOPTA.

Table 1-1: Titleholder and Liaison Person

Titleholder Details	Liaison Person
Exploration Permit T/49P Titleholder Details: Name: 3D Oil T49P Pty Ltd Address: Level 18, 41 Exhibition St, Melbourne, VIC, 3000 Telephone No: (03) 9650 9866 ABN: 90 163 960 807, ACN: 163 960 807	Liaison Person: David Briguglio Exploration Manager Level 18, 41 Exhibition St, Melbourne, VIC, 3000 Phone: (03) 9650 9866 Email: dbriguglio@3doil.com.au

1.5 Arrangements for Notifying Change

3D Oil will notify NOPSEMA of changes to the operation of the EP in accordance with the details provided in **Table 1-2**.

Table 1-2: Requirements for notification of EP changes

Regulation Requirements	OPGGS(E)R
Titleholder Change: A change of titleholder[1] change in the Titleholder's nominated liaison person or a change in the contact details for either the Titleholder or the liaison person. Notification to be provided within 7 days of the change.	Regulation 15(3)
End of EP Operation: The end of operation of the EP (i.e., at completion of the survey). *This is to be reported using the proforma (FM1408) available on the NOPSEMA website (https://www.nopsema.gov.au/environmentalmanagement/notification-and-reporting/)	Regulation 25A*
Activity Commencement: The titleholder must notify the regulator that an activity is to commence at least 10 days before the activity commences. ** This is to be reported using the proforma (FM1405) available on the NOPSEMA website (https://www.nopsema.gov.au/environmentalmanagement/notification-and-reporting/)	Regulation 29**
Activity Completion: The end of an activity (i.e., within 10 days of completion of the survey). ***This is to be reported using the proforma (FM1405) available on the NOPSEMA website (https://www.nopsema.gov.au/environmentalmanagement/notification-and-reporting/)	Regulation 29***

1.6 Revisions of the EP

Revisions to this EP that trigger re-submission to the regulators will be undertaken in accordance with the relevant regulations, as outlined in **Table 1-3**.

Table 1-3: Requirements for proposed revisions to the EP

Regulation Requirements	OPGGS(E)R
Submission of a revised EP before the commencement of a **new activity.**	Regulation 17(1)
Submission of a revised EP before any **significant modification or new stage of the activity** that is not provide for in the EP is proposed.	Regulation 17(5)

[1] Note n the event of a new t t eho der 3D o and the new t t eho der w a se w th the regu ators pr or to the t t e transfer process to cons der a comp ance requ rements under the Commonwea th OPGGS(E)R and whether a new or rev sed EP for the act v ty s requ red under OPGGS(E)R Regu at on 7(7) he new t t eho der w ut se the adv ce prov ded by the regu ators to ensure that can rema n comp ant once they become the t t eho der and undertake the petro eum act v ty (Refer Sect on 4)

Regulation Requirements	OPGGS(E)R
Submission of a revised EP before, or as soon as practicable after, **the occurrence or any significant new or significant increase in environmental impact or risk** not provided for in the EP.	Regulation 17(6)
At least 14 days before the **end of each period of 5 years** commencing on the day in which the original and subsequent revisions of the EP is accepted (N/A to Dorrigo MSS).	Regulation 19(1)
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.	Regulation 17(7)
A titleholder must submit a proposed variation to the EP for an activity **if requested by the regulator**.	Regulation 18

While a revision is being assessed by the regulators, any activities addressed under the existing accepted EP are authorized to continue.

Minor revisions to this EP that do not require resubmission to the regulators will be made:

- Where minor administrative changes are identified that do not impact on the environment (e.g., document references, contact details, etc.).
- Where 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 1-3**.

All amendments to the accepted EP will be made in accordance with 3D Oil's Management of Change (MOC) process (refer **Section 8.9**) and minor revisions not triggering legislative revision criteria to the EP will not be submitted to NOPSEMA for formal assessment.Minor revisions made to this document will be justified, tracked and incorporated during any scheduled internal reviews.

2 ACTIVITY AND LOCATION DETAILS

2.1 Activity Objectives

3D Oil has been awarded Exploration Permit T/49P by the Australian Government which provides for the exploration of hydrocarbon resources in this offshore Commonwealth area. Exploration activities support resource development within Australia which considers both short-term and long-term environmental/social considerations; and future provision of income to the Australian Government.

3D Oil intends to conduct the Dorrigo 3D MSS, in accordance with the principles of Ecologically Sustainable Development (ESD)[2], to better define the subsurface geology of the permit area and more accurately define prospective petroleum targets for exploration drilling in an economic, commercial, environmental and technically efficient manner. This is consistent with the agreed work-plan for T/49P with the Commonwealth Department of Industry, Innovation and Science (DIIS).

2.2 Activity Location

For the purpose of defining the operational boundaries of this EP, all project vessels are considered to be undertaking the petroleum activity when located in the 'Dorrigo Vessel Operational Area'. Mobilisation and demobilisation activities, and deployment from site associated with port calls or emergencies/refuge is not included within the operational boundary of this EP.

The Dorrigo 3D MSS data acquisition area covers an area of 1580 km^2 (max) and is located entirely within Commonwealth waters (refer **Figure 2-1**) of the Otway Basin. The MSS data acquisition area is defined by coordinates shown in **Table 2-1**. The seismic vessel will execute turns up to 10 km outside this defined acquisition area and will work within a 'Vessel Operational Area' of approximately 4350 km^2 (total) defined by coordinates provided in **Table 2-2**. The closest landfall to the vessel operational area is 18 km east (King Island) and 56 km north (Cape Otway). It is expected the vessel will operate in a north-south orientation when acquiring seismic data. The expected MSS acquisition lines are provided in **Figure 2-1** and all acquisition areas fall within the T/49P permit area.

MSS acquisition will be undertaken in water depths ranging from 100-840 m. Vessel turning areas (i.e. operational area)[3] will be in water depths of approximately 80m to 1420m.

The survey vessel will deploy and retrieve equipment off the continental shelf if required to avoid fishery interaction. This will be managed by close cooperation between the 3D Oil Offshore Representative, Fishing Liaison Officer (FLO), the local fishing fleet and the deployment of a scout/escort vessel to identify any conflicting fishing activities.

Table 2-1: Dorrigo 3D MSS (Data Acquisition) Boundary Coordinates (WGS 84, UTM54s)

[2] The Australian Government, through the National Strategy for Ecologically Sustainable Development (1992) and associated institutional arrangements, has set policy frameworks which integrate ESD principles into strategy documents such as the National Greenhouse Response Strategy, the National Strategy for the Conservation of Australia's Biological Diversity, the National Waste Minimisation and Recycling Strategy, etc. These strategies underpin legislative documents relevant to, and observed in, this Environment Plan such as Conservation Management and Threat Abatement Plans, Marine Bioregional Plans, Threatened Species Recovery Plans, Waste Minimisation and Energy Efficiency Policies. Accordingly, through the adoption of all relevant legislation and underpinning policy documents in this EP, 3D Oil will undertake all activity in T/49P consistent with the principles of ESD.

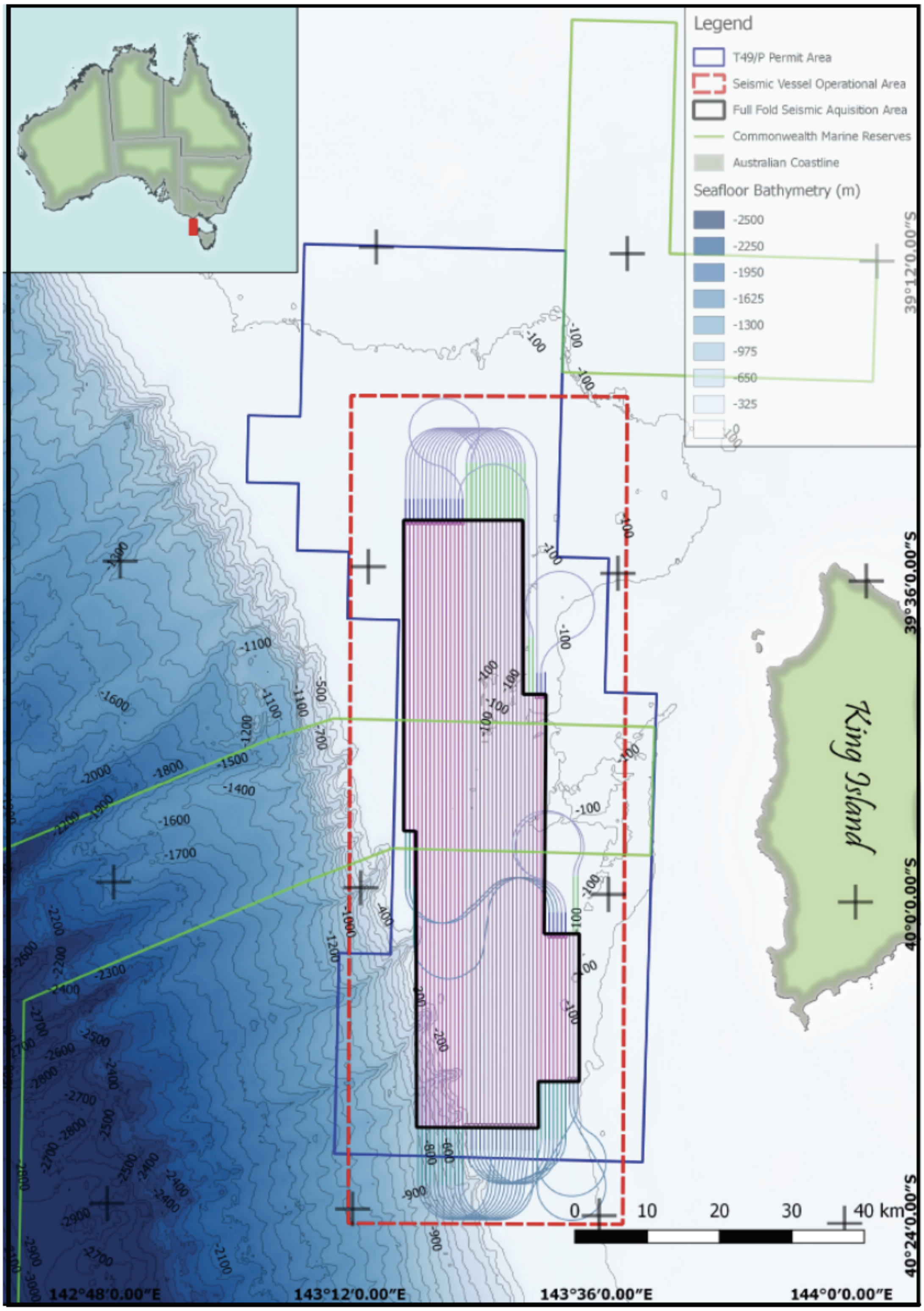
[3] Vessel turning has been conservatively estimated for Environment Plan purposes. It is expected that the vessel turning area will be smaller than that quoted.

Latitude			Longitude		
Degrees	**Minutes**	**Seconds**	**Degrees**	**Minutes**	**Seconds**
39	32	27.866	143	15	17.645
39	32	14.056	143	26	40.458
39	45	13.988	143	27	10.583
39	45	11.587	143	29	22.129
39	53	44.524	143	29	35.458
40	3	4.521	143	29	50.964
40	2	59.788	143	33	15.623
40	14	2.622	143	33	40.322
40	14	7.940	143	29	40.026
40	17	35.961	143	29	48.724
40	17	46.842	143	18	3.582
39	55	40.492	143	17	13.418
39	55	40.262	143	16	3.339

Table 2-2: Dorrigo 3D MSS (Operational Area) Boundary Coordinates (WGS 84, UTM54s)

Latitude			Longitude		
Degrees	**Minutes**	**Seconds**	**Degrees**	**Minutes**	**Seconds**
39	55	59.894	143	37	24.914
40	24	35.979	143	38	19.962
40	25	5.071	143	11	36.733
39	23	8.671	143	9	56.165
39	22	40.522	143	36	23.835

Figure 2-1: Dorrigo 3D MSS Area



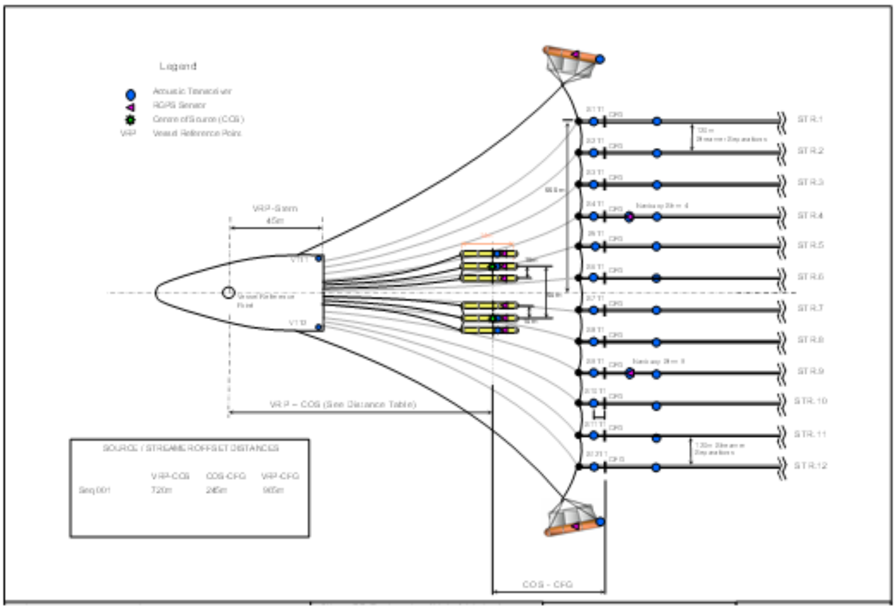
2.3 Activity Scope

The proposed Dorrigo 3D MSS is scheduled for 1st September - 30th October 2019. The survey duration is expected to be up to 35 days. The precise commencement and completion dates will be dependent on receipt of environmental approvals, vessel availability and weather conditions suitable for seismic acquisition.

The Dorrigo 3D MSS will be undertaken by an experienced seismic contractor utilising a purpose-built seismic vessel, towing seismic equipment along a series of predetermined seismic lines within the survey area. The vessel will, while acquiring seismic, travel at an average speed of approximately 8–9 km/h (4–4.5 knots). As the vessel travels along the survey lines, a series of acoustic pulses activated at approximately 12.5m-18.75m intervals[4] (approximately every 9-11 seconds) will be directed down through the water column into the seabed via two or three source arrays. These acoustic pulses transmit through the subsurface; reflect at geological boundaries and transmit back to the surface where they are detected by sensitive hydrophones, arranged along a number of cables (streamers) towed behind the survey vessel. Data collected by the hydrophones is stored in on-board computers for processing and analysis, allowing the structure of the underlying geological strata to be mapped and potential hydrocarbon reservoir targets to be identified.

This seismic equipment comprises a dual/triple source array, of volume up to 3260 in^3 operating at pressures of 2000 psi and will be towed at approximately 7 m water depth. Reflected sound waves will be detected by hydrophones in up to ten streamers of length up to 6000m, each separated by 100-125m, towed at a depth of approximately 8-25m behind the seismic vessel. The MSS vessel will traverse the survey area along defined transects (or seismic lines) approximately 500-720m apart (dependent on number of streamers). A typical schematic of a dual source, 12 streamer seismic vessel is provided in **Figure 2-2**. The overall streamer spread width is controlled by adjusting the rope lengths towing the barovane doors.

Figure 2-2: Typical 3D MSS source and streamer towing diagram [12 streamers]



The survey will use solid hydrophone streamers and will maintain neutral buoyancy. Each streamer will have depth controllers and emergency recovery units and may have further positioning and steering units. The emergency recovery unit is a device attached to the streamer at intervals of ~300

[4] This depends on the final parameter selection.

m. It senses if the streamer sinks below a pre-determined depth, and in such events, deploys an automatic pressure-activated airbag to float the streamer back to the surface.

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

The survey acquisition vessel may mobilise from Australian or International ports to the survey area.

Table 2-3 summarises the basic acquisition parameters for the Dorrigo 3D MSS. The minimum standard for the survey vessel is defined in **Section 2.4**.

Table 2-3: Dorrigo 3D MSS acquisition parameters

Parameter	Details
Program Details	
Earliest Commencement Date	1 September 2019
Duration of Survey	35 Days
Speed	4-4.5 knots
Maximum Fullfold Acquisition Area (km^2)	1580
Vessel Operational Area (km^2)	4350
Vessel lead-in/lead-out distance	5 km / 10 km
Depth of water (acquisition)	100-840 m
3D Survey Line Length:	85 km (max) 31 km (min)
Approximate Sail Lines Number	43
Distance between adjacent seismic lines	500-720 m
Distances between consecutive seismic lines	10 km
Seismic Parameters	
Volume of Operating Airgun Array	3260 cui (max)
Airgun operating pressure	2000 psi
Compressed air source depth	7 m
Peak near-field sound pressure level	255.5 dB re 1µPa @1 m (vertical) (Warner et al, 2018)
Primary Frequency	1-210 Hz
Source Interval	12.5 to 18.75 m
Streamers	
Number of streamers	10 (max)
Length	6000 m
Streamer spacing	100 – 125 m

Depth of Streamers	8 – 25 m
Streamer Type	Solid
General	
Hours of Operation	24/7
Method of crew change	Port Call or at Sea
Refuelling	Port call or at Sea (with spatial restrictions)
Support Vessels (including scout)	2
Supply Port	Portland/Geelong

2.4 Vessel Specification

2.4.1 General

3D Oil will engage a seismic contractor to conduct the survey using a purpose-built seismic vessel. At this time the vessel has not been selected, however the selected seismic vessel will have all necessary certification/registration and be fully compliant with all relevant MARPOL and SOLAS convention requirements specific for the vessel's size and purpose.

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

- *International Oil Pollution Prevention (IOPP) certificate* in accordance with MARPOL Annex I (enacted under AMSA Marine Orders Part 91, Marine Pollution Prevention – Oil);
- *International Sewage Pollution Prevention (ISPP) certificate* in accordance with MARPOL Annex IV (enacted under AMSA Marine Orders Part 96, Marine Pollution Prevention – Sewage);
- *Engine/International Air Pollution Prevention (EIAPP/IAPP) certificate* in accordance with MARPOL Annex VI (enacted under AMSA Marine Orders Part 97, Marine Pollution Prevention – Air Pollution);
- *Shipboard Oil Pollution Emergency Plan (SOPEP)* in accordance with MARPOL Annex I (enacted under AMSA Marine Order Part 91 – Oil and Part 93, Marine Pollution Prevention – Noxious Liquid Substances);
- *Shipboard Garbage Management Plan* in accordance with MARPOL Annex V (enacted under AMSA Marine Orders Part 95, Marine Pollution Prevention – Garbage);
- *International Anti-fouling System certificate* in accordance with the International Convention on the Control of Harmful Anti-fouling Systems on Ships 2008 (enacted under AMSA Marine Orders Part 98, Marine Pollution Prevention – Anti-fouling Systems).
- *IMO-approved Ballast Water Management Plan* in accordance with the International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004) (enacted under the Biosecurity Act 2016).

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

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

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

2.4.2 Maritime Safety Precautions

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

Prior to commencement of survey operations, 3D Oil will apply to the Australian Hydrographic Service (AHS), for the issue of a Notice to Mariners (published fortnightly) for the survey. A daily AUSCOAST warning of the survey vessel location will also be issued by AMSA through the Global Maritime Distress Safety System (GMDSS) communication network. The warning will provide details of the safe distance to be maintained around the seismic survey vessel and towed equipment.

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

Supplementary to radar detection, the support and scout vessels will have additional transmitting beacons fitted for the duration of the survey. The vessels will use either Automatic Identification System (AIS) transponders or radio global positioning system (GPS) transponders. The addition of this equipment and the data it transmits provides accurate real-time updates of the position of all survey vessels relative to the survey vessel and the towed seismic spread.
All vessels will can communicate and operate on dedicated ultra-high frequency (UHF) working channels and or Maritime very high frequency (VHF) working channels (typically monitoring Channel 16 and working on 74).

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

2.5 Logistics Support

Portland or the Port of Geelong is anticipated to be used as a logistics/supply base for the activity. During the MSS there will be two (2) vessels servicing the seismic vessel for logistical, safety and equipment management support. Where possible these vessels will be sourced locally. The main function of these support vessels is to escort the MSS vessel; to scout ahead of the MSS vessel for marine hazards or whales; to maintain a safe distance between the towed array and other vessels; to manage interactions with shipping and fishing activities; to act in an emergency-response capacity and, on a secondary basis, supply the MSS vessel with logistical supplies. The vessels will not anchor at sea unless required in an emergency. Refuelling of vessels at sea will not occur unless there is an emergency that would require such an action[5].

Although a crew change may not be required during this 35-day survey, one crew change could be necessary. The crew change will preferably occur during a port call however vessel or helicopter transfer may occur. If required, helicopter transfer anticipated from Essendon will only occur during daylight hours in acceptable wind and sea conditions however night transfer may be required in the event of an operational emergency, medical evacuation or other non-routine circumstance (i.e. impending bad weather conditions). There will be no helicopter refuelling on-board the seismic vessel.

Emergency medical facilities are available at Portland, Geelong or Melbourne. If required, crew can be air-lifted to Melbourne's medical facilities.

2.6 Simultaneous Surveys

3D Oil is not aware of any titleholders with accepted EPs for MSS activities that may take place in the Otway Basin during the Dorrigo survey period (September 1 to October 31, 2019). However, 3D Oil has been approached by Spectrum-Geo who may undertake a MSS at the same time, however not spatially coincident with the Dorrigo MSS. This simultaneous survey activity has been assessed for possible impacts in **Section 7.2** and preliminary measures have been agreed to control impacts.

It is possible that other surveys in addition to the Spectrum-Geo and the proposed 3D Oil Dorrigo 3D MSS may occur in the same region at the same times. 3D Oil will monitor the NOPSEMA website for additional possible survey activities in the Otway Basin and consult with the titleholders on these proposed activities as they arise.

[5] This has been included as a contingent activity in this Environment Plan

3.0 REGULATORY ENVIRONMENT

In accordance with OPGGS(E)R Regulation 13(4)(a), this section describes the environmental legislative requirements that apply to the Dorrigo 3D MSS petroleum activity.

3.1 Commonwealth Legislation

The Dorrigo 3D MSS is located entirely within Commonwealth waters and falls under Commonwealth legislation (between 3 to 200 nm from territorial base). **Table 3-1** provides a summary of Commonwealth legislation (including legislation adopting international conventions) relevant to the environmental management of the survey as required by OPGGS(E) Regulation 13(4).

The supply base for the survey is expected to be located at Portland or Geelong and as such Victorian legislation will apply to those activities. Additionally, although the MSS area is located entirely within Commonwealth waters, in the unlikely event of a hydrocarbon spill entering state waters, Victorian and Tasmanian oil spill response legislation will be triggered. **Table 3-2** provides a summary of Victorian and Tasmanian legislation relevant to the environmental management of the survey in those areas.

The OPGGS Act and associated OPGGS(E) Regulations 2009 is the key legislation regulating petroleum exploration and production in Commonwealth waters, and mandates that environmental considerations should be integrated into decision-making with regard to the administration of the Act. The OPGGS(E)R are administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). In accordance with this legislation, this MSS cannot proceed, and must be undertaken in accordance with a NOPSEMA-accepted Environment Plan (EP).

The Dorrigo MSS area spatially overlaps the Zeehan Commonwealth Marine Park (CMP). The petroleum activity will be undertaken in accordance with the rules for use set out in the South-east Commonwealth Marine Reserves Management Plan 2013-2023 (DNP, 2013). The Dorrigo MSS full-fold area spatially overlaps 37.5% of the Zeehan CMP Multiple-use Zone (IUCN - VI)[6] with no spatial overlap of the Zeehan CMP (Special Purpose Zone – IUCN VI). In accordance with that plan, activities must be consistent with the stated plan and zone objectives where the activity is being conducted (Schedule 8 of the EPBC Regulations) (DNP, 2013).

Petroleum activities are permitted in Multiple Use Zones and Special Use Zones (IUCN category VI) in accordance with Class Approval for Mining issued under the South-east Commonwealth marine Reserves Network Plan 2013-23 Section 5.2.7 issued on 15/12/17[7]. In accordance with this Class Approval, mining operations must be conducted in accordance with the following relevant requirements:

- Compliance with the EPBC Act 1999 and Regulations 2000, the South-east Commonwealth Marine Reserves Management Plan 2013-2023 (DNP, 2013) and other applicable Commonwealth and State laws;
- Mining operations subject to the OPGGS Act 2006 must be undertaken in accordance with an approved Environment Management Plan for those operations;

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6 The total area of the Zeehan CMP (Multiple Use Zone) is 933 km^2 (DNP, 2013). Spatial overlap of the Dorrigo MSS full-fold area with this zone is 350 km^2 and operational area is 680 km^2.

7 Available at https://parksaustralia.gov.au/marine/pub/class-approvals/SE-class-approval-mining-2017.pdf

- The Director of National Parks must be notified at least 14 days prior to the conduct of any operations in the CMP; and
- All employees and contractors engaged in the conduct of mining operations in the CMP must be fully informed of these conditions before commencing operations.

These management plans give effect to reserve management principles, objectives and prescribe what and how activities are allowed to occur within each marine park and zone. An assessment of the management principles and objectives for affected CMPs against the Dorrigo MSS activities is provided in **Appendix 7.**

3.2 Government Policy and Administrative Guidelines

This EP has been developed in accordance with the NOPSEMA Guidance Note for Environment Plan Content Requirements (N04750-GN1344, Revision 3, April 2016). The guidance note provides guidance to the petroleum industry on NOPSEMA's interpretation of the OPGGS(E)R to assist operators in preparing EPs.

Other relevant NOPSEMA guidelines that have been incorporated into the preparation of this EP:

- Acoustic impact evaluation and management (IP1765 , September 2018)
- Consultation requirements under the OPGGS Environment Regulations 2009 (IP1411, Rev 2, December 2014);
- Oil pollution risk management (GN 1488, Rev 2, February 2018);
- Notification and Reporting of environmental incidents (GN0926, Rev 4, February 2014);
- Operational and scientific monitoring programs (NOPSEMA Information Paper, N-04700-IP1349, March 2016;
- Petroleum activities and Australian marine parks (N-04750-GN 1785 Rev 0, 16/07/18);
- Environment Plan Decision making guideline (GL1721, Rev 5, June 2018).

Other legislative guidelines, regulator plans, conservation plans, and threat abatement plans which have been reviewed as part of the preparation of this EP include:

- Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, 2015);
- National Plan for Maritime Environmental Emergencies (AMSA, 2017)
- National Biofouling Management Guidance to the Petroleum Production & Exploration Industry (Commonwealth of Australia, 2009);
- Australian Ballast Water Management Requirements (Revision 7) (DAWR, 2017);
- EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance (DoE, 2013);
- EPBC Act Policy Statement 2.1- Interaction between offshore seismic exploration and whales (DEWHA, 2008);
- National Recovery Plan for Threatened Albatross and Giant Petrels (SEWPC, 2011c);
- National Recovery Plan for Ten Species of Seabird (DEH, 2005c);
- Blue Whale Conservation Management Plan (DoE, 2015);
- Conservation Management Plan for the Southern Right Whale (SEWPC, 2012);
- Threat Abatement Plan for Impacts of marine debris on vertebrate marine life (DoEE, 2018);
- Recovery Plan for the Great White Shark (SEWPC, 2013c);
- Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017);
- Recovery Plan for the orange-bellied parrot (DoE, 2016);

- South-east Marine Region Profile (DoE, 2015);
- South-east Commonwealth Marine Reserves Management Plan 2013-2023 (DNP, 2013)
- Australian IUCN Reserve Principles for Commonwealth Marine Protected Areas (EA, 2002b) Threatened species conservation advices for the following:
    - Humpback whale (TSSC, 2015a);
    - Sei whale (TSSC, 2015c);
    - Fin whale (TSSC, 2015b);
    - Red Knot (TSSC, 2016a);
    - Curlew Sandpiper (TSSC, 2015d);
    - Blue petrel (TSSC, 2015e);
    - Eastern curlew (TSSC, 2015f);
    - Fairy prion (southern) (TSSC, 2015g)
    - Lesser sand plover (TSSC, 2016b);
    - Bar-tailed godwit (West Atlantic) (TSSC, 2016c)
    - Bar-tailed godwit (North Siberian) (TSSC, 2016d);
    - Soft-plummaged petrel (TSSC, 2015h);
    - Hooded plover (TSSC, 2014); and
    - Fairy tern (TSSC, 2011).

3.3 Industry Codes of Practice and Guidelines

This EP has been developed with guidance from the following industry guidelines:

- Australian Petroleum Production and Exploration Association's (APPEA) Code of Environmental Practice (2008). This code gives guidance on the outcomes to be achieved when managing environmental impacts associated with petroleum exploration and production activities (including seismic surveys). It includes four basic recommendations to APPEA members undertaking activities:
    - Assess the risks to, and impacts on, the environment as an integral part of the planning process;
    - Reduce the impact of operations on the environment, public health and safety to as low as reasonably practicable (ALARP) and to an acceptable level by using the best available technology and management practices;
    - Consult with stakeholders regarding industry activities; and
    - Develop and maintain a corporate culture of environmental awareness and commitment that supports the necessary management practices and technology and their continuous improvement.
- The International Association of Oil and Gas Producers (OGP) have developed guidelines for Environmental Management in Oil and Gas Exploration and Production (1997). This provides an over-view of environmental issues and the technical and management approaches to achieving high environmental performance in oil and gas exploration and production;

- The International Association of Geophysical Contractors (IAGC) have collated an Environmental Manual for Worldwide Geophysical Operations (2013) which provides guidance on how to undertake geophysical field operations in an environmentally sensitive manner (including the marine environment.

3D Oil applies these industry guidelines when planning and managing offshore exploration activities.

3.5 Maintaining Compliance

3D Oil manages compliance with legislation and associated environmental regulatory publications according to the process is described in **Section 8-10**.

Table 3-1: Key Commonwealth Legislation

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Offshore Petroleum & Greenhouse Gas Storage Act 2006 & OPGGS (Environment) Regulations 2009	The OPGGSA addresses all **licensing, health, safety, environmental** and royalty **issues for offshore petroleum exploration and development operations** extending beyond the 3-nautical mile limit. The OPGGS (Environment) Regulations 2009 ensures that petroleum activities are undertaken in an ecologically sustainable manner and in accordance with an environmental plan which has appropriate environmental performance outcomes, standards and criteria. ***Relevance:*** *Petroleum activity requires the preparation and acceptance of an Environment Plan prior to undertaking the activity. The EP must be in accordance with the requirements of the legislation and demonstrate impacts and risks are ALARP and acceptable.*	Not applicable	Department of Industry (DOIIS)/NOPSEMA
Environment Protection & Biodiversity Act 1999	This Act focuses on environmental matters of National Environmental Significance (NES), streamlines the Commonwealth environmental assessment and approval process and provides an integrated system for biodiversity conservation and management of protected areas. **Matters of NES** are world heritage properties; RAMSAR wetlands; listed threatened species and communities; migratory species under international agreements; nuclear actions; the Commonwealth marine environment; activities in the Great Barrier Reef Marine Park and water triggers for coal seam gas and coal mining developments. Schedule 8 of the EPBC Regulations outlines the IUCN Reserve Management Principles which will be observed by this activity. ***Relevance:*** *Relevant items of NES and species contained within the international conventions enacted by this legislation have been identified within this EP (refer Section 3).*	• 1992 Convention on Biological Diversity & Agenda 21 • Convention on International Trade in Endangered Species of Wildlife and Flora 1973 (CITES) • Japan/Australia Migratory Birds Agreement 1974 (JAMBA) • China/Australia Migratory Birds Agreement 1974 (CAMBA) • Republic of Korea Migratory Birds Agreement 2006 (ROKAMBA) • USSR-Australia Migratory Bird Agreement • Convention on Wetlands of International Importance especially waterfowl habitat 1971 (RAMSAR) • International Convention on Whaling 1946 • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)	Department of Environment and Energy (DOEE) NOW assessed by NOPSEMA under streamlining arrangements

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Environment Protection (Sea Dumping) Act 1981	The Act protects the waters surrounding Australia's coastline from wastes and pollution and regulates waste loading and dumping activities, incineration at sea and artificial reef placement. Act prevents the deliberate **disposal of wastes** (loading, dumping, and incineration) at sea from vessels, aircraft, and platforms. ***Relevance:*** *Requirement observed within practices developed for this activity.*	Convention on the Prevention of Marine Pollution by dumping of waste & other materials 1972 (London Convention) MARPOL (*Regulates vessel routine/non-routine operations*)	DOEE
Hazardous Waste (Regulation of Exports and Imports) Act 1989	Relating to the controls over the importing and exporting of hazardous (intractable) materials. Permits are required to dispose of waste overseas or to import waste into Australia. ***Relevance:*** *Intractable waste will not be generated in this activity.*	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1992)	DOEE
Australian Maritime Safety Authority (AMSA) Act 1990	This Act specifies that AMSA's role includes protecting the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering Marine Orders in Commonwealth waters. Legislation also facilitates international cooperation and mutual assistance in **preparing and responding to a major oil spill incident** and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. ***Relevance:*** *Authority is included into necessary oil response documents for reporting purposes.*	International Convention on Oil Pollution (Preparedness, Response and Cooperation) 1990 (OPRC) (*Relates to non-routine operations (oil spills) and sets up a system of oil pollution contingency plans and cooperation in fighting oil spills*)	Australian Maritime Safety Authority (AMSA)
Historic Shipwrecks Act 1976 (& Historic Shipwreck Regulations 1978)	Protects the **heritage values of shipwrecks and relics** for shipwrecks over 75 years or more. It is an offence to interfere with a shipwreck covered by this act. ***Relevance:*** *Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified & assessed (as applicable) within this EP.*	• Australian-Netherlands Agreement concerning old Dutch Shipwrecks 1972 • Convention on Protection of Underwater Cultural Heritage 2001	DOEE
Ozone Protection & Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of **ozone depleting substances (ODPs) and SGGs**. ***Relevance:*** *Applicable to the handling of any ODP or SGG Substances on vessels during survey.*	• MONTREAL Protocol on substances that deplete the ozone layer 1987 (Concerns the phase-out of ODPs) • UN Framework Convention on Climate Change 1992 (Stabilise greenhouse gas concentrations in the atmosphere at a level which would prevent dangerous interference with the climate system)	DOEE

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
National Environment Protection Council Act 1994	Council develops (in conjunction with other state authorities) through the Intergovernmental Agreement on the Environment (IGAE) sets consistent environmental standards to be adopted between states. These requirements take the form of a National Environmental Protection Measure (NEPM) and include the *National Pollutant Inventory.* ***Relevance:*** *Pollution discharge monitoring and measurement.*	Not applicable	National Environment Protection Council
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	Regulates ship-related operational activities in Commonwealth waters and invokes certain requirements (discharge conditions and constraints) of the **MARPOL convention (Annexes I, II, III, IV, V & VI) relating to discharge of oil, noxious liquid substances, sewage, garbage, air pollution etc.** ***Relevance:*** *Discharge practices (oil/water, sewage, air emissions, garbage) by survey vessel activities observe these constraints.*	International Convention for the Prevention of Pollution from Ships [MARPOL 73/78] provisions and unified interpretations of the articles, protocols and Annexes of MARPOL 73/78, including the incorporation of all of the amendments that have been adopted by the MEPC and have entered into force, up to and including the 2000 amendments (as adopted by resolution MEPC.89(45))	AMSA
Biosecurity Act 2015 (& Regulation 2016)	The Act empowers authorities to assess and manage biosecurity risks associated with good and conveyances (for example, aircraft and vessels). Authorities may quarantine goods, vessels and people to **prevent the introduction, establishment or spread of diseases or pests (e.g. invasive marine species)** affecting human beings, animals, or plants. For the petroleum industry, it regulates the condition of vessels and drill rigs entering Australian waters with regard to ballast water and hull fouling. **Relevance:** The survey and support vessels will adhere to guidelines regarding quarantine clearance to enter Australian ports and waters. *Requirement observed within practices developed for survey vessels during international transits.*	International Convention for the Control and Management of Ships Ballast Water & Sediments 2004 World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS agreement) World Organization for Animal Health (OIE) and the International Plant Protection Convention (IPPC).	Department of Agriculture and Water Resources (DAWR)

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Navigation Act 2012	Regulates ship-related activities and invokes certain requirements of the MARPOL convention relating to **equipment and construction of ships (vessel survey and certification); crewing; seafarers' qualifications and welfare; occupational health and safety; carriage and handling of cargoes; and marine pollution prevention.** Several Marine Orders (MO) are enacted under this Act relating to offshore petroleum activities, including: • MO Part 11: Living & Working Conditions on Vessels • MO Part 21: Safety and emergency arrangements • MO Part 27: Safety of navigation and radio equipment • MO Part 30: Prevention of collisions • MO Part 41: Carriage of Dangerous Goods • MO Part 42: Carriage, stowage and securing of cargo and containers • MO Part 50: Special purpose ships • MO Part 57: Helicopter operations • MO Part 59: Offshore industry vessel operations • MO Part 91: Marine Pollution Prevention - Oil • MO Part 93: Marine Pollution Prevention - Noxious liquid substances • MO Part 94: Marine Pollution Prevention - Packages harmful substances • MO Part 96: Marine Pollution Prevention - Sewage • MO Part 95: Marine Pollution Prevention - Garbage • MO Part 97: Marine Pollution Prevention - Air pollution • MO Part 98: Marine Pollution Prevention - Antifouling Systems ***Relevance:*** *Observed in the selection of vessels for survey activities.*	International Convention for the Prevention of Pollution from Ships [MARPOL 73/78] (*certain sections*) International Convention for Standards of Training and Watch-keeping for Seafarers (STCW) International Convention for the Safety of Life at Sea (SOLAS) Convention on the International Regulations for Preventing Collisions at Sea (COLREGS) United Nations Convention on the Law of the Sea (UNCLOS)	Department of Infrastructure & Regional Development (administration) /AMSA (operational activities)
Protection of the Sea (Harmful Anti-fouling Systems) Act 2006	Regulates the use of harmful **anti-fouling systems employed on boats** and their effects on the marine environment. ***Relevance:*** *Observed in the selection of vessels for survey activities.*	International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001	Department of Infrastructure & Transport & Regional Development (administration)/AMSA (operations)

Legislation	Coverage & **Applicability to Activity**	International Convention Enacted	Administering Authority
Protection of the Sea (Powers of Intervention Act) 1981	This Act gives AMSA appropriate powers to intervene in shipping operations to protect the Australian coastline. ***Relevance:*** *AMSA authority acknowledged in these seismic activities.*	Convention relating to the Intervention on the High Seas in Cases of Oil Pollution Casualties (Provides for state parties to intervene on ships on the high seas when their coastlines are threatened by an oil spill from that ship).	AMSA
Protection of the Sea (Oil Pollution Compensation Fund) Act 1993	This act implements the requirements of the International Convention for the Establishment of an International Fund for Compensation of Oil Pollution Damage.	International Convention for the Establishment of an International Fund for Compensation of Oil Pollution Damage 1992	AMSA
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage which sets up a compensation scheme for those who suffer damage caused by spills of oil that is carried as fuel in ships' bunkers. There is an obligation on ships over 1,000 gross tonnage to carry insurance certificates when leaving/entering Australian ports or leaving/entering an offshore facility within Australian coastal waters. ***Relevance:*** *Survey vessel to hold the necessary insurance certificates.*	International Convention on Civil Liability for Bunker Oil Pollution Damage 2000	AMSA
Protection of the Sea (Shipping Levy) Act 1981	Provides that where, at any time during a quarter when a ship with tonnage length of no less than 24 m was in an Australia port, there was on board the ship a quantity of oil in bulk weighing more than 10t, a levy is imposed in respect of the ship for the quarter. ***Relevance to this survey:*** *The survey and support vessels will adhere to the shipping levy.*	Not applicable	AMSA
National Greenhouse and Energy Reporting Act 2007	Introduces a single **national reporting framework** for the reporting and dissemination of information about **greenhouse gas emissions**, greenhouse gas projects and **energy use and production of corporations.** ***Relevance:*** *Requirement to report greenhouse gas emissions above certain thresholds.*	Not applicable	Clean Energy Regulator

Table 3-2: Key Victorian and Tasmanian Legislation

Legislation	Coverage
VICTORIA	
Environment Protection Act 1970	This Act is the key Victorian Legislation regulating emissions to the environment within Victoria (relevant for waste disposal and transfer, national pollutant inventory reporting). Administered by the Victorian Environment Protection Authority.
Pollution of Waters by Oil and Noxious Substances Act 1986	This Act is the Victorian state legislation giving effect to the requirements of MARPOL 73/78 within state waters. Administered by the Victorian Environment Protection Authority.
Marine Act 1988	This Act provides for the registration of shipping vessels and navigational requirements and oil spill response arrangements within Victorian Territorial waters. Administered by the Victorian Department of Economic Development, Jobs Training and Resources.
TASMANIA	
Pollution of Waters by Oil and Noxious Substances 1987.	This act is designed to protect state waters from pollution by oil and other substances and to give effect to certain parts of the MARPOL convention. This act is administered by EPA Tasmania.
Environmental Management and Pollution Control Act 1984	This act provides for the management of environment and the control of pollution. This act is administered by EPA Tasmania.
Emergency Management Act 2006	This act provides for the protection of life, property and the environment in a declared State emergency by outlineing preparedness, response and recovery procedures. This act is administered by Office of Security and Emergency Management.
Tasmanian Ports Corporation Act 2005	This act sets out the administerative arrangements for the Tasmanian Ports Corporation Pty Ltd a government owned ports corporation.
Aboriginal Heritage Act 1975	This act protects aboriginal cultural heritage which is defined as any place, site or object made or created by, or bearing the sign of activities of original inhabitants of Australia or their descendants on or before 1876. All Aboriginal relics are protected under the Act and it is illegal to destroy, damage, deface, conceal or otherwise interfere with a relic, unless in accordance with the terms of a permit granted by the Minister. DPIPWE through Aboriginal Heritage Tasmania is responsible for administering the act.

4.0 STAKEHOLDER CONSULTATION

3D Oil has built upon the previous stakeholder consultation experience obtained in the 2014 Flanagan 3D MSSin T/49P and opened up communication with interested parties who may be affected by Dorrigo MSS activities to provide feedback on issues and concerns they may have. This provides an opportunity for open and honest communication that promotes integration of stakeholder values into its decision-making process. This provides the means for 3D Oil to identify interested individuals and groups as well as their needs, ideas, values, and issues of concern regarding the environmental and/or social impacts of activities related to the activity.

In keeping with 3D Oil's HSE Policy and Principles for engagement with Communities and Stakeholders (MCMPR, 2005), 3D Oil is committed to open, on-going and effective engagement with the communities in which it operates and providing information that is clear, relevant and easily understandable.

This section of the EP defines:

- Requirements for stakeholder consultation;
- Objectives of stakeholder consultation;
- Who needs to be considered in decision making;
- When decisions must be completed;
- The on-going consultation schedule; and
- How commitments are documented and tracked to closure.

4.1 Regulatory Requirements

Section 280 of the OPGGS Act states that a person carrying out activities in an offshore tenement 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 order to determine what activities are being carried out and whether petroleum activities may interfere with existing users, consultation is required.

In relation to the content of an EP, more specific requirements are defined in the OPGGS(E)R Regulation 11A. This regulation requires that a 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.

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.

OPGGS(E)R Regulation 14(9) also defines a requirement for consultation with relevant State and Commonwealth authorities and relevant interested persons and organisations to be provided for in this EPs implementation strategy. OPGGS(E)R Regulation 16(b) requires that the EP contain a summary and full text of this consultation (refer **Appendix 8**).

4.2 Stakeholder Consultation Objectives

The principal objectives of the consultation strategy are to:

- Confirm existing stakeholders and identify whether there are additional stakeholders to those identified during 3D Oil's previous Flanagan MSS within T/49P;
- Initiate and maintain open communication/dialogue between stakeholders and 3D Oil relevant to their interests;
- Comply with regulatory requirements;
- Proactively work with stakeholders on recommended strategies to minimise negative impacts and maximise positive impacts of the Dorrigo 3D MSS activity; and
- Provide a means for recording consultation, and track any commitments made by 3D Oil through to closure.

4.3 Stakeholder Identification

3D Oil has established contact with stakeholders which had interests in Exploration Permit T/49P during the Flanagan 3D MSS in 2014, and others identified as possibly having an interest in the activity, to establish a working relationship with them. 3D Oil identifies a stakeholder as a 'relevant person' as defined in OPGGS(E)R Regulation 11A.

Establishing the stakeholder listing for the Dorrigo 3D MSS involved the following:

- Review of consultation undertaken in the previous 2014 Flanagan MSS;
- Review of relevant legislation applicable to Commonwealth petroleum and marine activities;
- Identification of marine user groups in the area (possible recreational/commercial fisheries, fishing industry groups, merchant shipping). This included Commonwealth and state fisheries jurisdictions and fishing effort in the region based upon a study performed by SETFIA/Fishwell Consulting (2018);
- Identification of marine 'interest' groups which have a specific association with the area (e.g. technical and scientific entities, environmental non-government organisations (NGOs)); and
- Titleholders of nearby exploration permits and production licences through the National Offshore Petroleum Titles Administrator (NOPTA) website.

Stakeholders identified for the Dorrigo 3D MSS activity, categorised according to OPGGS(E)R Regulation 11A are listed in **Table 4-1**.

Table 4-1: Stakeholders for the Dorrigo 3D MSS

Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant:	
Australian Maritime Safety Authority (AMSA)	Department of Agriculture and Water Resources (DAWR) (*consultation not undertaken directly with Department but utilised guidance notes for all shipping*)
Australian Fisheries Management Authority (AFMA)	Director of National Parks (DNP)
Australian Hydrological Service (AHS)	
Each Department or agency of a State or Northern Territory to which activities to be carried out under the EP may be relevant:	
Mineral Resources Tasmania (MRT)	Department of Primary Industries, Parks Water and the Environment (DPIPWE) (Conservation Assessment Section)
Institute of Marine and Antartic Studies (IMAS)	DPIPWE (Wild Fisheries Management)
Victorian Fisheries Authority (VFA)	DPIPWE (Water and Marine Resources Division)
EPA Tasmania	Tasmanian Parks & Wildlife Service
The Department of the responsible State Minister, or the responsible Northern Territory Minister:	
Department of State Development (Mineral Resources Tasmania)	
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP:	
Fisheries:	
Commonwealth Fisheries Association (CFA)	Sustainable Shark Fishing (SSF)
Seafood Industry Victoria (SIV)	Southern Shark Industry Alliance (SSIA)
Tasmanian Seafood Industry Council (TSIC)	Small Pelagic Fishery Industry Association (SPFIA)
Warrnambool Professional Fisherman's Association	Victorian Rock Lobster Association
Port Campbell Fishermans Association	Tasmanian Rock Lobster Fishing Association (TRLFA)
Apollo Bay Fishing Cooperative	Tasmanian Scallop Fishermen's Association
Tasmanian Abalone Council	TARFish
Victorian Recreational Fish (VR Fish)	[redacted] (Vic Rock Lobster Fisherman)
[redacted] (Vic Rock Lobster Fisherman)	[redacted] (Vic. Giant Crab Fisherman)
[redacted] (Tas. Giant Crab Fisherman)	[redacted] (GHaT & Vic Rock Lobsetr Fisherman)
[redacted] (CTS Fisherman)	[redacted] [redacted] [redacted] [redacted] [redacted] (CTS Fishermen)
[redacted] (Vic Rock Lobster Fishermen)	[redacted] (Vic. Lobster/Giant Crab fisherman)
[redacted] (Tas Rock Lobster Fisherman)	[redacted] (Vic Rock Lobster Fisherman)
[redacted] (Vic Rock Lobster Fisherman)	[redacted] (Vic Rock Lobster Fisherman)
[redacted] (CTS Fisherman)	[redacted] (CTS Fisherman)
All SESSF Licencees & Victorian Lobster and Giant Crab Licencees	[redacted] (CTS Fisherman)
[redacted] (CTS Fisherman)	[redacted] (CTS Fisherman)
[redacted] (Tasmanian Rock Lobster Fisherman)	[redacted] (Tasmanian Rock Lobster Fisherman)
[redacted] (Tasmanian Rock Lobster Fisherman)	[redacted] (Tasmanian Fisherman)

[redacted] (Tasmanian Rock Lobster Fisherman)	[redacted] (Tasmanian Fisherman)
[redacted] (Tasmanian Fisherman)	[redacted] (Tasmanian Rock Lobster Fisherman)
[redacted] (Tasmanian Rock Lobster Fisherman)	[redacted] (Scallop & Squid Fisherman)
[redacted] (GHaT Fisherman – Scalefish)	[redacted] (GHaT Fisherman – scalefish)
[redacted] (Tasmanian Scallop & Rock Lobster Fisher)	
Oil Spill Preparedness and Response Agencies:	
GHD (Scientific Resources)	RPS-APASA
EPA Tasmania	AMSA
Tasmanian Parks & Wildlife Service	
Adjacent Titleholders:	
Beach Energy (Lattice Energy)	Spectrum Geo
APPEA	
Local Government Associations:	
King Island Shire Council	Otway-Colac Shire Council
Corangamite Shire Council	
Any other person or organisation that the Titleholder considers relevant:	
Community Interests:	
Australian Oceanographic Services	Ocean Racing Club of Victoria
King Island Press (Local Paper)	ABC News (Tasmania)
Conservation Interests:	
Blue Whale Study	

It should be noted that consultation with 3D Oil contractors who will assist with the execution of the petroleum activity is not addressed in this section of the EP. This also includes organisations that 3D Oil has or will have a contract (e.g. seismic contractors). Discussions held with these organisations that are not directly linked to the impact assessment in this EP are not included in the summary of consultation in **Table 4-3**. Consultation with these contractors and organisations is undertaken in accordance with OPGGS(E)R Regulation 14(5), 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 8.4.**

3D Oil recognises that the relevance of stakeholders identified in this EP may change in the event of an incident or emergency. Every effort has been made to identify stakeholders that may be impacted by a incident or emergency, the largest of which is considered a Level 2 fuel spill (refer **Section 7.12**). Therefore, any stakeholders known or likely to have operations within or be affected by a spill within the environment that may be affected (EMBA) by the largest credible hydrocarbon spill is included in 3D Oil's list of stakeholders. 3D Oil acknowledges that other stakeholders not identified in this EP may be affected, and that these may only become known to 3D Oil in such an emergency event.

4.4 Engagement Approach and Method

4.4.1 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:

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

Elements 1, 2 and 3 are those of primary relevance to the Dorrigo 3D MSS and have been adopted. Element 4 has been adopted where stakeholder conflicts or issues have required resolution. However, many fishing-related stakeholders (primarily lobster and crab fishermen) do not support seismic activities, even with available scientific evidence supplied which demonstrates little impact to stocks and believe that MSS activity is causing a decline in, or killing, fishing stock. Collaboration has not been successful with many members of this group.

3D Oil encountered significant restrictions with respect to this consultation approach/methodology, particularly with the State Fishing Industry Councils (Seafood Industry Victoria and Tasmanian Seafood Industry Council). The way 3D Oil has informed, consulted and involved stakeholders with the Dorrigo 3D MSS is outlined through this section.

4.4.2 Engagement Methodology

Prior to the commencement of consultation, 3D oil engaged SETFIA/Fishwell Consulting to undertake a review of the Commonwealth, Victorian and Tasmanian fishing activity within the Dorrigo MSS area. This study obtained fishing catch tonnages and seasonality of fishing during the past 10 years within the Dorrigo MSS area from the following fishing authorities - the Australian Fisheries Management Authority (AFMA), Victorian Fishing Authority (VFA) and the Institute of Marine and Antarctic Studies (IMAS). This information was used to inform the Dorrigo MSS consultation. In brief, the study identified that the Dorrigo MSS is spatially coincident with nine fisheries – two Victorian (Western Rock Lobster Fishery, Giant Crab Fishery), two Tasmanian (Rock Lobster Fishery, Giant Crab Fishery) and five Commonwealth fisheries (Commonweath trawl sector (CTS) (Otterboard and Danish seine); Gillnet Hook and Trap (GHaT) (shark gillnet, shark hook and scalefish hook)). The report identified that the Tasmanian Giant Crab Fishery was the fishery potentially most affected by the spatial overlap. The report identifies that the '*remaining eight fisheries are important and individual operators may be affected on a localised basis but the effect across these fisheries in their entirety is low'* (SETFIA/Fishwell Consulting, 2018 (p8)).

Given the previous interaction with stakeholders during the Flanagan 3D MSS in 2014, existing stakeholders were provided with preliminary information on the Dorrigo 3D MSS activity and arrangements for providing feedback to 3D Oil by email in March 2018 (refer **Appendix 8**). This information canvased a MSS window of October 2018 to April 2019 to establish any broad issues with the selected period to refine down a suitable period to position the survey. 3D Oil also initiated phone calls to stakeholders where contact details were known, providing an opportunity to ask additional questions based on the information provided seeking feedback on whether face-to-face meetings would be of benefit. A number of fishing stakeholders declined meetings, however a number of stakeholders agreed to meetings which were held in late June/early July 2018 in ports along the Otway coastline and Lakes Entrance. These were mainly held with Commonwealth Licencees and Victorian Lobster/Crab fishermen.

Meetings were also initiated with SIV (face-to-face) and TSIC/Tasmanian Rock Lobster Fishing Association (TRLFA) (phone) during the period April to May 2018. SIV & TSIC advised of a new SIV/TSIC Consultation Process which 3D Oil would need to adopt when approaching Victorian/Tasmanian Fishermen. Contained within that consultation material were principles premised on the following (SIV/TSIC, 2018):

- Compensation to fishermen for MSS activities which precluded fishermen from fully exercising their rights and interests in MSS areas as a result of survey activities (i.e. *displacement from area*);
- Recent scientific reports *clearly identifying the potential for longer term impacts* on commercially targeted and broader ecosystem services; and
- 'Should there be *potential negative impacts* on professional seafood operations, there should be payment of compensation by the titleholders to the impacted party(s)'.

The consultation methodology also required all consultation and negotiation to be coordinated through SIV/TSIC with their established networks as '*titleholders who deal with individual fishers and smaller association bodies may tick the consultation box, but in reality only deliver out of context 'direct contact' and create 'consultation fatigue*'' (SIV/TSIC, 2018, p3).

3D Oil assessed the SIV/TSIC consultation process against OPGGSER consultation requirements and suggested a modified consultation strategy to SIV/TSIC which aligned the OPGGSER and SIV/TSIC requirements. 3D Oil proceeded to implement the 'modified strategy' with SIV/TSIC in September 2018. Delays in the methodology from SIV/TSIC then started to encroach on MSS approval timelines and alternate strategies to provide information to Victorian and Tasmanian fishing licencees was adopted. This included:

- Utilisation of the VFA licencee database[8], with VFA mailing Dorrigo MSS information to all Victorian Lobster and Giant Crab Licencees (undertaken in October 2018). No feedback was received from this additional mailout;
- Utilisation of the AFMA database[9], with mailout to all Licencees within the GHaT and CTS sectors. No feedback was received from this additional mailout;
- Utilisation of published information in the King Island Press (16 January 2019) and Tasmanian Advocate (3rd & 10th Jaunray 2019) to communicate MSS activity to potentially affected Victorian/Tasmanian fishermen.

3D Oil also sent a revised stakeholder notification advice in September 2018 to all stakeholders advising them of the delay to the Dorrigo MSS from the 2018 season to between September 1 and October 31, 2019 to accommodate stakeholder concerns and avoid high productivity periods within the Otway region. 3D Oil has acknowledged all feedback received to date from stakeholders. Where issues and concerns have been raised, 3D Oil has provided feedback providing information on the issue/concern to ensure both parties are aware of the available

8 DPIPWE were also approached to undertake a simliar activity for Tasmanian Fisheries, however advised that they were not able to undertake this task.

9 AFMA provides the licencee database and information was sent by 3D Oil to these respective licencees.

science on the issue for further discussion. 3D Oil will continue to consult with these stakeholders on any issues/concerns raised as part of ongoing consultation (refer **Section 4.7**).

In undertaking this consultation, 3D Oil has adhered to the consultation guidelines (refer **Table 4-2**) released by various Commonwealth government agencies and industry associations in response to the consultation requirements of the OPGGS(E)R.

Table 4-2: Consultation Guidance for the Dorrigo 3D MSS

Agency	Guidance	Requirements	3D Oil Response
COMMONWEALTH			
NOPSEMA	Consultation requirements under the OPGGSER 2009 (N-04750-IP1411, Rev 2, Dec, 2014) available at https://www.nopsema.gov.au/assets/Information-papers/A347285.pdf	This guideline describes NOPSEMA's consideration of consultation requirements when assessing EPs and identifies NOPSEMA's position on key regulatory requirements. It also describes relevant persons and defined functions, interests and activities outlined in the OPGGS(E)R.	3D Oil has used the descriptions of relevant persons to categorise stakeholders for this project and also provided information specified in this guideline within this section.
AMSA	Offshore Petroleum Industry Advisory Note (18th November 2018) available at https://www.amsa.gov.au/safety-navigation/navigating-coastal-waters/offshore-activities/offshore-petroleum-industry-advisory	To assist offshore petroleum industry titleholders address their oil spill preparedness and response requirements, we invite titleholders to enter into a Memorandum of Understanding (MOU) with us. This MOU sets out an understanding of respective roles and responsibilities when responding to ship-sourced and non-ship-sourced marine pollution incidents. The MOU is the sole method through which we consult with titleholders about their environmental plans.	AMSA has clarified that a MOU is not required for a vessel-based activity.
STATE			

Agency	Guidance	Requirements	3D Oil Response
Victorian Fishing Authority	Undertaking seismic surveys in Victorian Managed Waters – Policy for Victorian Fisheries (2017) available at https://vfa.vic.gov.au/about/publications-and-resources/undertaking-seismic-surveys-in-victorian-managed-waters	Guidelines provide the expectations of the VFA when undertaking consultation including ecological, economic and social impacts considering th e suitability of the location (cumulative impacts on fish, fishing activity, fish habitat; patterns of fishing activity); suitability of timing of surveys (moulting, reproduction, peak fishing periods, commercial fishing closures); historic catch prior to MSS; suitable mitigation measures to protect against detrimental impacts; and up-to date scientific advice on impact of seismic surveys to relevant species. Consultation methodology includes provision for natural justice, targeted consultation on relevant persons (fishing industry bodies namay assist in determining relevant persons); timely consultation; reasonable efforts in determining who may be affected; hearing of all relevant views; sufficient information provided on how MSS may impact on stakeholder functions, interests and activities; activity not to interfere with fishing to a greater extent than is necessary; consultation to be transparent and accurately documented with claims addressed.	In accordance with the consultation guidelines 3D Oil has obtained catch and effort data, consulted with state fishing authorities and provided letters to Victorian fishermen. Suggested mitigation measures to manage specific risks to key species have been assessed within Section 7.2 as to their practicability and effectiveness in application for the Dorrigo MSS area.
EPA Tasmania	EPA Tasmania – Offshore Petroleum Industry Guidance Note (2018) available at https://epa.tas.gov.au/Documents/Offshore%20Petroleum%20Industry%20Guidance%20Note.pdf	Guidelines provide details for incident management for petroleum activities undertaken in Commonwealth waters which may impact on Tasmanian waters. Relevant information provision requirements to consult on oil spill arrangements are provided.	3D Oil has provided available oil spill information to EPA Tasmania for comment. Consultation guidelines are largely associated with large-spill scenarions from hydrocarbon infrastructure (i.e. drilling activities, production platforms).

Agency	Guidance	Requirements	3D Oil Response
SIV/TSIC	Mining , Gas and Petroleum Consultation Policy, Version 1, April 2018	Consultation process sets out to address and where possible mitigate environmental and access issues. The Policy provides a consultation plan blueprint to achieve meaningful and appropriate consultation, which includes: Pre-activity Planning: • Scoping: Provision to SIV/TSIC of all technical work to identify likely isues and risks and sectors impacted; • Planning: Qualify potential impacts (short-term displacement or longterm damage impacts to flora/fauna in marine environment and disturbance to ecosystem function). Development of a communication & engagement plan (run through TSIC/SIV); • Engagement: Execute communications and engagement plan, obtain fishing history statistics. • Negotiate: SIV/TSIC to develop framework to mitigate risk and facilitate negotiations to ensuremembers are fairly treated; • EP Review: In cases where issues/risks are identified but negotiation/compensation are not required; review EP for changes which will reduce impacts from the activity (e.g. equipment used, paths taken, timeframes adjusted) During Activity: SIV/TSIC monitor activity and communicate with fishers on progress. After Activity: Review reports on compliance. (i.e. comparison of what was modelled compared with what was measured) with associated adjustment in compensation.	3D Oil has: • Assessed this methodology and provided a modified version to align with OPGGSER requirements. This modified stragey was presented to SIV/TSIC without any issues identified. • Seeks to engage with SIV/TSIC in discussing issues with individual members associated with the Dorrigo MSS. • Most of the 'catch' identification has already occurred via the SETFIA/ Fishwell Consulting Fishery analysis and will not need to be duplicated.
INDUSTRY			
Ministerial Council on Minerals and Petroleum Resources (MCMPR)	Principles for engagement with Communities and Stakeholders (MCMPR, 2005)	Guidance provides for consultation includes open, accurate and timely communication; transparency in information and reporting; collaboration to seek mutually beneficial outcomes; inclusiveness of stakeholders early in the process and conducting engagement in a manner which fosters respect and trust.	3D Oil has endeavoured to adopt this approach in all consultation activities undertaken for the Dorrigo MSS activity.

4.4.3 Distribution of Survey Information via Fishing Associations

3D Oil has developed and maintained its own register of commercial fishers in the Otway Basin building on stakeholder engagement initiatives related to the Flanagan 3D MSS in 2014. However, to ensure broader communications relevant to new commercial fishers, 3D Oil has sought the support of these existing stakeholders and utilised information form the Dorrigo MSS Fishery Assessment Study (SETFIA/Fishwell Consulting, 2018) to identify new stakeholders. This contact information is important as affected fishermen will be advised by a daily SMS during the survey period of the survey activities for the day.

3D Oil expects additional stakeholders not currently identified in this EP may be affected, and that these stakeholders may only become known to 3D Oil through ongoing engagement and consultation carried forward. Project information will be made available on the 3D Oil website (http://www.3Doil.com.au/) for all interested members of the public to access particularly during survey activities (48-hour look-ahead).

4.5 Stakeholder Engagement Register

All stakeholder engagement activities, including actions arising and commitments made are recorded and tracked via the stakeholder engagement register that is controlled and maintained by the 3D Oil Project Manager (or delegate). The register is a 'live' consultation log that is updated during the planning and activity phases of the survey as consultation activities are undertaken.

4.6 Summary of Stakeholder Consultation

Stakeholder consultation has involved extensive consultation with a broad range of stakeholders, as listed in **Table 4-1**. **Table 4-3** outlines the key themes in the feedback (objections and claims) and 'measures adopted because of the consultations.' Stakeholder engagement has involved a combination of email exchanges, face-to-face meetings and phone conversations.

Table 4-3: Key themes and measures adopted because of the consultations

Theme (Feedback/ Objections/Claims)	Stakeholders Involved	Measures adopted because of the consultations
Damage to the wider marine environment & resources (fish, plankton, invertebrates) from acoustic sound	SIV (Stakeholder #2) TSIC (Stakeholder#3) TRLFA (Stakeholder #9) SETFIA (Stakeholder #12) SSF (Stakeholder #13) DPIPWE (Stakeholder #31) [redacted] (Stakeholder# 38) [redacted] (Stakeholder#39) [redacted] (Stakeholder #42) [redacted] (Stakeholder Log) [redacted] (Stakeholder #58) [redacted] (Stakeholder #61)	3D Oil has assessed the impacts to the marine environment and, via current science, impacts to environmental resources are localised, temporary and recoverable. High productivity periods have been avoided to reduce possible impacts to as low as reasonabley practicable. For all stakeholders who expressed a concern associated with marine resources relevant assessment, literature has been provided to act as a basis for further discussion on this issue. No feedback has been provided from stakeholders on this information. Of particular importance there has been no concern raised about this theme from the fishing regulators (VFA and DPIPWE). 3D Oil notes that there are some stakeholders opposed to the survey and do not want to engage on discussions around scientific studies however do not want the MSS to proceed at all. 3D Oil has respected their explicit instructions not to be contacted.
Communications during survey and notification of completion of survey should be immediate and not within 10 days	SETFIA (Stakeholder #12) SSF (Stakeholder #13) [redacted] (Stakeholder#41) [redacted] (Stakeholder #42)	3D Oil has modified the 'completion notification to fishermen' so that this occurs immediately rather than within 10 days as a result of this feedback (refer **Section 7.8** and **Section 8.11**).

Theme (Feedback/ Objections/Claims)	Stakeholders Involved	Measures adopted because of the consultations
		Fishermen will be advised by SMS (a service to be carried out by SETFIA during the survey) so they know the status of the survey. It has been important during consultation to obtain mobile phone contact numbers so this measure can be effective. The control worked well during the Flanagan MSS in 2014. 3D Oil will also contact TAMAR Radio 4533 to provide daily updates during survey activity as a backup to the SMS provision (refer **Section 7.8**).
Cumulative impacts of multiple surveys	SETFIA (Stakeholder #12) SSF (Stakeholder #13)	3D Oil identified that it is liaising with other titleholders who may undertake seismic at the same time as the Dorrigo MSS. A simultaneous operations protocol will be established to ensure that a buffer of at least 40 km is maintained between surveys. There will be no overlap of MSSs within the T/49P permit area (i.e. no third-party ingress). 3D Oil will monitor the NOPSEMA website for any potential surveys which arise after submission of the EP (refer **Section 7.2**). *No response has been provided from this information provided.*
	Spectrum Geo (Stakeholder #35)	Liaisons with and future development of a simultaneous operations program is survey activities are occurring at the same time (refer **Section 7.2**).
Reduction in MSS area over trawl grounds	SETFIA (Stakeholder #12)	3D Oil and SETFIA reviewed the geological targets covered by the survey. Given the presence of a potential large reserve in the southern section of the survey area, if the current survey does not cover the area, a future survey would be probable. SETFIA agreed that one survey was preferable to two surveys in the area.
Ship refuge during heavy weather needs to consider fishing equipment	SSF (Stakeholder #13)	3D Oil and SSF agreed that within the survey vessel tender the available options during heavy weather are to stand out to sea or to pull in training equipment to prevent damage to fishing equipment in shallower wares (refer **Section 7.8**)
Adoption of relevant EPBC Policy 2.1 Controls to protect cetaceans	DPIPWE (Resource Conservation) (Stakeholder#17)	3D Oil has adopted all relevant controls from EPBC Policy Statement 2.1 (refer **Section 7.2**).
Notification, liaison and support in the event of an oil spill	EPA Tasmania (Stakeholder #18) DNP (Stakeholder #30)	3D Oil has adopted the suggested notification, liaison and support requests from EPA Tasmania (refer **Section 7.14** & **Appendix 2 & 3**)
Significant vessel movement in the northern section of the Dorrigo MSS Area	AMSA (Stakeholder #23)	3D Oil has adopted all the control measures suggested by AMSA to prevent vessel impedance and the potential for oil spills (refer **Section 7.8**)

Theme (Feedback/ Objections/Claims)	Stakeholders Involved	Measures adopted because of the consultations
Timeframe of MSS overlapping periods where the blue whale may be present and foraging	Blue Whale Study (Stakeholder #25)	3D Oil originally positioned the Dorrigo MSS over a broader period to understand stakeholder issues with the proposed period. After feedback, 3D Oil refined the survey period to between Sept1-Oct 31 to eliminate overlap with high productivity periods and blue whale presence. This was agreed with BWS as the optimum timeframe (refer **Section 7.2**).

A report on relevant persons consultation undertaken to date, together with 3D Oil's responses and assessment of feedback merits is included in **Appendix 8**. **Table 4-3** focuses on stakeholders who have been identified as 'relevant persons' whose functions, interests or activities may be affected by the activity. It also includes key stakeholders with whom engagement has taken place to enable 3D Oil to determine whether they are 'relevant persons' for the survey. A complete copy of original communications to/from all stakeholders, including attachments, and evidence to support this EP is provided in **Appendix 8**.

Efforts taken to identify all relevant persons

The following efforts, in chronological order, were made to identify relevant persons who may be affected by the Dorrigo activity:

- Review of consultation undertaken in the previous 2014 Flanagan MSS;
- Review of relevant legislation applicable to Commonwealth petroleum and marine activities;
- Engagement of a local expert to identify fishers (SETFIA/Fishwell Consulting);
- Check of NOPTA's titles database to identify adjacent titleholders.

This initial list consisted of 5 Commonwealth departments, 8 other Government departments, 1 relevant Minister, 30 fishers and 16 fishing associations, 3 titleholders, 3 local councils, 4 community groups, and 1 conservation group. These persons were carried forward into the consultation process. Following these initial efforts, the following steps were taken to help ensure 3D Oil continued to search for potentially affected persons:

- Initial project fact sheet (16 March 2018);
- ASX announcement with link on 3D Oil's website (30 April 2018);
- Face to face liaison meetings with persons who responded to the initial notification (April – May 2018);
- Details of the Dorrigo survey appeared in the TSIC and Tasmanian Rock Lobster Fishing Association (TRLFA) newsletter (May 2018);
- Port visits along to Portland and Lakes Entrance (June/July 2018);
- Project update fact sheet (27 September 2018);
- Agreement to use SIV and TSIC's consultation method to reach their membership (September 2018).
- Details of the Dorrigo survey appeared in the SIV fishing industry association newsletter (October 2018)

In May 2018, SIV and TSIC provided a consultation methodology and stated that all Victorian and Tasmanian fishers should be consulted with through their peak fishing association. VFA supported this position so 3D Oil agreed to explore this option with SIV and TSIC. In early September 2018, 3D Oil confirmed with SIV and TSIC that they would pay the fees associated with carrying out consultation with their members on behalf of 3D Oil. 3D Oil requested a proposal from SIV and TSIC for delivering consultation services. A proposal including a list of deliverables and associated deadlines was received from TSIC by the end of September (Record 2C1) and subsequently accepted by 3D Oil.

In October 2018, 3D Oil was concerned that TSIC was not able to carry out the agreed consultation process. This was primarily because TSIC had not delivered a consultation report by the agreed timeframe. Record 2E shows that 3D Oil waited two months (December 2018) for the delivery of a consultation report from TSIC. As at 11 April 2019, 3D Oil has yet to receive a consultation report from SIV or TSIC relating to any consultation they carried out on behalf of 3D Oil. In December 2018 TSIC requested that 3D Oil respond to a series of queries regarding the Dorrigo activity, which 3D Oil did (Record 2G).

SIV responded to 3D Oil's request for a proposal for consultation services at the end of September 2018, however, did not respond to 3D Oil's request for a meeting meant to agree on scope and timeframes (Record 2CB). SIV re-engaged in December 2018, however, by this time 3D Oil had adopted an alternative approach for reaching out to Victorian licence holders and thus were not able to adopt SIV's consultation service at this time. In December SIV requested additional documentation and answers to a series of queries regarding the proposed activity to which 3D Oil responded (Record 3D).

When the SIV and TSIC consultation reports were delayed, 3D Oil commenced an alternative strategy in parallel with the ongoing engagement with SIV and TSIC. This was undertaken because of 3D Oil believed they could not rely on SIV and TSIC to carry out the consultations and produce a report for submission to NOPSEMA. To ensure that all relevant persons were given the opportunity to be consulted with the additional steps of this alternative strategy were:

- Utilisation of the VFA licensee database[10], with VFA mailing Dorrigo MSS information sheet to all Victorian Lobster (Western Zone) and Giant Crab Licensees (undertaken in October 2018).
- Utilisation of the AFMA database[11], with mailout to all Licensees within the South East Shark and Scalefish Fisherey (SESSF) including the GHaT and CTS sectors (January 2019).
- Acquisition of Tasmanian Rock Lobster and Giant Crab fishing licence holders contact details and two phone call rounds to attempt contact (January 2019)
- Publication of survey details in local newspapers (Tasmanian Advocate 3 & 9 January 2019; King Island Press (16 January 2019).

[10] DPIPWE were also approached to undertake a similar activity for Tasmanian Fisheries, however advised that they were not able to undertake this task.

[11] AFMA provides the licensee database and information was sent by 3D Oil to these respective licensees.

The alternative strategy implemented by 3D Oil resulted in contact with a further 59 Victorian rock lobster and giant crab licence holders and 11 Tasmanian Rock Lobster and Giant Crab license holders. In addition, 218 South East Shark and Scale-fish Fishery fishers were identified and contacted by letter. Some feedback was received from Tasmanina license holders, all of which were responded to prior to the submission of the EP on 30 January 2019.

In addition to the extensive list above 3D Oil routinely asked for contact details of other people who may consider themselves to be relevant at meetings and during phone calls. At all times, a register of relevant persons was kept. This register will be maintained through the EP assessment process and throughout the activity. The register as at first submission is listed in **Table 4-1**.

Table 4-3A provides a summary of all the efforts made to properly consult with all relevant perons, and particularly fishers in the region. It is 3D Oil's consideration that reasonable efforts have been made to identify all persons who may be affected by the survey and that the consultation process required by the OPGGSER has been carried out.

It should be noted that during April 2018 3D Oil was able to contact and speak with a number of Victorian Rock Lobster and Giant Crab licence holders via teleconference. 3D Oil was able to meet with members of these groups and Tasmanian Giant Crab fishery during a port visit to Portland in July 2018.

Demonstration that sufficient information has been provided

The initial notification to identified persons sought to commence engagement and determine if the person considered themselves relevant persons for the purpose of consultation under the OPGGS Environment Regulations. It shared the basic details of the survey, a location map and coordinates, a summary of the legislative requirements, and how to get in touch with 3D Oil. 19 responses were received from people that were identified at this time (March 2018), 2 of which confirmed no feedback.

There were some persons who 3D Oil met that requested further information. This information was provided in verbal exchanges during consultation meetings and teleconferences. This often led to either; no feedback being offered, an objection or claim being withdrawn, or a commitment being made to manage the activity in a particular way. These conversations have been recorded in meeting minutes provided in Appendix 8.

There were 8 persons who actively engaged in the consultation process and requested further written information be provided (either maps or impact assessment information) to be able to make an informed assessment of the possible consequences of the Dorrigo survey on their functions, interests, and activities. When that information was requested, 3D Oil took the time necessary to prepare content for the EP rather than generate duplicate information. A summary of the information provided to these 8 persons is provided in Table 4-3B.

This decision was made because 3D Oil wanted persons consulted with to be aware of the information that NOPSEMA would be using to make is assessment. In doing so, the sufficiency of the information provided to relevant persons is guaranteed because no further information exists on which 3D Oil, or indeed NOPSEMA, will be making a decision.

SIV requested the sound modelling report and all impact and risk assessments applied to fisheries. The sound modelling report was provided in hard copy to SIV and impact and risk assesments as they apply to fisheries were supplied to both SIV and TSIC on two occasions, once in September and again in December.

There were requests for full copies of the EP from SIV and TSIC. 3D Oil considered whether this addition content was required for SIV and TSIC to make an informed assessment of the activity on their functions, interests, or activities. It was determined that the remaining information in the EP was not related to the functions, interests, or activities of these persons and was not related to their objections or claims about the activity. As part of this consideration 3D Oil also factored in the likely ongoing delays to consultation that may occur. On balance, it was decided that providing full copies of the EP was not required as the information exceeded the sufficient information required to be provided to SIV and TSIC. This response was provided to SIV and TSIC verbally.

In conclusion, 3D Oil is reasonably satisfied that relevant persons who engaged in the consultation process have received sufficient information and the records in Appendix 8 are provided as evidence to support this position.

Table 4-3A – Summary of consultation activities in relation to the persons consulted with during preparation of the EP

	Consultation activities in preparing the EP										
Relevant Person Groups	***Fact sheet*** 16 March 2018	***Liaison meetings*** April/May 2018	***TSIC Newsletter*** May 2018	***Port visits*** June/July 2018	***SIV & TSIC consultation policy*** Sept 2018	***Fact sheet: update on timing of survey*** September 2018	***SIV newsletter*** October 2018	***VFA database mailout*** October 2018	***AFMA database mailout*** January 2019	***Tasmanian license database*** January 2019	***Newspaper articles*** January 2019
All persons identified	✓					✓					
Commonwealth agencies	✓					✓					
State agencies and local councils	✓					✓					
VIC/Tasmanian fishing associations	✓	✓			✓	✓					
Victorian fishers	✓	✓		✓	✓	✓	✓	✓			✓
Tasmanian fishers	✓	✓	✓	✓	✓	✓				✓	✓
Commonwealth fishers	✓			✓		✓			✓		✓
Titleholders	✓					✓					
Conservation groups	✓					✓					

Table 4-3B – Summary of information provided to persons who requested further information and the period they had to consider that information

Relevant Person	**Summary of information received**	**Relevant Record (Appendix 8)**	**Date sent**	**Time between date sent and first submission**	**Time between date sent and resubmission**
TSIC	General information: fact sheet	**2**	16 March 2018	320 days	391 days
	Meeting (teleconference) to discuss the activity	**2AA**	4 April 2018	301 days	372 days

Relevant Person	Summary of information received	Relevant Record (Appendix 8)	Date sent	Time between date sent and first submission	Time between date sent and resubmission
	Draft EP content including: Environment Description, Impacts and Risk Assessment Methodology, Southern Rock Lobster & Giant Crab Fisheries, Impact Assessment to Plankton and Invertebrates and accompanying reference list.	2B	4 Sept 2018	148 days	219 days
	Information for communication to TSIC members under the SIV/TSIC consultation methodology	2D	25 Sept 2018	127 days	194 days
	General information: altered timeframe		27 Sept 2018	125 days	196 days
	Draft EP content including: Environment Description, Impacts and Risk Assessment Methodology, Southern Rock Lobster & Giant Crab Fisheries, Impact Assessment to Plankton and Invertebrates and accompanying reference list.	2F and 2G	18 December 2018	43 days	175 days
SIV	General information: fact sheet	3	16 March 2018	320 days	391 days
	Meeting to discuss the activity	3B	6 April 2018	299 days	370 days
	Sound modelling (hard copy)	2B	13 July 2018	201 days	201 days
	Draft EP content including: Environment Description, Impacts and Risk Assessment Methodology, Southern Rock Lobster & Giant Crab Fisheries, Impact Assessment to Plankton and Invertebrates and accompanying reference list.	3D	4 Sept 2018	148 days	148 days
	General information: altered timeframe		27 Sept 2018	125 days	196 days
	Draft EP content including: Environment Description, Impacts and Risk Assessment Methodology, Southern Rock Lobster & Giant Crab Fisheries, Impact Assessment to Plankton and Invertebrates and accompanying reference list.	3E	4 December 2018	57 days	128 days
SETFIA	General information: fact sheet	12	16 March 2018	320 days	391 days
	Port visit meeting	12B	8 June 2018	236 days	307 days
	Reasons for being unable to reduce the survey without spreading the survey over 2 years.	12C and 12D	16 July 2018	198 days	269 days
	General information: altered timeframe		27 Sept 2018	125 days	196 days
Sustainable Shark Fishing ([redacted]	General information: fact sheet		16 March 2018	320 days	391 days
	Port visit meeting	13	8 June 2018	236 days	307 days
	Sound modelling, sound impact assessment.	13A, 13B, 13C	19 June 2018	225 days	296 days
	General information: altered timeframe		27 Sept 2018	125 days	196 days

Relevant Person	**Summary of information received**	**Relevant Record (Appendix 8)**	**Date sent**	**Time between date sent and first submission**	**Time between date sent and resubmission**
[redacted]	Telephone call explaining the details of the survey	38	3 July 2018	211 days	282 days
	General information: altered timeframe		27 Sept 2018	125 days	196 days
	Email with specific information related to claims, objections and concerns. Information about impacts to spawning crab, giant crab, southern rock lobster, shark, trevally, and fish (in general) provided.	38A	17 December 2018	44 days	115 days
Mures Fishing ([redacted]	General information about the survey and listening to objections or claims about the survey	61	10 January 2019	20 days	91 days
	Response to objections and claims	61A	22 January 2019	8 days	79 days
Tasmanian Abalone Council ([redacted])	General information: fact sheet	11	16 March 2018	320 days	391 days
	General information: altered timeframe		27 Sept 2018	125 days	196 days
	General information: fact sheet	58	10 January 2019	20 days	91 days
	Email request seeking information about the activities of commercial abalone divers	11B	22 January 2019	8 days	79 days
[redacted]	General information: fact sheet	58	10 January 2019	20 days	91 days
	Email with specific information related to claims, objections and concerns. Information about impacts to spawning crab, giant crab, southern rock lobster.	58A	22 January 2019	8 days	79 days

Demonstration that a reasonable period has been provided
3D Oil commenced the relevant persons consultation process 320 days before the first submission to NOPSEMA. The process commenced with the provision of a general notification to persons identified by the process outlined above. Following the deferment of the survey to a later year, a second general notification was provided. This second notification was 125 days before the first submission.

Relevant persons who requested more information were then provided with direct extracts of the draft EP content relevant to their objections and claims. Table 4-3B shows the persons who received additional information and the period between receiving that information and first submission of the EP.

During the consultation process 3D Oil came to understand that delaying the timing of the survey would allow for more time for the consultation to occur. This allowed for an additional general notification to all persons and a relief of pressure on the detail consultation occurring with the engaged relevant persons.

Close of consultation in preparation of the EP
3D Oil views consultation as an iterative and ongoing process. Notwithstanding, as per NOPSEMA guidance, there is an expectation that consultation be 'closed' prior to submission of the EP. What this means in practice is that 3D Oil should respond to affected persons in such a manner that the can be informed about how the consultation with them will be portrayed to the regulator. 3D Oil has responded to each of the 19 relevant persons who engaged throughout the process. 3D Oil waited at least 43 days for further comment before making its first submission.

Whilst the consultation processes will continue (described below) 3D Oil is reasonably satisfied that it has carried out the consultations required by Division 2.2A, in accordance with NOPSEMA guidance, and has adopted appropriate measures because of those consultations.

4.7 Ongoing Consultation

3D Oil elected not to define a 'reasonable period' (as specified in the OPGGS(E)R Regulation 11(3)) in the information letter for stakeholders to provide comments. This is because consultation is considered as an ongoing process until the completion of the Dorrigo 3D MSS activity. The long-standing and well-established industry practice is to allow 30 days as the 'reasonable period' for stakeholders to respond to consultation material, after which time the EP can be submitted to the regulators. In this instance, consultation has been ongoing for the past 9 months within the Commonwealth/Tasmanian and Victorian fisheries. For all other stakeholders who had not responded within 30 days, a reminder was sent to advise of the pending submission of the EP.

Stakeholder consultation will be ongoing during the Dorrigo 3D MSS. Key milestones that trigger further consultation include:

- Dorrigo MSS funding confirmation;
- EP acceptance and the availability of the EP summary on the NOPSEMA website;
- Notification one month prior to survey commencement (for fishing activity in the MSS area);
- Commencement of the survey (5 days prior to equipment deployment, and at commencement);
- Survey completion;
- Any significant incidents (e.g. large fuel spill);
- If there is a change to the MSS activity scope which would affect the stakeholder interests, 3D Oil will consider impacts and risks to the stakeholder and seek their feedback on proposed changes if their interests are affected[12].

3D Oil will continue to search for relevant persons after acceptance of the EP. In addition, 3D Oil will keep relevant persons up-to-date with activity status by sending periodic notifications to all identified relevant persons who have not explicitly reequested that communications cease.

In relation to abalone drivers, 3D Oil will continue to attempt to identify and contact commercial operators to ensure they are informed about the activity and aware of protocols when a seismic vessel is operating proximate to their activities. This will primarily be done through ongoing engagement with Tasmanian Abalone Council Inc.

<u>Notifications</u>: All notifications will include the relevant details on the activity for the notification type (e.g. for commencement of survey – location, timeframe, vessel details, website details for 48 hr lookahead) and contact details or where any claims, objections, queries or concerns may be directed. Contact details will include the EP liaison person, telephone number and email address for further enquiry. **Table 8.2** provides a summary of the requested notification triggers for each stakeholder group established during the current consultation.

3D Oil recognises the need for ongoing stakeholder consultation throughout the planning and activity stage of the Dorrigo 3D MSS. As extensive consultation has been undertaken already, consultation trigger milestone communications to stakeholders are not expected to raise any new or additional concerns.

<u>Changes in External Environment/Program</u>: In the event of a change to the program scope or other changes occur as detailed in **Section 8.10** (e.g. there are developments in the scientific understanding of impacts and risks; or new information regarding the receiving environment

[12] An environmental risk assessment will be undertaken together with an ALARP and acceptability assessment in such an event.

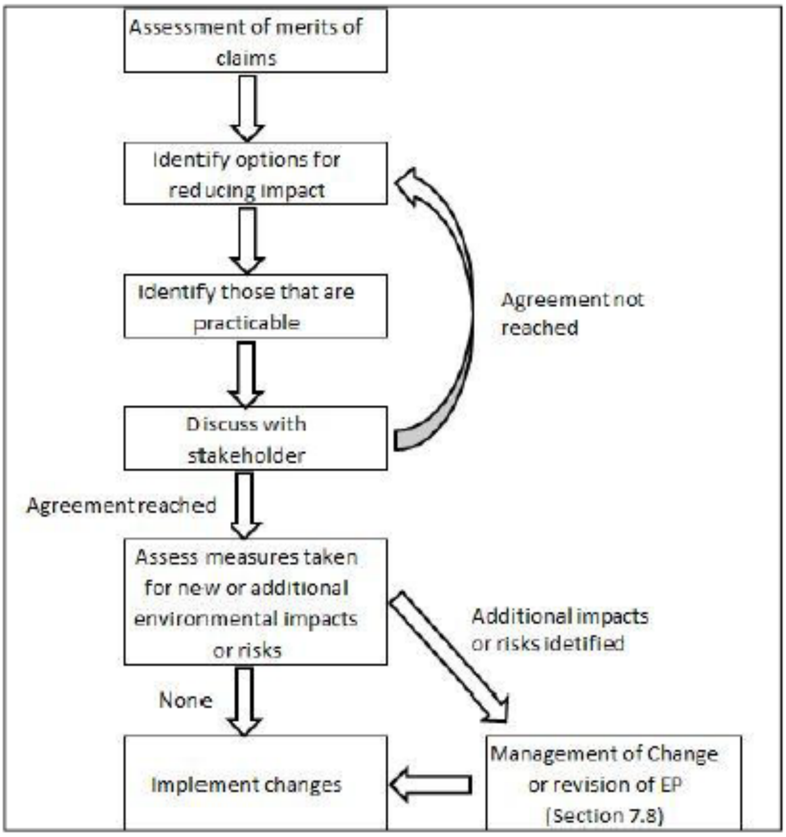
relevant to the Dorrigo 3D MSS activities identifies a potential new or increase in potential impact or risk) which affect stakeholder's interests or activities, 3D Oil will inform relevant stakeholders of the change and seek their feedback. As required by OPGGSER Regulation 16(b), 3D Oil shall assess the merits of any new claims or objections made by a relevant stakeholder whereby they believe the activity will have an adverse impact on their interests or activities. If the claim has merit, where appropriate, 3D Oil will modify the management of the activity. The assessment will be done using the methodology detailed in this EP as detailed in **Section 6.**

3D Oil shall endeavour to finalise the merits of any claim or objection received during the survey within one week of receipt and undertake any resulting management of change actions as soon as practicable, but preferably within that timeframe. The assessment of merit and any resulting management of change actions will be shared with the concerned stakeholder. For objections and claims that do not hold merit, 3D oil will respond to stakeholders providing reasoning and supporting information (as relevant) to support 3D Oil's conclusions. This may include the provision of reasonably available options/controls explored to mitigate the degree to which the stakeholder may be affected and/or demonstration that the risk or impact in question has been reduced to ALARP and acceptable levels.

Ongoing Stakeholder Feedback: Any claims or objections raised by stakeholders after submission of the EP will be assessed for merit and a response provided. If a change to the activity or controls adopted during the MSS occurs as a result of stakeholder consultation, the change will be managed in accordance with 3D Oil's Management of Change process (refer **Section 8.9**).

If the claim or objection relates to a new or significant increase in existing impact or risk, a revised EP will be submitted to NOPSEMA for assessment in accordance with OPGGS(E)R Regulation 17(6) (refer **Section 1.6**). 3D Oil will determine at the time of the risk assessment, whether an impact or risk is 'significant' based upon available information (e.g. reviewed scientific information, stakeholder claims or concerns). Notification to existing and new stakeholders of any significant new or increased risks will occur prior to the submission of the revised EP as part of the consultation activity for the EP revision. This process for assessing, evaluating and implementing ongoing stakeholder feedback throughout the life of this EP is provided in **Figure 4.1**.

Figure 4-1: Process for assessing, evaluating and implementing ongoing stakeholder feedback



5.0 DESCRIPTION OF EXISTING ENVIRONMENT

In accordance with OPGGS(E)R Regulation 13(2) the 'environment that may be affected' (EMBA) by the activity is described in this Section, together with its values and sensitivities. Where appropriate, descriptions of the regional environment are provided for context.

The 'environment' is defined in the OPGGS(E)R 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 EMBA for the Dorrigo 3D MSS has been established through hydrocarbon spill modelling as the greatest area that could potentially be impacted in the event of a level 2 fuel spill (refer **Section 7.12** for a justification for the spill scenarios and resulting modelling results). The EMBA is defined as:

The probable extent of low-level hydrocarbon exposure to the sea surface (>0.5 µm surface oil), entrained in the water column (>11,844 ppb.hrs total petroleum hydrocarbons) and shoreline contact (>10 g/m^2) resulting from the loss of 400 m^3 of marine diesel oil (MDO) from the survey vessel. This conservatively includes a 48 km radial distance around the Dorrigo operational boundary to the north, west and south and to the west coast of King Island (not extending to the east coast of the island).

All distances quoted to environmental sensitivities within this EP are taken from the nearest Dorrigo operational boundary unless otherwise specified.

5.1 Regional Setting

The Dorrigo 3D MSS lies in the Otway marine bioregion (NOO, 2002) as classified by the Interim Marine and Coastal Regionalisation for Australia (IMCRA). This bioregion extends from Apollo Bay (Vic) to Cape Jaffa (South Australia) and includes the western islands of Bass Strait such as King Island.

The characteristics of the Otway marine bioregion environment[13] include very steep-moderate offshore gradients, high wave energy and cold temperate waters subject to upwelling events (i.e. the Bonney Upwelling) (IMCRA, 1998). Currents are generally slow, but moderately strong through the entrance to Bass Strait. Upwelling water is nutrient rich and corresponds with increases in the abundance of zooplankton which attracts baleen whales and other species (including EPBC-listed species) which feed on the plankton swarms (krill). Shoreline habitats of the Otway coastline include penguin colonies, fur seal colonies and bird nesting sites.

[13] Area of Otway Meso-scale region is 37,331 km^2 (IMCRA, 1998).

5.2 Physical Environment

5.2.1 Bathymetry

The southern shelf or coastal boundary of the Australian mainland is a maximum width of 200 km in the central Great Australian Bight (GAB) which narrows to 20 km on the Bonney coast of South Australia/Victoria (Butler et al, 2002). Bass Strait, to the east of the Bonney coast, consists of a broad shallow region, bordered on the eastern and western sides by very deep waters of the continental slope. The depth of the shelf at the Bonney coast increases gradually to 100 m where a distinct increase in steepness is observed (Butler et al, 2002). The continental slope and abyssal plain (between 1000-5000 m) along the Bonney Coast are connected by a number of very large and steep canyons which are thought to contribute to upwelling events (Butler et al, 2002). To the west of Tasmania there are also numerous canyons cut from the continental shelf at about 300 m depth to the continental rise (at about 3500m depth) with the shallower continental margin characterised by gentle to moderate sloping ground (NOO, 2002). On the continental shelf, the seabed slopes gradually upwards in a northerly and easterly direction across the shelf to a depth of about 30 m within 1 km of the coastline.

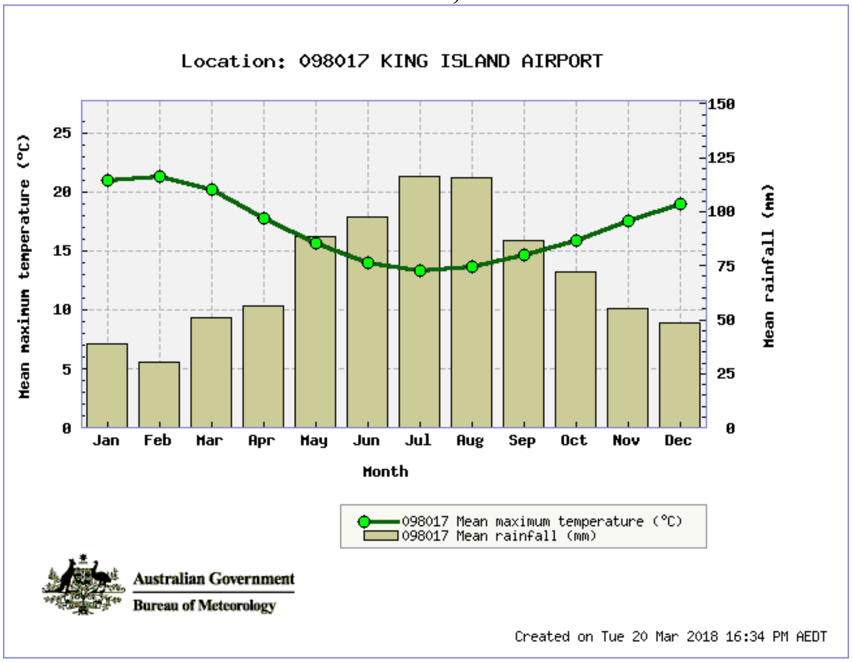
The Dorrigo MSS area is located on the outer edge of the Australian continental shelf with a small amount of acquisition over the continental slope in the south-west of the survey area.

The movement of sediments from the continental shelf to the abyssal plain has been modelled for the west Tasman margin. The shelly sands of the outer continental shelf (70% calcium carbonate) grade into ooze on the slope (60 – 65% calcium carbonate – derived from the remains of small calcareous organisms called foraminifera). Deeper on the abyssal plain, the sediments are pelagic ooze (less than 50% carbonate). Similarly, sand concentrations also grade from the outer shelf (60% sand by weight) down to the slope (10 – 15% sand by weight) through to the abyssal plain (less than 10% sand by weight) (NOO, 2002). The Folk classification for the seabed sediment type within the Dorrigo MSS operational area is gravelly sand-gravelly muddy sand with a mean grain size of 0.25-0.5 mm (Passlow et al, 2005).

5.2.2 Climate

The climate of the region is temperate with cool, wet winters and warm dry summers (IMCRA, 1998). The area has a mean maximum temperature of 21.3°C (February) and a mean minimum temperature of 7.6°C (July) (BOM, 2018). The annual average rainfall is 859 mm with the predominant rainfall falling between May and October (refer **Figure 5-1**) (BOM, 2018).

Figure 5-1: Mean Rainfall and Mean Maximum Temperature for King Island Airport (BOM, 2018)



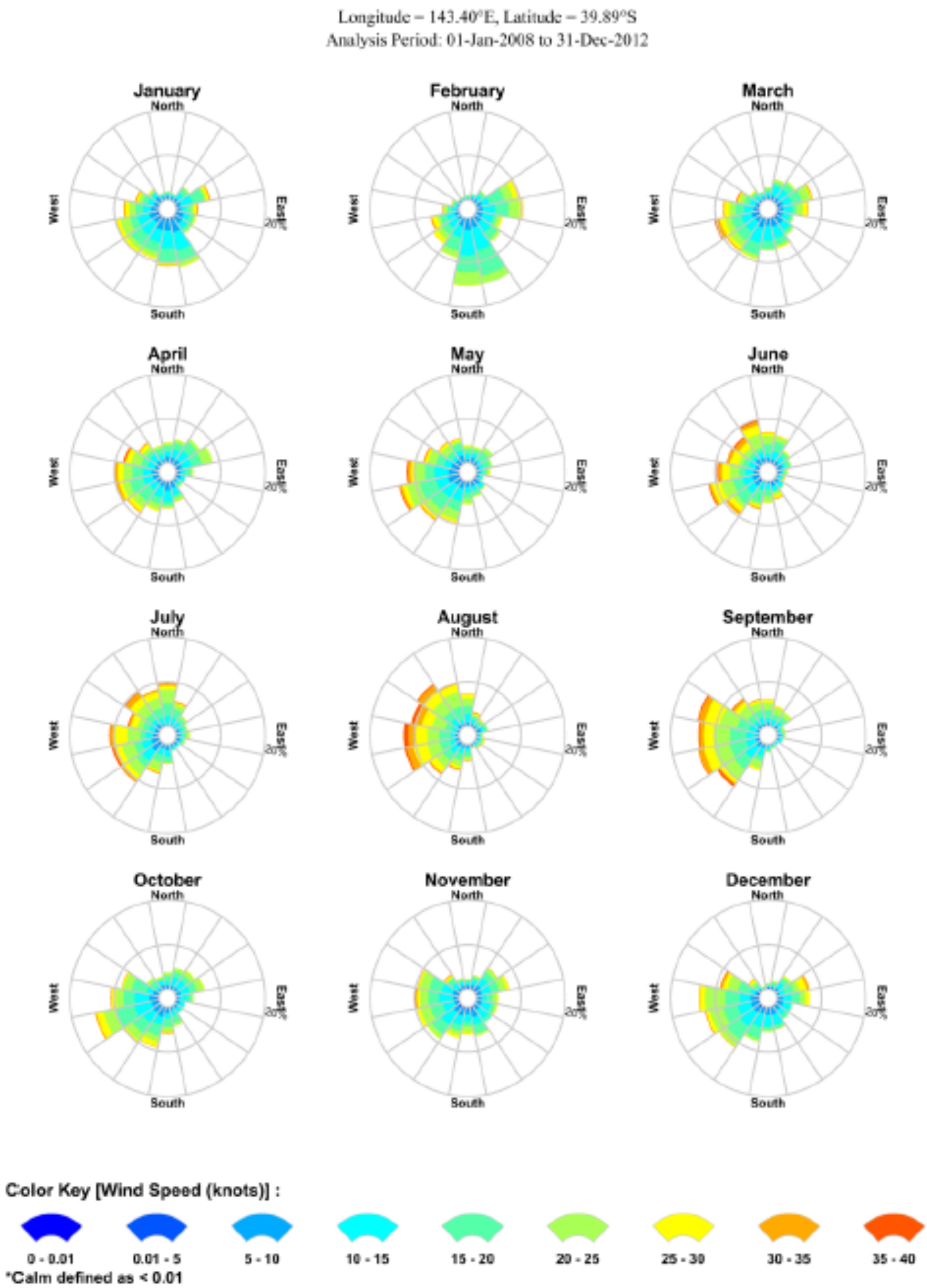
5.2.3 Winds

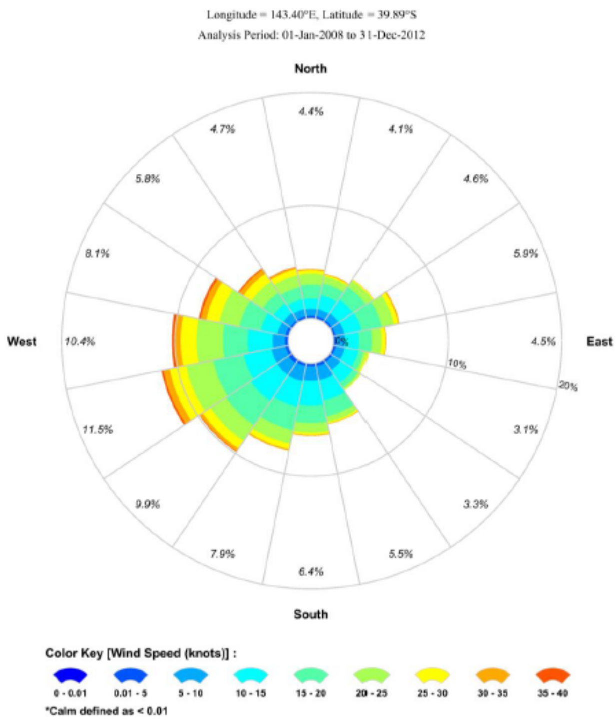
Bass Strait is located on the northern edge of the westerly wind belt known as the Roaring Forties. In winter, when the subtropical ridge moves northwards over the Australian continent, cold fronts generally create sustained west to south-westerly winds and frequent rainfall in the region (McInnes &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

Occasionally, intense mesoscale low-pressure systems occur in the region, bringing very strong winds, heavy rain, and high seas. These events are unpredictable in occurrence, intensity, and behaviour, but are most common between September and February (McInnes & Hubbert, 2003). Wind speeds in the area are typically in the range of 10–30 km/hr, with maximum gusts reaching 100 km/hr.

The wind roses for the Dorrigo MSS area (refer **Figure 5-2**) indicate winds from the south/west sector predominate during the September-December period with an average wind speed of 15-19 knots (RPS, 2018). For the period January to April, the wind direction is more variable (southwest to southeast). South-westerly winds are dominant for most of the year with the windiest months from June to September (RPS, 2018). Highest mean wind and wind gust speeds, 7.86 and 12.2m/s respectively, occur during August (Woodside, 2003). Severe storms occur in all months of the year though more often during the winter months. During the most severe events, wind speeds of 12-18m/s are common and gusts of up to 40m/s can occur (Woodside, 2003).

Figure 5-2: Wind Roses for Dorrigo MSS Area (RPS, 2018)





5.2.4 Tides

Tides are semi-diurnal with some diurnal inequalities (Jones & Padman, 2006; Easton, 1970), generating tidal currents along a north-east/south-west axis, with speeds generally ranging from 0.1 to 2.5 m/s (Fandry, 1983). The maximum range of spring tides in western Bass Strait is approximately 0.8- 1.2 m, however the tidal ranges and velocities vary rapidly in the western entrance to Bass Strait (IMCRA, 1998). Sea level variation in the area can arise from storm surges and waves (Santos, 2004).

5.2.5 Currents

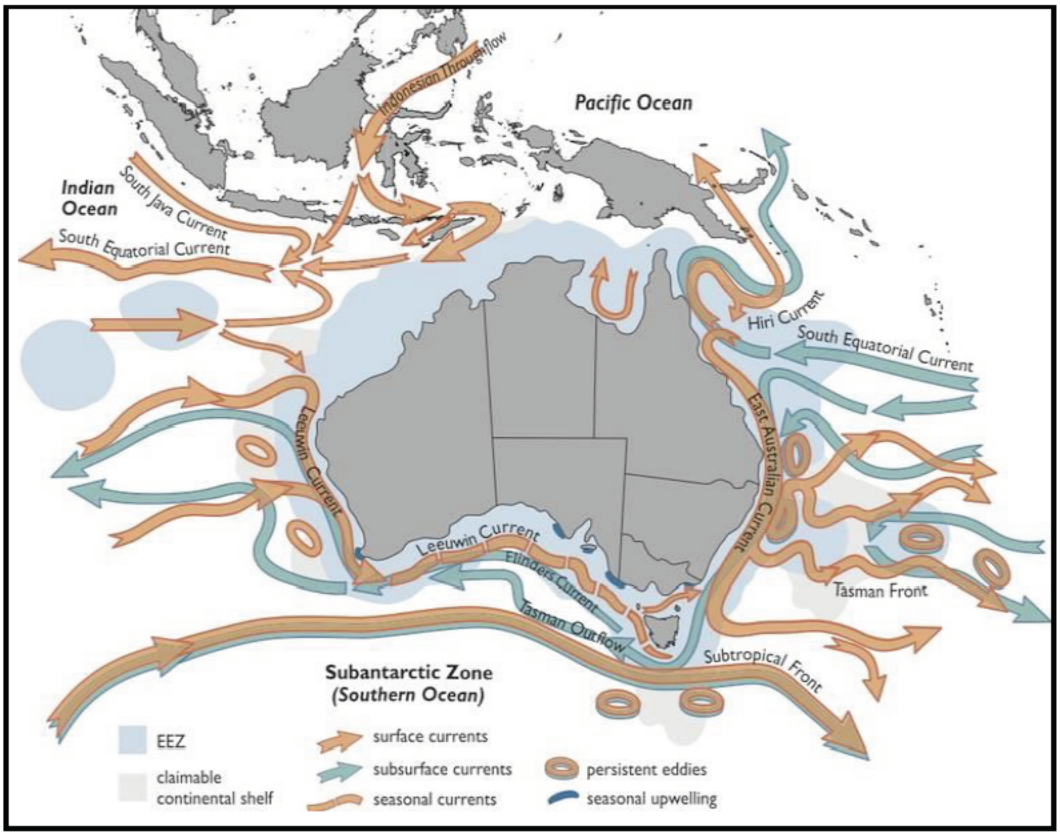
The major ocean current which influences water flows in the Dorrigo MSS region is the Leeuwin Current which flows from the eastern end of the Great Australian Bight (GAB), skirts the western end of Bass Strait and then along the west coast of Tasmania tracing the edge of the continental shelf (NOO, 2002) (refer **Figure 5-3**). Near the seabed, currents run parallel with the coast and can exceed 0.5 m/s when generated by a storm (Woodside, 2003). Close to the shore where water depths are less than 10m, the currents are of variable speed and are often strong. Current speeds are estimated to range from 0.31m/s for a mean spring tide to 0.5-1m/s at the adjacent Thylacine Field (Woodside, 2003).

Monthly surface water current roses for the Dorrigo MSS area are provided in **Figure 5-4**.

5.2.6 Sea Water Temperature

Waters are cold temperate with the mean sea surface temperatures varying from 13°C in winter to 18°C in summer (RPS, 2018). The far eastern region (i.e. King Island area) is influenced during winter months by warm waters, making this region warmer than other Tasmanian waters at that time (IMCRA, 1998).

Figure 5-3: Australian Ocean Currents



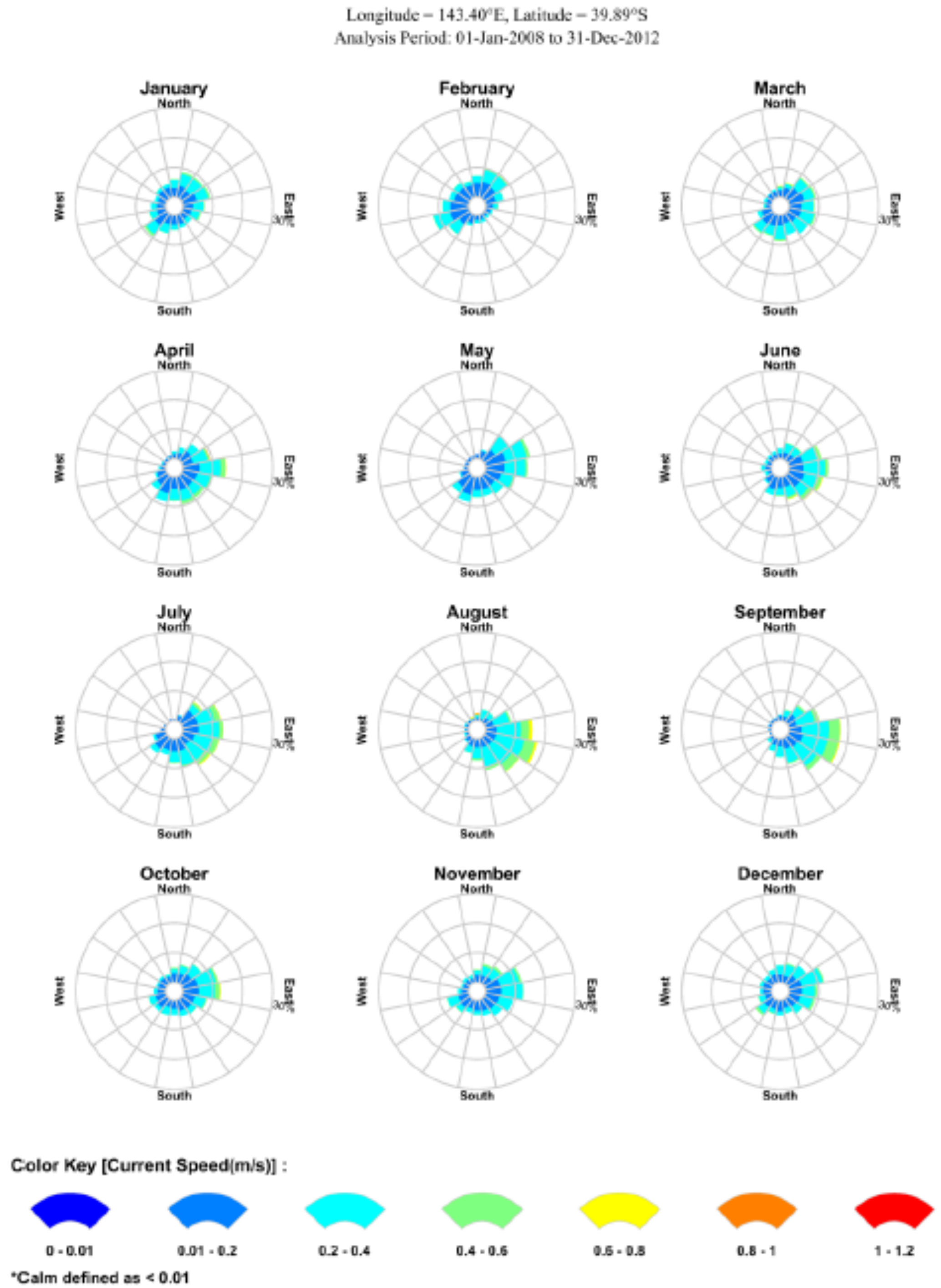
During winter, the South Australian current moves dense, salty warmer water eastward from the Great Australian Bight into the western margin of the Bass Strait (see **Figure 5-3**). In winter and spring, waters within the strait are well mixed with no obvious stratification, while during summer the central regions of the straight become stratified (RPS, 2018).

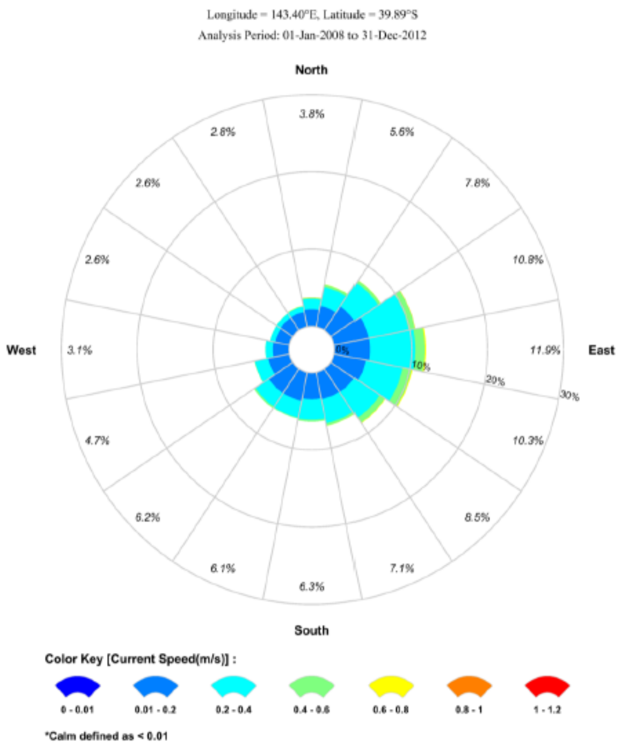
5.2.7 Waves

The Otway coastline is typically high energy, with wave energy dependent on orientation to prevailing swell direction and cross shelf width. The western region is typified by high deep-water wave energy, attenuated by a steep offshore to near-shore gradient and offshore reefs which provide for moderate to low energy conditions (IMCRA, 1998). In the region, swell waves and sea waves occur throughout the year. Swell waves approach from the SW (approx. 60%) and the SSW (approx. 30%). Dominant sea waves are from the SSW (approx. 27%), the SW (approx. 25%) and WSW (approx. 12%) (Woodside, 2003).

In-situ wave measurements collected at the Minerva gas field site revealed that 2 to 3.5 m waves occur for 50% of the time and waves over 7.6 m in height occur during winter (BHP-Santos, 1999; cited in Santos, 2004). The maximum significant wave height in this region is higher than elsewhere in the state, reaching between 7 and 8 m in height (Edmunds *et al*., 2010). During storms wave heights of 6-8m and sometimes over 10m can occur in the region (Woodside, 2003).

Figure 5-4: Current Roses for Dorrigo MSS Area (RPS, 2018)





5.2.8 Ambient Underwater Sound

Woodside's Thylacine monitoring used two acoustic loggers, one positioned 5.1 km southwest of the drilling location and the other in a shipping lane, approximately 15 km to the south. The Thylacine drilling area is approximately 50 km south of the Casino gas field, in 100 m water depth. Baseline broadband underwater noise recorded by Woodside at the Thylacine field, located ~20 km north-west from the nearest Dorrigo MSS boundary was of the order of 93 to 97 dB re 1µPa (Woodside, 2003). This mostly reflects wind and wave noise, typical of rough sea conditions in exposed ocean and is consistent with other published estimates. Richardson et al. (1990) determined average ambient noise levels of 98 dB in the range of 20 to 1,000 Hz in the Canadian Beaufort Sea.

The Southern Ocean main shipping channel passes just north of the Dorrigo MSS area. For studies undertaken for the thylacine field, approximately five to six large ships per day were detected passing through this area during Woodside's monitoring (Woodside, 2003). These vessels were sufficiently close for the noise to be discernible as regular, short duration spikes up to 125 dB re 1 µPa (mostly in the 10 to 100 Hz band). In the shipping lane, ships raised the average noise level above 100 dB re 1 µPa (close to rough sea background) 13% of the time, above 105 dB re 1µPa 6% of the time, and above 120 dB re 1 µPa 0.23% of the time (Woodside, 2003). Woodside (2003) recorded an average of 5.4 ships per day on a logger deployed close to the shipping lane, 60 km due south of Port Fairy (~ 95 km to the north west of the Dorrigo MSS area) between 28 November 2001 and 5 March 2002. Here, shipping noise levels exceeded 100, 110 and 120 dB re 1 µPa for about 13%, 2% and 0.2% of the time respectively.

5.3 Coastal Environment

King Island is 64km in length (north to south) and 26km (east to west). The topography is characterised by low relief landforms with its highest point, Gentle Annie, 168 m above sea level (Threatened Species Section, 2012). Most of the northern portion of the island falls below 40 m above sea level and is considerably flatter than the plateau area located in the south of the island. North of the southern plateau lies exists low lying swamps and flats with a small range of hills along the east coast and coastal dune formations in the west (Sim, 1991; cited in Huys, 2012). These dune formations occur along the west and northwest coastal regions and to a lesser extent along the western coastal fringe of the southern plateau area. The dunes are extensive, often 70 m or more in height and extending up to 3 km inland (Huys, 2012).

The western coastline of King Island is a high energy coastline with high winds and large seas and consists of sea cliffs with sandy beaches (refer **Figure 5-5**). Penguin and mutton bird rookeries are present at Cataraqui (SW King Island). A list of coastal sensitivities is provided in **Table 5-1** based upon the King Island Biodiversity Plan (Threatened Species Section, 2012) and Natural Values Atlas of Tasmania (DPIPWE, 2018f).

Figure 5-5: King Island Coastline

Rocky Shoreline	
Sand Shoreline	

Table 5-1: Coastal Sensitivities with the Dorrigo oil spill EMBA

Environmental Receptor	Location (Sensitivity)									
	Cape Wickham to Cape Farewell (Cape Wickham Conservation Area)	Cape Farwell to Quarantine Bay	Quarantine Bay to Peerless Point (Porky Beach Conservation Area)	Currie Harbour	Stingray Bay to Seal Rocks (Cataraqui Point Conservation Area)	Seal Rocks State Reserve	Sunrise Point to Stoke Point (Stokes Point Conservation Area)	New Year Island Game Reserve	Christmas Island Nature Reserve	Waterwitch Reef Research Area
Coastal Types and Habitats										
Sub-tidal Rocky Reef	✓	✓	✓		✓	✓	✓	✓	✓	✓
Rock Shoreline/platform	✓	✓	✓		✓	✓	✓	✓	✓	
Sandy Beach	✓ (Victorian Cove)	✓ (Quarantine Bay, Yellow Rock Beach	✓ (Unlucky Bay, Porky Beach, Pass River Bay, Whale Bone Beach)	✓	✓ (Fitzmaurice Bay, Ettrick Beach, Sandfly Beach, Burgess bay, British Admiralty Beach)		✓ (Derbys Bay, Surprise Bay)	✓	✓	
Pebble or Shingle Beach	✓	✓	✓		✓	✓	✓	✓	✓	
Estuary/Wetland		✓ (Yellow Rock Rr)								
Steep Rocky Cliffs	✓	✓	✓		✓	✓	✓	✓		
Species presence										
Seagrass meadows	No areas identified									
Abalone/rock lobster beds										✓
Giant Kelp	No areas identified									
Saltmarsh		✓ (Yellow Rock Rr)								
Kelp Farming	✓	✓	✓		✓ (to Ettrick Beach)					
Little Penguin colony									✓	

Environmental Receptor	Location (Sensitivity)									
	Cape Wickham to Cape Farewell (Cape Wickham Conservation Area)	Cape Farwell to Quarantine Bay	Quarantine Bay to Peerless Point (Porky Beach Conservation Area)	Currie Harbour	Stingray Bay to Seal Rocks (Cataraqui Point Conservation Area)	Seal Rocks State Reserve	Sunrise Point to Stoke Point (Stokes Point Conservation Area)	New Year Island Game Reserve	Christmas Island Nature Reserve	Waterwitch Reef Research Area
Shorebird colonies	✓ (hooded plover, pied oystercatchers)	✓ (hooded & red-capped plover, fairy terns, oystercatchers)	✓ (hooded & red-capped plove, oyster catchers)	✓ (Hooded Plovers)	✓ (Hooded & Red-capped plover, terns, oystercatchers)		✓ (Hooded & Red-capped plover, oystercatchers)	✓ (oystercatchers)	✓ (Little & Fairy Tern, hooded & red-capped plovers, Caspian tern, oystercathers)	
Seabird Rookery	✓ (shearwaters, white-bellied sea eagle)	✓ (shearwaters, white-bellied sea eagle)	✓ (shearwaters)		✓			✓(shearwaters)	✓	

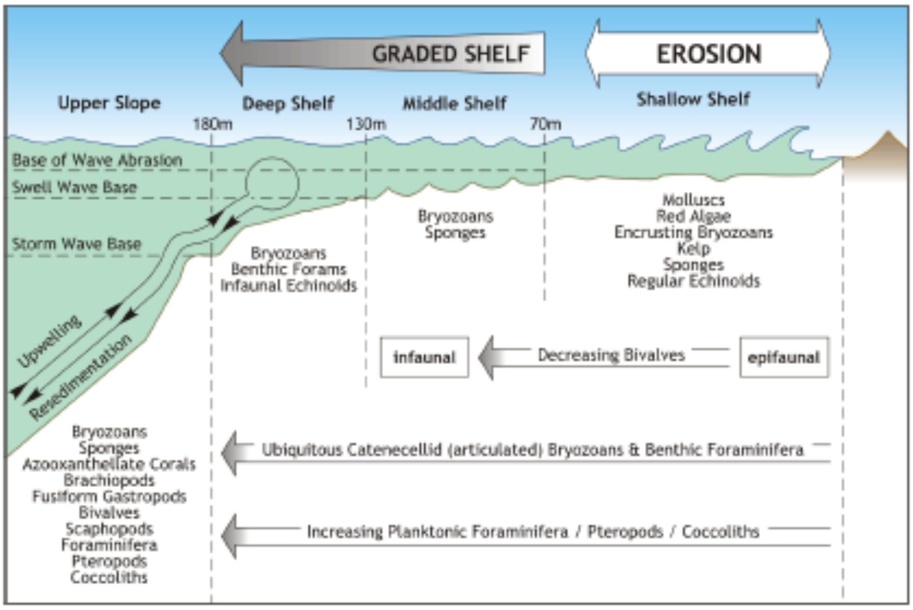
5.4 Biological Environment

A search of the EPBC Protected Matters Search Tool (PMST) was conducted in March 2018 for the Dorrigo MSS vessel operational area and the EMBA for the worst-case hydrocarbon spill. The results of these searches provide the key sources of information for this section. A copy of the EPBC PMST is provided in **Appendix 1**.

5.4.1 Benthic Assemblages

Boreen et al (1993) examined 259 sediment samples collected over the Otway Basin and the Sorell Basin of the west Tasmanian margin. Samples were taken during two research cruises (January/February 1987 and March/April 1988) on the *RV Rig Seismic* using dredges, corers, grabs and a heat-flow probe. Based on assessment of the sampled sediments the authors concluded the Otway continental margin is a swell-dominated, open, cool-water, carbonate platform. A conceptual model was developed that divided the Otway (bioregion) continental margin into five depth-related zones – shallow shelf, middle shelf, deep-shelf, shelf edge and upper slope (refer **Figure 5-6**).

Figure 5-6: Otway continental margin model



Within these zones:

- In the shallow shelf area (0-70m) are exhumed limestone substrates that host dense encrusting mollusc, sponge, bryozoan and red algae assemblages with epifauna such as bivalves. This is observed in the Apollo Marine Reserve where the seafloor has many rocky reef patches inter-dispersed with areas of sediment and in places has rich benthic fauna dominated by sponges (DOE, 2014). South-east Australia is also recognised as having one of the richest macrophyte floras in the world (409 genera with 1124 species) and the benthic algal communities include more than 200 species of which 165 species are rare (Butler et al, 2002).
- The middle shelf (70-130 m) is a zone of swell-wave shoaling and production of mega-rippled bryozoan and sponge sands;
- The deep shelf (130-180 m) is described as having accumulations of intensely bioturbated, fine, bioclastic sands supporting bryozoans, benthic forams and in-faunal echinoids; and
- The shelf edge/top of slope supports aphotic bryozoan/sponge/coral communities.

5.4.2 Plankton

Bonney Upwelling

Within the region, the seasonal Bonney Coast upwelling contributes to locally productive pelagic habitats that exhibit a range of zooplankton such as copepods, decapods, krill and gelatinous zooplankton. This key ecological feature (KEF) is located ~ 135 km from the nearest Dorrigo MSS operational boundary (refer **Figure 5-7**).

The Bonney Upwelling is a prominent and classic oceanographic upwelling (Schahinger, 1987). Surface upwelling of cold, nutrient rich water typically occurs in the summer and autumn along the narrow continental shelf between Robe (SA) and Portland (Victoria). Surface expression of the upwelling is only intermittent further to the southeast where the shelf is wider. Nonetheless the upwelling can extend to at least as far as Origin's Thylacine gas platform (Levings and Gill, 2010) located ~ 20 km northwest of the Dorrigo MSS area.

This Bonney Upwelling generally starts in the eastern part of the Great Australian Bight (GAB) in November/December and spreads eastwards to the Otway Basin (Gill *et al.*, 2011) as the latitudinal high-pressure belt migrates southward. The upwelling occurs via Ekman dynamics, where the ocean surface experiences a steady wind stress which results in a net transport of water at right angles to the wind direction. The shallow surface layer where this movement takes place is called the Ekman Layer (Butler *et al*., 2002).

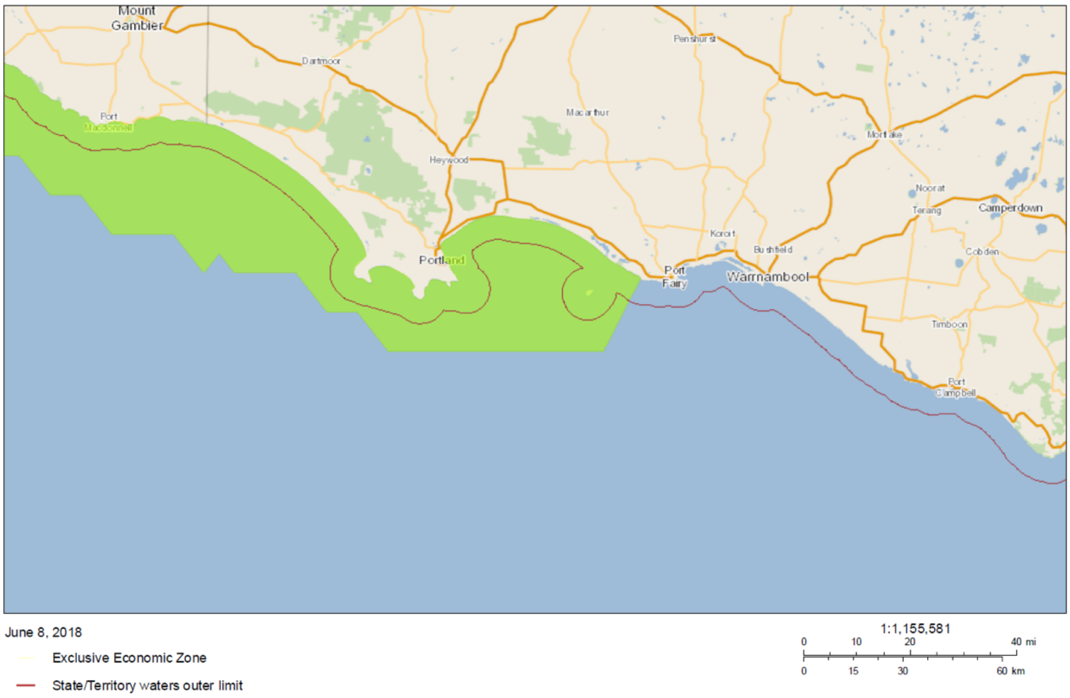
The primary ecological importance of the Bonney Upwelling is as a feeding area for the blue whale (*Balaenoptera musculus*). The upwelled nutrient-rich water promotes blooms of coastal krill (*Nyctiphanes australis*), which in turn attracts blue whales to the region to feed. The upwelling is one of only three identified feeding areas consistently used by blue whale in Australian coastal waters (Butler *et al.,* 2002). The upwelling occurs when strong south-easterly surface winds induce warm, nutrient-deficient surface waters away from the coastline. This leads to surface upwellings bringing cool, nutrient-rich deep waters closer to the surface where there is enough sunlight for primary production to take place (Hosack & Dambacher 2012). The upwelling season begins slowly in November and December, peaks from January to March, and then declines from April (Nieblas et al. 2009). Similar to other seasonal upwelling systems, Nieblas et al. (2009) found that intra-seasonal variability follows four distinct phases within the upwelling season of "onset", "sustained", "quiescent" and "downwelling". The phases commence in November/December, January/February, March and April respectively (DoEE, 2018c).

West Tasmanian Upwelling

A detailed analysis of satellite-derived ocean data (*chlorophyll a* levels) for the periods 1998-2000 and 2005-2014 suggests that the western Tasmanian shelf also accommodates a productive ecosystem (refer **Figure 5-8**). Based upon this study, this region forms part of the Great South Australian Coastal Upwelling System and experiences two phytoplankton blooms per annum. The first and larger bloom occurs in the late austral summer months (typically March-April) resulting from upwelling favourable winds which occur between December-April. Stronger upwelling winds do not always create phytoplankton blooms (Kampf, 2015). The second smaller phytoplankton bloom occurs in spring (October) coincident with the onset of spring bloom in the western Tasman Sea (Kampf, 2015). The mechanism for this smaller bloom remains unclear (Kampf, 2015).

Figure 5-7: Bonney Upwelling (DOEE, 2018)

Bonney Upwelling KEF



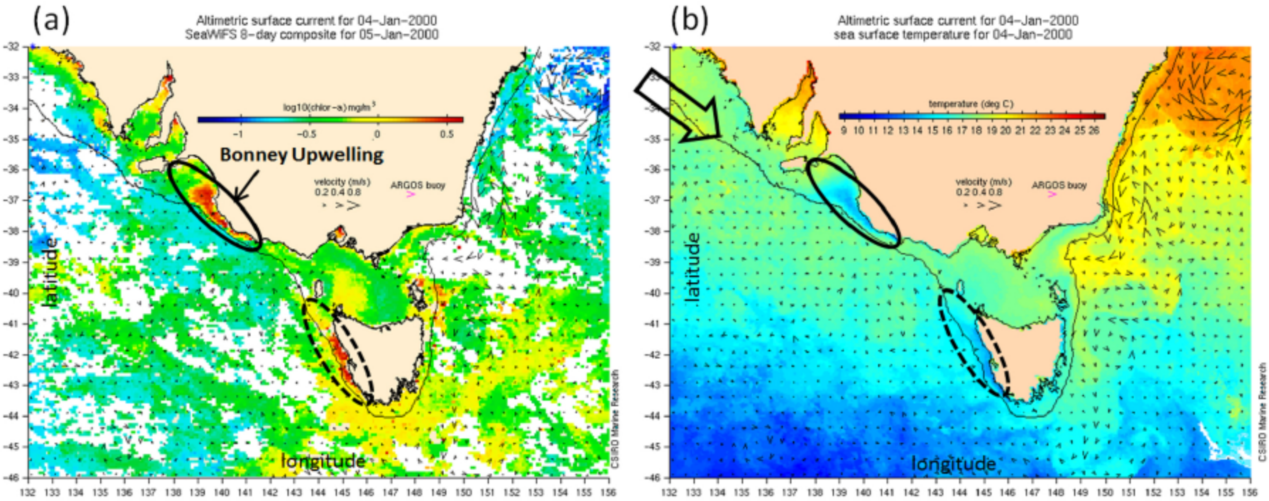
Kampf (2015) identifies that the accuracy of satellite data cannot be used to identify upwelling jets however would suggest the existence of upwelling jets on the western Tasmanian shelf. The significance of these jets is that they operate to disperse nutrient-rich water northwards along the shelf and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

<u>Plankton Type and Distribution in Dorrigo MSS</u>

Coastal krill, *Nyctiphanes australis*, swarm throughout the water column of continental shelf waters primarily in summer and autumn, feeding on microalgae and providing an important link in the blue whale food chain. There have been relatively few studies of plankton populations in the Otway and Bass Strait regions, with most concentrating on zooplankton. Watson and Chaloupka (1982) reported a high diversity of zooplankton in eastern Bass Strait, with over 170 species recorded. However, Kimmerer and McKinnon (1984) reported only 80 species in their surveys of western and central Bass Strait.

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

Figure 5-8: Coastal Upwelling Event in early January 2000 evident in satellite derived distributions of (a) MODIS-OC3 chlorophyll a and (b) sea surface temperature. The large arrow in (b) indicates the pathway of the South Australian Current (Kempf, 2015)



5.4.3 Invertebrates

The marine invertebrates in the region include:

- Porifera (e.g. sponges);
- Cnidarians (e.g. jellyfish, corals, anemones, sea-pens);
- Bryozoans (filter feeders);
- Arthropods (e.g. sea spiders);
- Crustaceans (e.g. rock lobster, giant crab, krill);
- Molluscs (e.g. bivalves, sea slugs, gastropods);
- Echinoderms (e.g. urchins, sea cucumbers); and
- Annelids (e.g. polychaete worms).

Studies by the Museum of Victoria (Wilson and Poore, 1987; Poore *et al.,* 1985) found that invertebrate diversity was high in southern Australian waters although the distribution of species was patchy, with little evidence of any distinct biogeographic regions. Details of invertebrates which may be present in the Dorrigo MSS area or in the Dorrigo oil spill EMBA are provided in **Table 5-2.**

Southern rock lobster and giant crab also support sustainable commercial fisheries across the continental shelf and upper slope areas and abalone is present in the Dorrigo oil spill EMBA. Characteristics of these species are discussed in **Section 5.7** (Commercial Fishing).

Table 5-2: Invertebrates which may be present in the Dorrigo MSS area or in the Dorrigo oil spill EMBA

Invertebrate	Details
Porifera (Sponges)	Sponges are sessile, multicellular organisms that have bodies full of pores and channels allowing water to circulate through the animal which provides food and oxygen and remove wastes. The flow is actively generated by the beating of flagella and filter bacteria and phytoplankton from the water which passes through them (Bond & Harris, 1988). Porifera flourish in waters where water movement is strong (Butler et al. 2002). Sponges do not have nervous, digestive or circulatory systems. Sponges reproduce by asexual and sexual means. Increasing temperature is generally accepted as a major environmental factor regulating the onset of reproduction activity particularly in regions of large seasonal change (spring/summer) (Fromont, 1993). Sponges are efficient colonisers of marine hard surfaces although they will not typically colonise a newly cleared surface as rapidly as some other groups (e.g. bryozoans). Once established sponges are effective competitors in retaining living space through asexual reproduction and by using chemicals to deter competitors and predators (Butler et al, 2002). Large sponges are a host to a myriad of commensal invertebrates including crustaceans, molluscs, worms and echinoderms as well as microorganisms. Only a few specialised species prey on sponges due to their highly developed chemical defences. For fish they are generally unpalatable but may present shelter and food in the form of associated species (Butler et al, 2002).
Hydrozoans	Species are found in almost every marine habitat type except heavy surf zones. They are most abundant and diverse in warm shallow waters probably reflecting food abundance. Most species have a planktonic larval stage which is pelagic before settling onto benthic substrates and developing a polyp, A founding polyp produced new polyps by budding. In many colonies, polyps are polymorphic with different structures reflecting different functions. Polyps produce "adult" sexually-reproducing medusae which are free-swimming and release sperm and eggs in the water (broadcast spawners) where fertilisation occurs. Colonies are usually sessile benthic, but some notably the siphonophores are pelagic floaters. Most hydrozoans are predators or filter-feeders. Filter feeders trap small zooplankton, pelagic hydrozoans show selectivity in prey types taking mainly fish larvae, soft bodied invertebrates or micro-crustaceans. Predators can include snails, worms, fish and crustaceans (University of Michigan, 2018).
Bryozoans	Bryozoans are sessile, aquatic invertebrate filter feeding animals which attach to hard substrates and form lace-like colonies. They have no respiratory organs, heart, or blood vessels. Instead they absorb oxygen and eliminate carbon dioxide through the body wall. Colonies of bryozoans are started by a single individual that, after its larval existence, settles onto a substrate and begins to reproduce asexually (by budding) after settlement. Bryozoans are hermaphrodites and fertilisation can be external in the water column or internal with embryos brooded in the body (as per ascidians) fertilised with sperm brought in on the feeding current. The larvae which are hatched are then released and swim but do not feed. They swim towards the light then after a few hours swim down to the sea floor to colonise. For species which do not brood but release eggs, fertilised eggs become part of the plankton stream for approximately 2 months until they are large enough to descend and start a new colony (Earthlife, 2014). Temperature controls all aspects of bryozoan life. In spring, rising water temperatures and increased intensity of light stimulate phytoplankton growth which initiates active budding in bryozoans and to some degree sexual reproduction (Smithsonian Institute, 2016). Most bryozoans use chemicals as well as spines as a predator deterrent and thus have only relatively few specialised predators (Butler et al, 2002)
Annelids	Annelids are a large phylum of segmented worms, including polychaetes, clitellates, ragworms, earthworms and leeches. Polychaetes are brightly coloured segmented worms. Most are less than 10 cm long, although they can range from 1 mm to 3 m and include forms such as sand worms, tube worms and clam worms. They are found in all habitats from the supra-littoral to the deepest parts of the ocean. Some such as the feather-duster worms are sedentary, living in tubes buried in sand/mud and feed by trapping food particles in mucus or by ciliary action. Others such as the clam worm are active mobile predators which capture prey in jaws (University of Michigan, 2018). Most polychaetes have separate sexes - male and female and the sperm and eggs are released into the surrounding water through ducts or openings. The fertilised eggs hatch into larvae, which float among the plankton, and eventually metamorphose into the adult form by adding segments (MESA, 2017).

Invertebrate	Details
Ascidians	All ascidians (sea squirts) are sessile, sac-like marine invertebrate filter feeders and include both solitary and colonial species. The species has a digestive, circulatory and nervous system however lacks any special sensory organs. Reproduction includes both asexual budding and sexual reproduction with a free-living larval stage. The species are hermaphrodites and fertilisation can be external with development in the water column (solitary species) or internal with embryos brooded in the body (colonial species). Solitary larvae are free-swimming for periods of 1-24 hours and prior to hatching have been floating free in the water for up to 3 days. They are therefore subject to current dispersal which contributes to gene flow and removes risks of isolation. The colonial species are seldom free swimming for more than one hour and attach to substrates rapidly. In temperate and cold seas, breeding is usually seasonal and restricted to the warmer season but in tropical waters it may continue throughout the year (Shenkar, 2008). Limited information on predators is available but they include some fish, molluscs and sea-stars. As some species are known to contain toxins which deter predators and settling larvae, most solitary and colonial species a great ability to rapidly repair any damage through vegetative growth (Butler et al, 2002).
Molluscs (Gastropod – abalone)	Univalve gastropods can live for up to 20 years and grow to a shell length of over 200 millimetres (mm). Abalone feed on algae and predators include crabs, rock lobster, octopi, fish and rays. Blacklip abalone is the predominant species which is fished in the area although greenlip abalone is also present. Blacklip abalone is found in shallow depths between 5-20 m and can be found in caves and crevices and on sheltered reefs. Greenlip abalone is found in shallow reef habitats (5-40 m) and rough water at the base of steep granite cliffs. Abalone is a broadcast spawner with spawning with the species spawning from Spring to Autumn (Kailola et al, 1993). Abalone habitat is present along the west coast of King Island (refer **Section 5.7.5.8**).
Molluscs (Cephalopod)	Cephalopods (squid, octopus and cuttlefish) are active mobile predators. Generally, cuttlefish and octopus eat crustaceans (including lobsters) living on or near the seabed while squid eat crustaceans and fish. Cephalopods have a high growth rate, their life-span is short and there is a single reproductive season (Boyle & Rodhurst, 2005). The species actively swim by jet propulsion and propagate by sexual reproduction. The individual size and number of eggs (released in a jelly like egg mass) during a reproductive season is variable and ranges from a few large eggs (<30mm long) attached to the seabed to numerous (>1 million) small eggs drifting in the plankton. The incubation period is highly temperature dependent and is completed with the hatching of the larval stage which resembles a miniature adult. After breeding the adults die within a short time and in species with a highly synchronised breeding population this can result in conspicuous mass mortality (Boyle & Rodhurst, 2005). Hatchlings have been collected in late spring to summer over a broad area of the southern Australian continental shelf, from 28°S in southern Queensland to 34°S in the western GAB (Jackson & McGrath-Steer, 2003). The Giant Squid (*Architeuthis sp.*) is a deep-water, active cephalopod which appear mostly in areas with submarine channels of canyons which cut transversally across the continental shelf, features with suitable habitat including high productivity (Guerra et al, 2011). Habitat water depths are estimated at 500 – 1000m (Landman et al, 2004), which are coincident with deep-water trawl fisheries (recorded as the main threat to the species) (Guerra et al, 2011). Studies, combined with photographic evidence, identify the giant squid to be a highly active predator with considerable strength (Winkelmann et al, 2013) and estimates of lifespan vary from 3 years to 13 years (Landman et al, 2004). Deepwater pelagic cephalopods and fish are prevalent in gut contents of trawled Architeuthis, with a diversity of shallow-water benthic or sessile organisms in guts of stranded specimens (Bolstad & O'Shea, 2004). On this basis the species appears to be a pelagic rather than a bentho-pelagic species (Bolstad & O'Shea, 2004). The location and type of spawning of Architeuthis are unknown however the eggs are likely to be planktonic as in other oegosid squids (Guerra et al, 2011). The species is globally distributed, reported to be from one global species (low genetic diversity) and that it is extremely vagile, possibly dispersing through both a drifting paralarval stage, or migration of larger individuals (Winkelmann et al, 2013).

Invertebrate	Details
Crustaceans (krill)	Krill (*Nyctiphanes australis)* is common coastal species in southern Australian waters endemic to the subtropical convergence zone. It has a maximum weight of approximately 0,02g, a maximum length of 17mm, and estimated life span of 1 year and has a depth distribution of surface to 150 m water depths (Nicol & Endo, 1999. Studies into the feeding habits of krill identified that the species consumed detritus, diatom and crustacean fragments and sponge spicules (Dalley and McClatchie, 1989). The species occurs in dense aggregations close inshore off the coast of Tasmania (Nicol and Endo, 1997). The species broods its eggs until they hatch rather than spawning them directly into the water column. *N. Australis* reaches sexual maturity after about four months and the female lays several broods of eggs in one season). *N. australis* is one of the most important dietary items for jack mackerel, short-tailed shearwater, fairy prion, Australian salmon, skipjack tuna and tiger flathead as well as other abundant fish and seabirds (Nicol and Endo, 1997)

5.4.4 Fish

The EPBC Act PMST (DOEE, 2018a) for the Dorrigo 3D MSS operational area identified one shark species as vulnerable, the Great White Shark (*Carcharodon carcharias)*; and two shark species as migratory, Shortfin mako (*Isurus oxyrinchus*) and porbeagle (*Lamna nasus*) as having a possible presence in the area. In addition, the database search (DOEE, 2018a) identified twenty-seven listed fish species[14] (2 pipe-horse species; 21 pipe-fish species; two sea-horse species; and 2 sea-dragon species) as possibly having habitat within the area. Details of these fish species are discussed further in this section. **Table 5-3** provides details of the species listed under the EPBC Act. Other species present in the area are described in **Section 5.4.4.6** and species of commercial significance are described in **Section 5.7.5**.

5.4.4.1 Great white shark

The *great white shark (Carcharodon carcharias)*, a highly mobile migratory species listed as vulnerable, is widely distributed throughout temperate and sub-tropical regions in the northern and southern hemispheres. It is primarily found in coastal and offshore areas of the continental shelf and islands however has been caught in varying depths up to 1280m (EA, 2002). White sharks are generally observed between the coast and the 100 m depth contour (Bruce et al, 2006) with areas of frequent encounter around seal colonies particularly when juveniles are present (EA, 2002). Australian fur seal colonies are known to occur at Lady Julia Percy Island (Vic) (~ 145km NW); Reid Rocks (Tas.) (~ 44 km east); and Seal Rocks (Vic) (~ 160 km NE) (Shaughnessy, 1999). New Zealand fur seal colonies occur at Cape Bridgewater (Vic) (~ 190 km NW); Lady Julia Percy Island (~ 145 km NW); Kanowna Island (Vic) (~ 235 km east) and Maatsuyker Island (Tas.) (~ 420 km SSE) (Kirkwood et al, 2009).

White sharks do not feed exclusively on pinnipeds, feeding also on small cetaceans, finfish (e.g. snapper), other sharks, reptiles and seabirds (EA, 2002). Studies of white sharks sighted at pinniped colonies indicate the sharks appear to be largely transient with only a few longer-term residents (EA, 2002). The location of shark pupping areas in Australia is not known, however juveniles aggregate seasonally in certain areas such as Goolwa (SA), Corner Inlet-Lakes Entrance (Vic), Newcastle-Foster (NSW), Fraser Island (Qld) and Portland (Vic) (approx. 175 km WNW) (DOE, 2014d). White sharks appear to return on a seasonal basis and appear to have a degree of fidelity to certain areas (Bruce and Bradford, 2008).

[14] These species generally occur in inshore areas.

The National Conservation Values Atlas (NCVA) identifies that the Dorrigo 3D MSS area overlaps a known distribution BIA for the great white shark in the region. The known distribution BIA reflects areas used by white sharks as they move between nursery areas particularly for juvenile white sharks during autumn-winter-spring (DoEE, 2018b). The white shark may transit the survey area to nursery and foraging locations.

Recovery Plan for the white shark (SEWPC, 2013):
The Recovery Plan for the white shark (*Carcharodon carcharias)* (SEWPC, 2013) has been reviewed for threats posed by MSS activities. No threats have been identified which are considered relevant for impacts expected from the Dorrigo 3D MSS activity. Sound is not identified as a threat to species recovery.

5.4.4.2 Shortfin mako shark

The shortfin mako shark (Isurus oxyrinchus) listed as migratory, is found worldwide in tropical and temperate waters. They are pelagic oceanic swimmers but are occasionally found inshore. In warm, tropical oceans, they swim to depths of 500 m as they prefer cool water (about 65°F (18.5°C)) however they are seldom found in waters colder than 16ºC. The species feeds mainly upon squid and bony fishes including mackerels, tunas, bonitos and swordfish, but may also eat other billfish and small cetaceans (Last & Stevens, 2009).

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

The species may be present in the Dorrigo MSS area during the survey period however the NCVA does not identify that the survey OA is important biological habitat for the species (DoEE, 2018b).

5.4.4.3 Porbeagle (Mackerel shark)

The *porbeagle* or *mackerel shark* (*Lamna nasus*) listed as migratory; is a pelagic, oceanic fish; prefers cool waters (temperatures below 16ºC); has a depth range of 715m and is distributed from latitudes 76°N to 59°S (Froese & Pauly, 2012). The species are abundant on continental shelves but are also found inshore. The mackerel shark feeds mainly on herring, mackerels; cod, white hake, red hake, haddock, cusk, and squid (WoRMs, 2018). Reproduction is oophagous with 1-5 pups born in winter in the Australasian region (Last & Stevens, 2009).

The species may be present in the area during the survey period however the NCVA does not identify that the Dorrigo 3D MSS area is important biological habitat for the species (DoEE, 2018b).

Table 5-3: EPBC Act – Listed fish species which may occur in or around the Dorrigo 3D MSS area (DoEE, 2018a)

Status:

E: Endangered

V: Vulnerable

M: Migratory

L: Listed

Likelihood of Occurrence:

LO: Species or species habitat likely to occur in area

MO: Species or species habitat may occur within area

FMO: Foraging/Feeding may occur within area

FKO: Foraging/Feeding known to occur in area

KO: Species or species habitat known to occur within area

FLO: Foraging/Feeding likely to occur in area

BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Sharks	Carcharodon carcharias	Great White Shark	V, M	KO	✓	Known Distribution (Low density)	✓	Known Distribution	✓ [Ref .1]
	Isurus oxyrinchus	Shortfin Mako	M	LO	✓	-	✓	-	-
	Lamna nasus	Porbeagle, Mackerel Shark	M	LO	✓	-	✓	-	-
	Prototroctes maraena	Australian grayling	V	KO	X	-	✓	-	✓ [Ref .2]
Syngnathidae (pipefish, pipehorse, seadragons, seahorse)	Heraldia nocturna	Upside-down Pipefish	L	MO	✓	-	✓	-	-
	Hippocampus abdominalis	Big-belly Seahorse	L	MO	✓	-	✓	-	-
	Hippocampus breviceps	Short-head Seahorse	L	MO	✓	-	✓	-	-
	Hippocampus minotaur	Bull-neck seahorse	L	MO	X	-	✓	-	-
	Histiogamphelus briggsii	Crested Pipefish	L	MO	✓	-	✓	-	-
	Histiogamphelus cristatus	Rhino Pipefish	L	MO	✓	-	✓	-	-
	Hypselognathus rostratus	Knifesnout Pipefish	L	MO	✓	-	✓	-	-
	Kaupus costatus	Deepbody Pipefish	L	MO	✓	-	✓	-	-
	Kimblaeus bassensis	Trawl pipefish	L	MO	X	-	✓	-	-
	Leptoichthys fistularius	Brushtail Pipefish	L	MO	✓	-	✓	-	-
	Lissocampus caudalis	Australian Smooth Pipefish	L	MO	✓	-	✓	-	-
	Lissocampus runa	Javelin Pipefish	L	MO	✓	-	✓	-	-
	Maroubra perserrata	Sawtooth Pipefish	L	MO	✓	-	✓	-	-
	Mitotichthys mollisoni	Mollison's Pipefish	L	MO	X	-	✓	-	-
	Mitotichthys semistriatus	Half-banded pipefish	L	MO	✓	-	✓	-	-
	Mitotichthys tuckeri	Tuckers pipefish	L	MO	✓	-	✓	-	-
	Notiocampus ruber	Red Pipefish	L	MO	✓	-	✓	-	-
	Phycodurus eques	Leafy Seadragon	L	MO	✓	-	✓	-	-
	Phyllopteryx taeniolatus	Common Seadragon	L	MO	✓	-	✓	-	-
Syngnathidae (Con't)	Pugnaso curtirostris	Pugnose Pipefish	L	MO	✓	-	✓	-	-

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

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

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
	Solegnathus robustus	Robust Pipehorse	L	MO	✓	-	✓	-	-
	Solegnathus spinosissimus	Spiny Pipehorse	L	MO		-	✓	-	-
	Stigmatopora argus	Spotted Pipefish	L	MO	✓	-	✓	-	-
	Stigmatopora nigra	Widebody Pipefish	L	MO	✓	-	✓	-	-
	Stigmatopora olivacea	a pipefish	L	MO	✓	-	✓	-	-
	Stipecampus cristatus	Ringback Pipefish	L	MO	✓	-	✓	-	-
	Urocampus carinirostris	Hairy Pipefish	L	MO	✓	-	✓	-	-
	Vanacampus margaritifer	Mother-of-pearl Pipefish	L	MO	✓	-	✓	-	-
	Vanacampus phillipi	Port Phillip Pipefish	L	MO	✓	-	✓	-	-
	Vanacampus poecilolaemus	Longsnout Pipefish	L	MO	✓	-	✓	-	-

References: [1] Recovery Plan for the white shark (*Carcharodon carcharias)* (SEWPC, 2013)
[2] National Recovery Plan for the Australian Grayling (Backhouse *et al*., 2008)

Definitions:

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

5.4.4.4 Australian Grayling

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

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

5.4.4.5 Syngnathidae species

Browne et al (2008) identifies these species exist over a broad geographical range, however within this range their distribution is limited to suitable habitat which is determined by the species' camouflage, size, food source, behaviour and reproduction. Species can inhabit seagrass and macro-algal habitats, reef habitats, and broken bottom habitats (described as a mixed mosaic of margins of seagrass meadows, shelly or rubbly bottom and sandy bottom with patchy seagrass or detritus, and disturbed areas). Many pipefish, seahorse and sea-dragon species lie in shallow bays and coastal waters, especially seagrass beds, and on reefs covered with macro-algae where they are well camouflaged. Pipe-horses can be found in deeper continental shelf waters but little information on their distribution is available (McClatchie et al, 2006). Syngnathids utilise a swim bladder to control their depth within the water column. Two species of pipe-horse are listed for the Dorrigo 3D MSS area which have a depth range similar to the Dorrigo MSS area. They are:

- Robust Pipe-horse (*Solegnathus robustus*): The species is common within its known depth range (42-68m) and occurs in benthic habitats on the continental shelf particularly in South Australia (McClatchie et al, 2006). No critical habitats have been identified (Pogonoski et al, 2008a); and
- Spiny Pipe-horse (*Solegnathus spinosissimus*): This species is most commonly taken by trawl in areas with muddy bottoms at depths of 29-232 m, but it occurs as shallow as 2-3 m in the Derwent & Huon Estuaries, Tasmania. It is found in shallow waters in the southern part of its range where waters are shaded or are darkened by tannins and is often found over rubble substrates and near rich invertebrate platform reefs where the species probably attaches itself to encrusting animal growths. No critical habitats have been identified however trawling is identified as a key threat to the species (Pogonoski et al, 2008b).

Given the depth range of the Dorrigo survey area and the seabed sediment type on the continental shelf, these pipe-horse species are not expected to be present within the Dorrigo survey area.

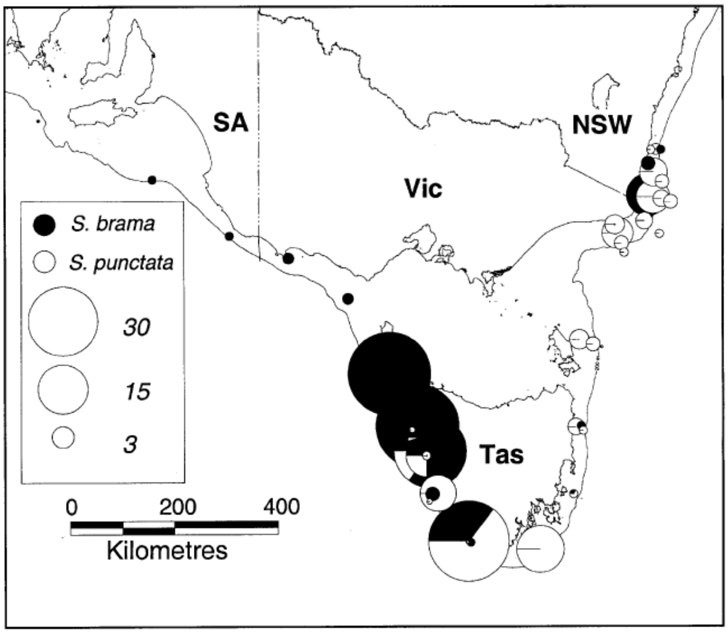
5.4.4.6 Other fish species

Fish species present in the region are largely cool temperate species, common within the South Eastern Marine Region. The known fish fauna of temperate Australia consists of between 550-600 species which live inshore and on the continental shelf. Fish include bony fish and sharks/rays with the composition and distribution of fish strongly influenced by the depth and structure of the environment (NOO, 2002). Forty-five species of fish are of commercial significance in the general south-east marine region including Tuna species (Yellow fin, Southern Bluefin, Skipjack), Shark species (Blue, Gummy, and School), warehou, whiting, bream, gemfish, trevally, perch and snapper (NOO, 2002). Commercially important species in the southeast marine region, habitat type, depth range, spawning details are provided in **Table 5-4** (* Identified as species which may be present in

Dorrigo MSS area (SETFIA/Fishwell Consulting, 2018)). Species identified as having nursery grounds within the Zeehan Commonwealth Marine Park (CMP) (DoEE, 2018d) are:

- *Blue warehou*: A highly mobile species found in shelf and upper slope waters. Spawning has been recorded on the Tasmanian west coast from 5 July to 6 September with a peak in mid to late August (Bruce et al, 2001). Distribution of larvae suggests that the species spawns over a large area from Kangaroo Island to Southern Tasmania with a major spawning grounds located on the central west and north-west coasts of Tasmania (refer **Figure 5-9**). A separate major spawning area occurs off eastern Victorian/southern NSW with spawning approximately one month earlier than those of west Bass Strait (Bruce et al, 2001).
- *Spotted warehou*: Also a highly mobile species found in shelf and upper slope waters. Spawning dates for larvae in Tasmanian waters ranged from 18 July to 17 August with a peak in early-mid August across broad areas of south-eastern Australia (between south-western Tasmania and southern NSW) (Bruce et al, 2001) (refer **Figure 5-9**). Juveniles are widespread in southern Australian waters with bays and estuaries in south-eastern Tasmania major nursery areas for both warehou species.

Figure 5-9: Distribution of blue warehou (*S. brama*) and spotted warehou (*S. punctata*) larvae < 5 mm BL. Scale, number of larvae per 1000 m^3 (Bruce et al, 2001)



- *Ocean perch*: A demersal fish inhabiting waters of the southern continental shelf and slope between Newcastle (NSW) and Shark Bay (WA) (Paxton and Colgan, 1993) with both a shallow on deep water form (Furlani, 1997). Broadscale spawning occurs throughout Tasmanian waters from late winter to late summer peaking during September to December (Furlani, 1997). The species is viviparous with the juvenile phase pelagic (Furlani, 1997).

For other details on spawning, refer to commercial fisheries (**Section 5.7.5**).

Table 5-4: Commercially important species in the SE marine region (spawning)

Species Name	Spawning Type	Normal Depth Range	Spawning Location	Spawning in Dorrigo MSS	Timeframe (Otway Basin)												References
					J	F	M	A	M	J	J	A	S	O	N	D	
Albacore Tuna	At least twice each summer	0-500 m	Between 5°-25°S	X													NOO (2002), Kailola et al (1993)
Southern Bluefin Tuna	Multiple spawning	NA	Between 5°-20°S (indian Ocean)	X													NOO (2002), Kailola et al (1993)
Blue Shark	NA	0-350 m	Coastal NSW	X													NOO (2002), Kailola et al (1993)
Blue-eye Travalla*	Multiple spawning	200-900m	Continental slope	✓													NOO (2002), Kailola et al (1993)
Jackass morwong*	Serial Spawners	40-400 m	Bass Strait & Tasmanian Coastal Waters	✓													NOO (2002), Kailola et al (1993)
Tiger Flathead*	NA	< 200 m	Bass Strait & Southern Tasmania	✓													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Sand Flathead	NA	30-160 m	Bays, estuaries & shallow coastal waters	X													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Pink ling*	Aggregation	20-800 m	Strahan (Tas), Lakes Entrance (Vic), Gabo Island (NSW)	X													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Jack mackerel	Widespread spawning	0-460 m	Tasmania	✓													NOO (2002), Kailola et al (1993),
Striped trumpeter	Multiple spawners	0-300m	Inshore reefs to spawn (30-50 m depth)	✓													NOO (2002), Kailola et al (1993), Bruce et al (2002), Tasfish, 2018
John Dory	Serial spawners (aggregations rare)	0-200 m	Widely dispersed, NSW and NZ locations	✓													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Hapuka	NA	0-450 m	Unknown Australia, Cook Strait (NZ)	X													NOO (2002),Beentjes & Francis (1999)
Orange Roughy	Spawning aggregations in winter	700-1200 m	St Helens, Central NSW, South of Tasmania	X													NOO (2002), Kailola et al (1993),
Oreos	Synchronous	750-1200 m	Widespread through SEMR	✓													NOO (2002), Kailola et al (1993),
Blue grenadier*	Isochronal spawners	200-1000	West coast of Tasmania (Cape Sorell)	X													NOO (2002), Kailola et al (1993),
Blue warehou*	Three batches of eggs per season	50-500	West Coast Tasmania/Southern NSW	✓													NOO (2002), Kailola et al (1993), Bruce et al (2001)
Spotted warehou	NA	0-650	Spawning western Tasmania to southern NSW	✓													NOO (2002), Kailola et al (1993), Bruce et al (2001)
Western gemfish*	NA	0-400 m	Summer in west of Great Australian Bight	X													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Mirror Dory*	NA	50-600 m	NSW waters	X													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Silver trevally*	Partial spawner (several egg batches)	0-120 m	Shelf and estuary waters	✓													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Ocean perch*	Viviparous, protracted spawning	50-750 m	Coastal waters around Tasmania	✓													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Dogfish	Ovoviviparous (1-9 per litter)	50-900 m	Mid-slope, closure areas for breeding - not Dorrigo	✓													NOO (2002), Kailola et al (1993), Bruce et al (2002)
Gummy shark*	Ovoviviparous	0-80 m	Shallow, coastal waters	X													NOO (2002), Kailola et al (1993), Bruce et al (2002)
School shark*	Ovoviviparous	0-800 m	Waters of South Australia	X													NOO (2002), Kailola et al (1993)
Sawshark*	Ovoviviparous	< 300 m	Shallow coastal areas	X													NOO (2002), Kailola et al (1993), AFMA (2018)
Elephant fish	Aggregate	0-200 m	Continental shelf	✓													NOO (2002), Kailola et al (1993)
Snapper	Serilka spawners	0-35 m	Waters < 50 m	X													NOO (2002), Kailola et al (1993)
Australian salmon	Spawning aggregation	0-30 m	Lakes Entrance to Bermagui	X													NOO (2002), Kailola et al (1993)
Southern Rock Lobster*	Fertilised egg release (multiple cohorts)	0-200 m	Continental shelf	✓	LR			Mating			FE			LR			NOO (2002), Bruce et al (2002)
Giant Crab*	Fertilised egg release	18-400 m	Edge of the continental shelf	✓	LR					Mating				FE		LR	FRDC, 2017
Abalone	Fertilised egg release	0-40m	Inshore reef area	X													Mundy & Jones, 2017; Morgan & Shepard, 2006
Pilchard/Sardine	Synchonous multiple-batch spawners	< 200 m	Inshore on the continental shelf	✓													NOO (2002), Kailola et al (1993), Bruce et al (2002)

Legend:

(light shading)	Species not present in the Dorigo MSS area during spawning
(dark shading)	Species may be spawning in the Dorrigo MSS area
FE	Fertilise Eggs
LR	Larvae Release

5.4.5 Cetaceans

The EPBC Act PMST (DOEE, 2018a) lists 28 cetacean species as possibly occurring in the Dorrigo MSS area. Within the EMBA, 29 species may be present. Of these, five species are listed as threatened: the blue whale (*Balaenoptera musculus*), humpback whale (*Megaptera novaeangliae*), southern right whale (*Eubalaena australis),* fin whale (*Balaenoptera physalus*) and sei whale (*Balaenoptera borealis*); and 10 species are listed as migratory. **Table 5-5** provides details of the species which are listed under the EPBC Act which may have habitat within the Dorrigo MSS area and EMBA. Details of those threatened and migratory cetacean species are discussed further in this section.

5.4.5.1 Humpback whale

The humpback whale *(Megaptera novaeangliae)*, a migratory species listed as vulnerable, is found throughout Australian Antarctic waters and Commonwealth offshore waters (DoEE, 2018e). Humpback whales feed on krill primarily during the summer months in Antarctic waters south of about 55°S (peak season mid-January to February) (DoEE, 2018e). Some feeding has also been observed in Australia's coastal waters, but this is thought to be opportunistic and forms only a small portion of their nutritional requirements (DoEE, 2018e). Two recognised populations exist in Australia, the western Australian population of humpbacks, which is a genetically distinct group from the eastern Australian group. The species commences a northerly migration from Antarctic waters reaches southeast Australia in April-May. The species then migrates north to the Great Barrier Reef (14ºS-27ºS) where breeding takes place, after which the southern migration commences (D0EE, 2018e). Migratory humpbacks on their southern migration pathway are in south-east Australian waters in November-December each year (refer **Figure 5-10**) (DEH, 2005a).

The migratory pathways for this species are distinct along the eastern and western Australian coastlines with a lower presence in the GAB (DEH, 2005a). Groups of young males typically lead the migration while pregnant cows and cow-calf pairs follow. The exact timing of the migration can vary depending of water temperature, sea ice and predation risk (DoEE, 2018e). In Victoria there are reports of Humpback Whales in all months except February (DoEE, 2018e).

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

- September – 0.35 whales sighted/1000 km survey distance;
- October – 0 whales sighted/1000 km survey distance;
- November – 0.05 whales sighted/1000 km survey distance;
- December – 0.07 whales sighted/1000 km survey distance;
- January, February, March, April – 0 whales sighted/1000 km survey distance;
- May – 0.11 whales sighted/1000 km survey distance;
- June – 0.99 whales sighted/1000 km survey distance;
- July – 1.0 whales sighted/1000 km survey distance; and
- August – 0 whales sighted/1000 km survey distance.

Table 5-5: EPBC listed marine mammal species which may occur in or around the Dorrigo MSS survey area (DoEE, 2018a)

Status:

E: Endangered

V: Vulnerable

M: Migratory

L: Listed

Likelihood of Occurrence:

LO: Species/ species habitat likely to occur in area

MO: Species/ species habitat may occur within area

FMO: Foraging/Feeding may occur within area

FKO: Foraging/Feeding known to occur in area

KO: Species/ species habitat known to occur within area

FLO: Foraging/Feeding likely to occur in area

BO: Breeding known to occur in area

Species Type		Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Cetaceans		Balaenoptera acutorostrata	Minke Whale	L	MO	✓	-	✓	-	-
		Balaenoptera bonaerensis	Antarctic Minke Whale	M	LO	✓	-	✓	-	-
		Balaenoptera borealis	Sei Whale	V,M	FLO	✓	-	✓	-	✓ [1]
		Balaenoptera musculus	Blue Whale	E, M	FKO	✓	Foraging (annual high use) Distribution	✓	Foraging (annual high use) Distribution	✓ [2]
		Balaenoptera physalus	Fin Whale	V, M	FLO	✓	-	✓	-	✓ [3]
		Berardius arnuxii	Arnoux's Beaked Whale	L	MO	✓	-	✓	-	-
		Caperea marginata	Pygmy Right Whale	M	FMO	✓	-	✓	-	-
		Delphinus delphis	Common Dophin	L	MO	✓	-	✓	-	-
		Eubalaena australis	Southern Right Whale	E, M	KO	✓	-	✓	Connecting habitat	✓ [4]
		Globicephala macrorhynchus	Short-finned Pilot Whale	L	MO	✓	-	✓	-	-
		Globicephala melas	Long-finned Pilot Whale	L	MO	✓	-	✓	-	-
		Grampus griseus	Risso's Dolphin	L	MO	✓	-	✓	-	-
		Kogia breviceps	Pygmy Sperm Whale	L	MO	✓	-	✓	-	-
		Kogia simus	Dwarf Sperm Whale	L	MO	✓	-	✓	-	-
		Lagrnorhynchus obscurus	Dusky Dolphin	M	LO	✓	-	✓	-	-
		Lissodelphis peronii	Southern Right Whale Dolphin	L	MO	✓	-	✓	-	-
		Megaptera novaeangliae	Humpback Whale	V, M	KO	✓	-	✓	-	✓ [5]
		Mesoplodon bowdoini	Andrew's Beaked Whale	L	MO	✓	-	✓	-	-
		Mesoplodon densirostris	Blainville's Beaked Whale	L	MO	✓	-	✓	-	-
		Mesoplodon grayi	Gray's Beaked Whale	L	MO	✓	-	✓	-	-
		Mesoplodon hectori	Hector's Beaked Whale	L	MO	✓	-	✓	-	-

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

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

Species Type		Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
		Mesoplodon layardii	Strap-toothed Beaked Whale	L	MO	✓	-	✓	-	-
		Mesoplodon mirus	True's Beaked Whale	L	MO	✓	-	✓	-	-
		Orcinus orca	Killer Whale	M	LO	✓	-	✓	-	-
		Physeter macrocephalus	Sperm Whale	M	MO	✓	-	✓	-	-
		Pseudorca crassidens	False Killer Whale	L	LO	✓	-	✓	-	-
		Tursiops aduncus	Indian Ocean bottlenose dolphin	L	LO	X	-	✓	-	-
		Tursiops truncatus s. str.	Bottlenose Dolphin	L	MO	✓	-	✓	-	-
		Ziphius cavirostris	Cuvier's Beaked Whale	L	MO	✓	-	✓	-	-
Other Mammals		Arctocephalus forsteri	New Zealand Fur Seal	L	MO	✓	-	✓	-	-
		Arctocephalus pusillus	Australian Fur Seal	L	MO	✓	-	✓	-	-

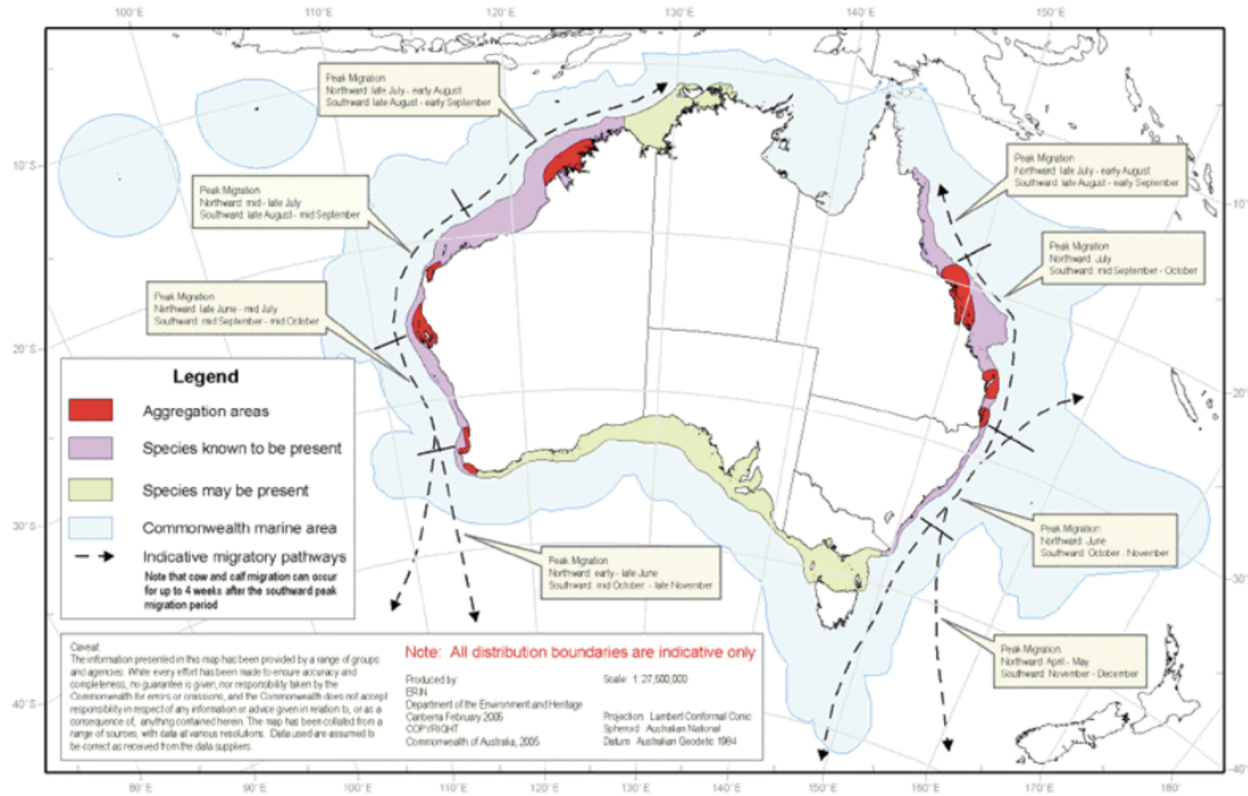
Definitions: Refer Table 7-1

References:

[1] Conservation advice for the Sei Whale (TSSC, 2015e)
[2] Blue Whale Conservation Management Plan (DoE, 2015)
[3] Conservation advice for the Fin whale (TSSC, 2015d)
[4] Conservation Management Plan for the southern right whale (SEWPC, 2012)
[5] Conservation advice for the Humpback Whale (TSSC, 2015c)

Observation data for humpback whale occurrence corresponds with the timing of migration to and from calving grounds off northern Australia (Dawbin 1966; cited in Gill et al. 2015), and evidence of autumn feeding is consistent with opportunistic feeding observed in migration routes off eastern Australia (Stamation et al., 2007; cited in Gill et al., 2015).

Figure 5-10: Distribution, migration and recognised aggregation areas of the humpback whale (DEH, 2005c)



The NCVA records that the survey area does not lie in a BIA (breeding, feeding, resting or migration pathway) for the humpback whale (DoEE, 2018b). It is possible that this species may be encountered migrating during the Dorrigo MSS activities, however the proposed MSS area is located further west than the humpback's normal (eastern) migration route and based upon observation data, the timing of the survey is expected to avoid peak encounter periods and the potential for encounter is considered unlikely.

Recovery Plan/Conservation Advice (Humpback Whale):

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

Information from the conservation advice for the Humpback whale (TSSC, 2015a) identifies the following threats relevant to the Dorrigo 3D MSS:

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

Conservation and management actions details for these threats are detailed in **Table 5-6.** Noise interference is discussed in **Section 7.2**, entanglement with marine debris in **Section 7.9** and vessel disturbance and strike in **Section 7.11**.

Table 5-6: Conservation advice for the Humpback Whale (TSSC, 2015a) – Threats relevant to activity

Relevant Threat/ Objectives	Conservation and Management Action	Action taken within EP
Assessing and addressing anthropogenic noise; shipping, industrial and seismic surveys	All seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. Should a survey be undertaken in or near a calving, resting, foraging area, or a confined migratory pathway then Part B. Additional Management Procedures must also be applied.	Dorrigo survey is not within BIA (calving, resting, foraging or confined migratory pathway) of Humpback whale. EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales will be applied.
	For actions involving acoustic impacts (example pile driving, explosives) on humpback whale calving, resting, feeding areas, or confined migratory pathways site specific acoustic modelling should be undertaken (including cumulative noise impacts).	Acoustic modelling has been undertaken for this survey. Survey area is not within recognised calving, resting, feeding or migratory pathways for the species.
	Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified a noise management plan should be developed.	Not applicable to Dorrigo survey.
Entanglement – Marine Debris	-	Threat Abatement Plan (marine debris) will be applied within this EP.
Minimising Vessel Collisions	Maximise the likelihood that all vessel strike incidents are reported in the National Ship Strike Database. All cetaceans are protected in Commonwealth waters and, the EPBC Act requires that all collisions with whales in Commonwealth waters are reported. Vessel collisions can be submitted to the National Ship Strike Database at https://data.marinemammals.gov.au/report/shipstrike	Reporting requirement to be included within **Section 8.11** (Cetacean collision with vessel)
	Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike.	Vessel strike risk assessment included in this EP (**Section 7.11**)

5.2.5.2 Blue whale

The blue whale *(Balaenoptera musculus),* a migratory species listed as endangered, is present in waters off Australia's Antarctic Territory and is widespread in all Australian waters at various times of the year (DoEE, 2018f). The species is oceanic and appears to undertake extensive migrations between warm water (low latitude) breeding areas and cold-water feeding grounds during summer between approximately 20ºS and 60-70ºS (Bannister et al, 1996; DoE, 2015). Migration pathways are not known however it is thought the species migrates to Antarctic waters in early summer and leaves in autumn migrating to tropical breeding areas (Indonesian and possibly SW Pacific waters) during winter (DoEE, 2018f). Blue whales have extensive, global migration patterns that are not known to follow particular coastlines or oceanographic features (Bannister et al, 1996). Exact breeding ground locations are also not known (Bannister et al, 1996) however it is thought a region in deep oceanic waters around the Indonesian Archipelago may be significant (DoEE, 2018f).

Migration:

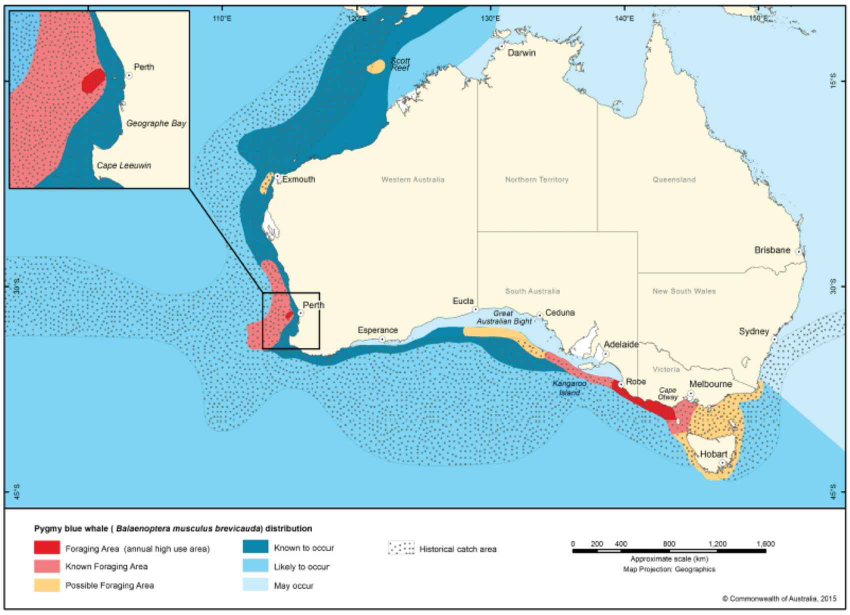
There are two recognised subspecies of the Blue whale in Australian waters - the true-blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda)*. Pygmy blue whales don't migrate as far south (to approximately 55°S) compared with the true-blue whale (Bannister et al, 1996). While true blue whales appear to feed mainly, if not exclusively, in the Antarctic, pygmy blues feed in more temperate latitudes. It is therefore likely that records of blue whales feeding in Australian waters between late spring-autumn are pygmy blue whales (DEH, 2005b) (hereafter referred to as blue whales). The blue whale feeds on pelagic crustaceans (zooplankton including krill, salps and copepods) (DoEE, 2018f). Krill has strong swimming abilities (McClatchie et al, 2006b) with vertical migration within the water column between 10-40 m. The blue whale distribution around Australia is provided in **Figure 5-11** and migration pathways are provided in **Figure 5-12**.

Photo-identification has confirmed within and between season movement of pygmy blue whales between the Bonney upwelling and Perth Canyon feeding areas (Garcia-Rojas et al, 2018). Satellite tagged individuals have been tracked migrating north from the Perth Canyon to Indonesian waters almost to the equator, the likely breeding area for this population (Branch et al, 2007; Gales et al, 2010; Double et al, 2014: cited in Garcia-Rojas et al, 2018). While migratory pathways require further delineation, satellite tagging undertaken has established the following (refer **Figure 5-13**):

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

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

Figure 5-11: Pygmy blue whale distribution around Australia (DoE, 2015)



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

Figure 5-12: Pygmy blue whale migration routes (DoE, 2015)

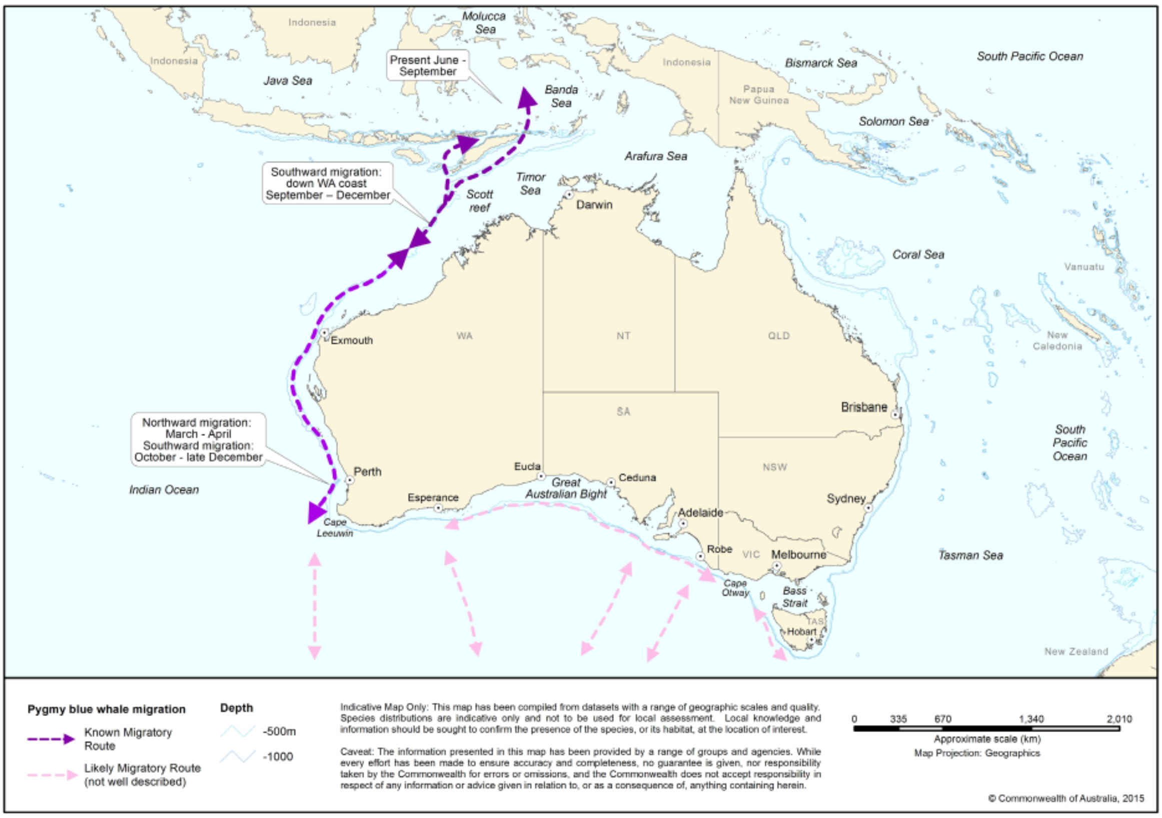
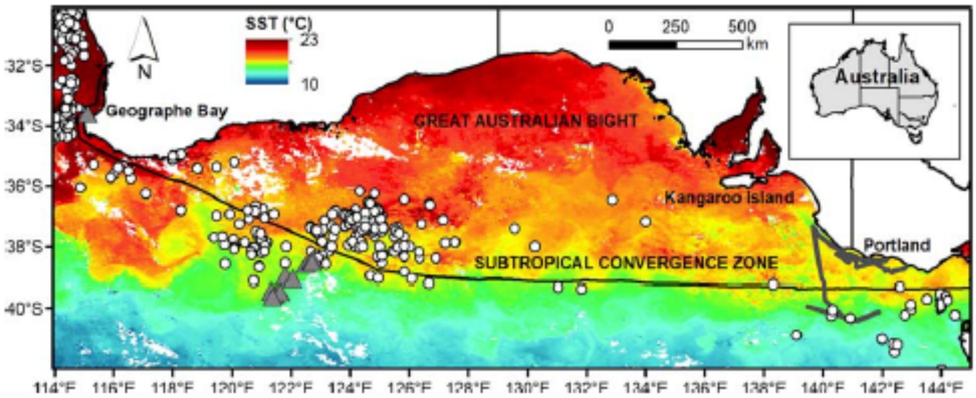


Figure 5-13: Satellite Tracking of pygmy blue whale individuals in the Subtropical Convergence Zone south of Australia (STC) between 4 December 2002-31 January 2003 (grey triangles) and 5-18 April 2005 (grey line). Historical Soviet whaling catches of pygmy blue whales are indicated by the white circles) (Garcia-Rojas et al, 2018)



Blue whale temporal presence in Otway Basin:
Key feeding areas within Australian waters for the blue whale are the Bonney upwelling system, adjacent water off South Australia and Victoria, and the Perth Canyon (WA). According to the NCVA (DoEE, 2018b), the continental shelf area between Robe and Cape Otway is a foraging area with high annual use where the blue whale feed on abundant swarms of krill nourished by the Bonney Upwelling, a seasonal event where nutrient rich cold waters are pushed to the surface from the deeper ocean. The blue whale is known to feed predominantly between January to April although the within-season distribution trends in Bass Strait are unknown. Distribution and timing of blue whales in the Bonney upwelling can vary. During November and December 2012, large numbers of blue whales were sighted in the eastern area of the Bonney Upwelling, just west of Bass Strait (DoE, 2015).

Branch et al (2007), based upon blue whale records for historic catch, sightings, strandings, mark-recapture movement studies and acoustic detections (period 1950-2007), established a low seasonal presence between June and October with increased sightings in November. Aerial surveys (1998-2001) did not sight blue whales during June-October (Gill, 2002; cited in Gill et al, 2011). Non-systematic surveys conducted between June and October have found no whales, nor have any been reported from other sources (Thiele 2005; cited in DoEE, 2018f).

Gill et al. (2011) undertook 69 aerial surveys between January 2002 and May 2007 to establish the spatial and temporal variation of abundance and distribution of blue whales in the area extending from west of Kangaroo Island (~136°E) to Cape Otway (Vic) during the upwelling season (November-May). The following observations[15] were made with respect to blue whales:

- Blue whales are usually restricted to the western and central zones in November entering the eastern zone in December (refer **Figure 5-14** below);
- Blue whales are widely spread through the central and eastern zones during January-April
- In the eastern zone, encounter rates peak in February (9.8 whales/1000km); dropping slightly to 8.8 whales/1000km in March; then declining to approximately 4 whales/1000km in April

[15] It was noted that each season is unique and the exact timing and location of the first appearance of Blue Whales in the area varies.

and to a single sighting in May (0.4whales/1000km). Encounter rates in November are zero and in December is 1 whale/1000km (refer **Figure 5-15);**

- The central zone is most consistently used by blue whales;
- Eighty percent of blue whales are encountered at depths between 50-150m and 93% of sightings occurred in water depths <200m in the eastern and central zones with 10% of sightings within 5km of the 200m isobath; and
- A mean blue whale group size of 1.3±0.6 was observed per sighting record with cow-calf pairs observed in 2.5% of the sightings. This group size minimises the potential for 'prey' competition (DoEE, 2018f).

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

An aerial survey undertaken for the WHL Energy La Bella MSS on 30th November 2013 (more recent data) identified blue whales aggregating along the shelf-break area to the west of the Dorrigo 3D MSS area (refer **Figure 5-16**). Blue Whale Study (**Stakeholder No 25**) has identified that during the 2012 Astrolabe and Bellerive MSS to the northwest of the Dorrigo MSS area, 21 blue whales were observed on 10th November and in January 2012 blue whales were scattered along the shelf to the southern end of King Island. Blue whales have been sighted in the Dorrigo area during November, and appear to feed right throughout the Dorrigo MSS area, though not necessarily in November. BWS has never found blue whales in the Dorrigo MSS area in October although some early birds have sometimes been sighted around Portland during October.

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

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

Figure 5-14: Blue whale sightings in the Otway Basin (Gill et al, 2011)

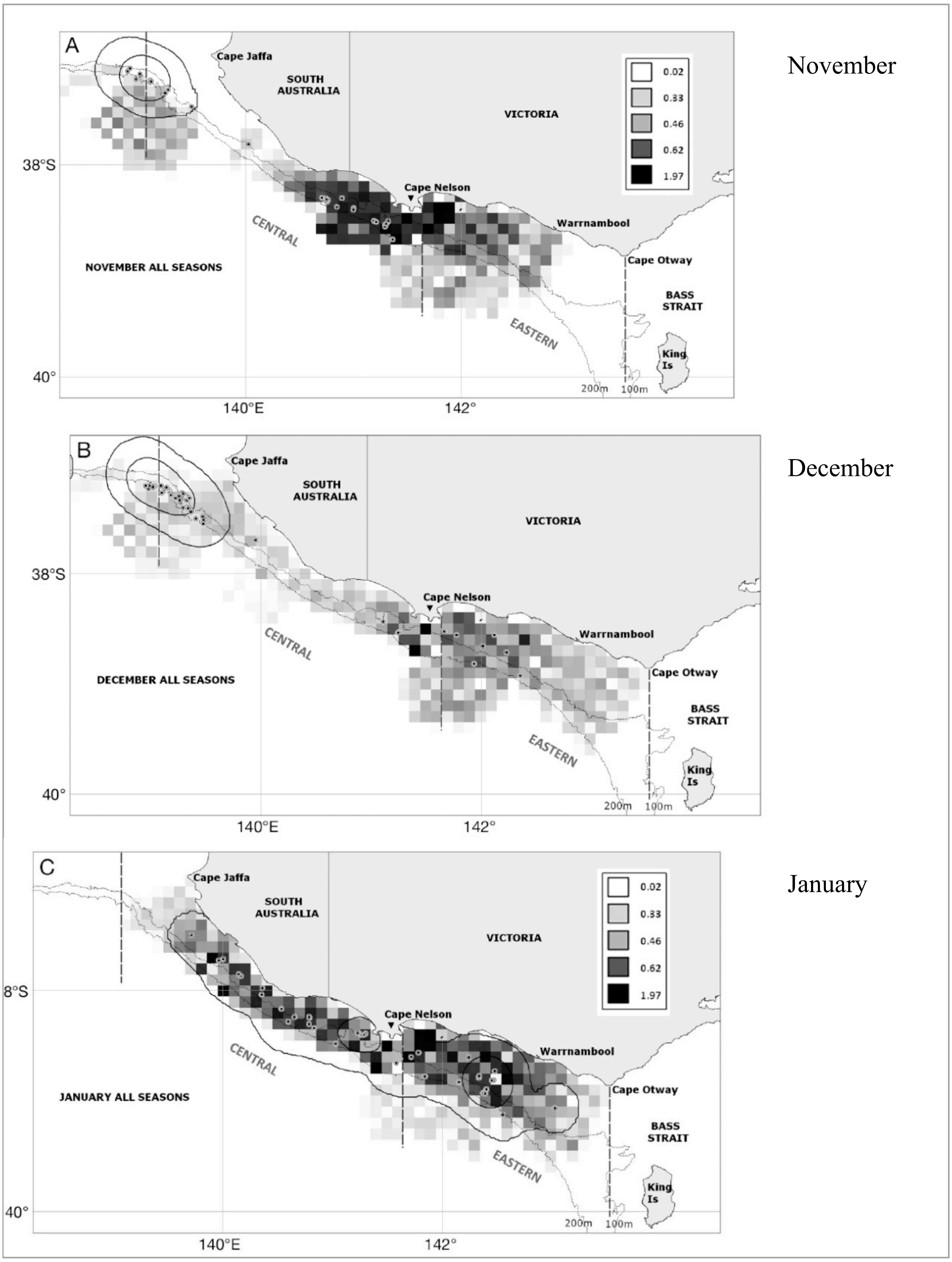
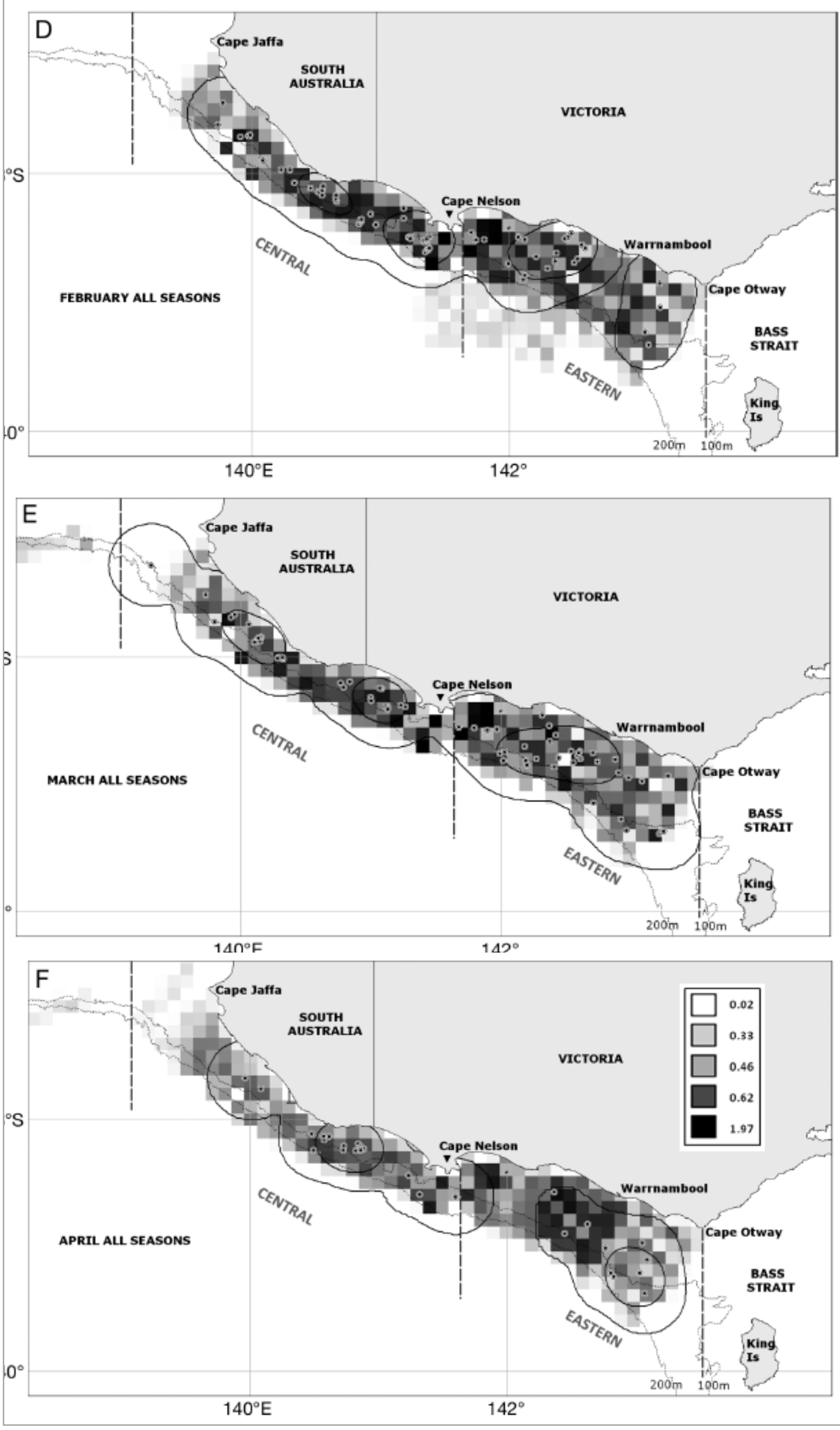


Figure 5-14: Blue whale sightings in the Otway Basin (Gill et al, 2011) (Con't)



February

March

April

Figure 5-15: Blue Whale Encounter Rate by Month for Central & Eastern Zones (Gill et al, 2011)

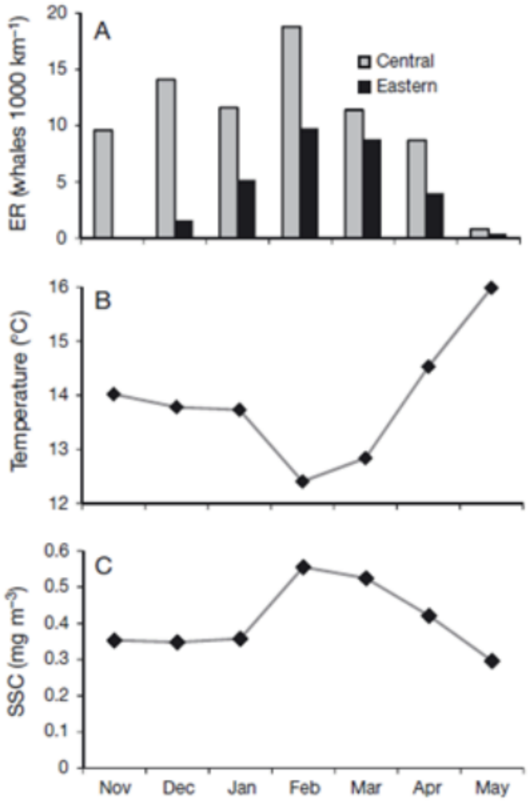
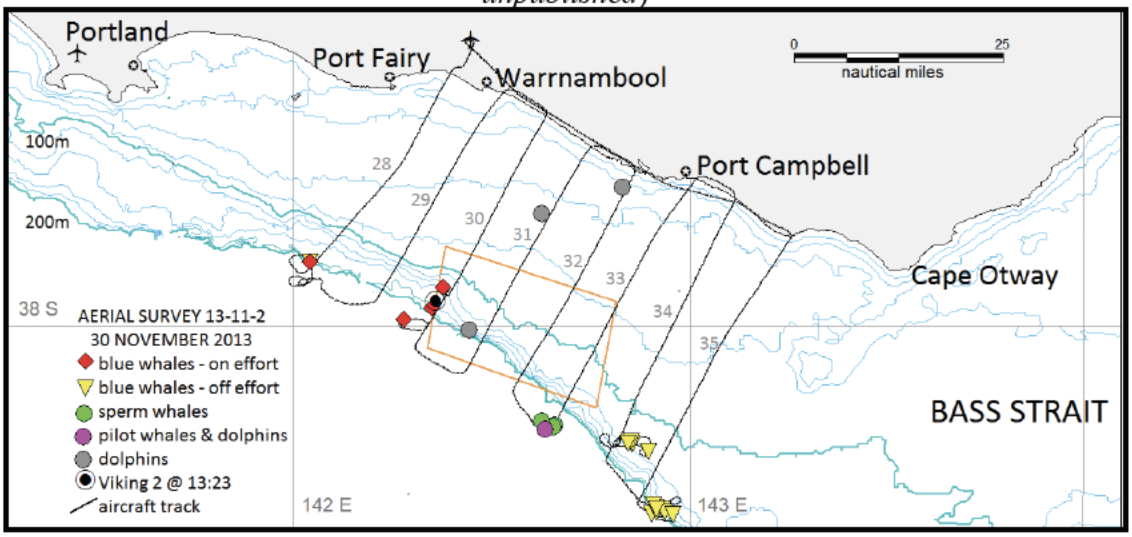


Figure 5-16: Aerial Survey – La Bella MSS (30th November 2013) (WHL Energy, 2013, *unpublished*)



Encounter Rates:
The Dorrigo MSS survey period (September 1 to October 31) is temporally positioned to avoid overlap with biologically important timeframes where the blue whale is present in the Otway Basin (i.e. Bonney upwelling period). Encounter is not expected based upon available sighting data and upwelling information.

Conservation Management Plan (Blue whale):

The Blue Whale Conservation Management Plan (DoE, 2015) identifies noise interference and vessel disturbance as threats which are relevant to the Dorrigo 3D MSS (refer **Table 5-7**). Noise interference is addressed in **Section 7.2** and vessel interference/collision is addressed in **Section 7.11**.

Table 5-7: Conservation management plan for the blue whale (DoE, 2015) – Threats relevant to activity

Relevant Threat	Action Objective	Action within EP
Noise Interference	Anthropogenic noise in BIAs will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area.	Position Dorrigo survey outside foraging timeframe observed for the blue whale in the bonney upwelling area.
	EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales is applied to all sesimic surveys.	Implement EPBC Policy Guideline 2.1 for survey activities.
Vessel Strikes	Ensure all vessel strike incidents are reported on the National Ship Strike database.	Report all vessel strike incidents on the National Ship Strike Database. Included in requirements in **Section 8.11.**
	Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented.	Implement requirements of the draft Stragey for mitigating vessel strikes of marine megafauna.

5.2.5.3 Southern right whale

The southern right whale *(Eubalaena australis)* (SRW) a migratory species listed as endangered, is seasonally present on Australia's southern coastline, distributed in the southern hemisphere between 20ºS and 60ºS with main feeding areas thought to occur between 40ºS and 55ºS (DoEE, 2018g). The species is pelagic in summer foraging in the open Southern Ocean (Bannister et al, 1996) between 32° and 65°S (DoEE, 2018g) and migrates from the subantarctic to southern Australian coastal waters to calve and mate (Mustoe & Ross, 2004). The species are regularly present on the Australian coast between early-April to early November with isolated individuals seen outside these periods (DoEE, 2018g).

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

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

Peak periods for mating for the species is from mid-July through August (DoEE, 2018g). Pregnant females generally arrive during late May/early June and depart with calves in September-October however the general time of arrivals and departures varies on an inter-annual basis. Calving females are known to have high site fidelity and a 3 to 4-year calving interval. Other population classes stay for shorter and variable periods undertaking coastal movements and departing the coast earlier than female-calf pairs (SEWPC, 2012).

In recent decades, sightings of SRWs have been recorded around the coastline of Tasmania with most sightings occurring on the east coast, particularly in the south east region. The areas of most frequent use are consistent with the locations of the whaling stations and reflect the areas of sheltered bays and shallow water where the whales used to congregate and breed in large numbers (AMMC, 2012). Within Tasmanian waters, the seasonal occurrence of SRWs show most whales are observed between June and August, although they have been reported in all months (AMMC, 2009). Reports of SRWs in Tasmania show an overall increase in recent years, not-withstanding significant inter annual variation and increasing observations of whale aggregations remaining in the area for increasing periods, increasing observations of feeding and highly active and social behaviours. Cow-calf pairs are recorded in low numbers in Tasmania in most years (AMMC, 2012).

Tasmanian sighting data (1899 – 2018) identifies the east coast of Tasmania as having a higher sighting occurrence than the west coast (928 of 1068 sighting records) and King Island (13 of 1068 sighting records) (AMMC, 2018). Tasmanian sightings comprised of up to 7 individuals per sighting predominantly in south-eastern Tasmania, with 1-2 individuals per sighting usual (AMMC, 2018). Of the sightings around King Island, 12 were observed in the more sheltered coastal areas along the east coast of King Island (AMMC, 2018). A total of 19 SRWs were observed within these 13 sightings (AMMC, 2018).

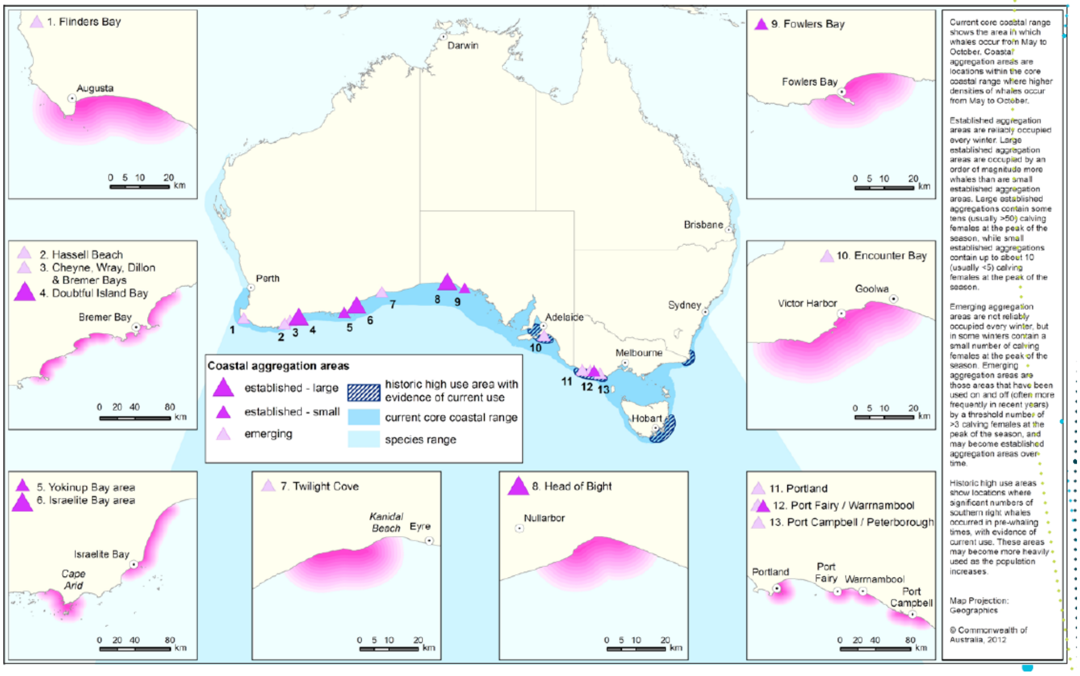
SRWs until recently have been thought to be one population, however it is possible two populations exist – the south-east SRW population (Ceduna to Sydney including Tasmania) which is demographically separate to the south-western SRW population (located between Cape Leeuwin, WA and Ceduna) (SEWPC, 2012). In terms of spatial recovery, the south-west population is recovering moderately well with three well established calving areas and evidence of a number of smaller and emerging calving areas being regularly but variably occupied. The south-east population is not showing the same spatial recovery with very low regular habitat occupancy, particularly when considered in relation to historic ecology (SEWPC, 2012). Photo-identification studies for the SE population (~300 individuals) shows there is little population movement within the region or between the SE and other regions (AMMC, 2009).

Calving Areas:
Key breeding areas within Australia are southern Western Australia (Doubtful Island Bay, Israelite Bay, Twilight Cove, Flinders Bay and Albany), South Australia (Head of Bight (HOB)) and Victoria (Warrnambool) (~125 km NNW of the Dorrigo MSS area) (SEWPC, 2012). Areas along the Victoria coastline such as Port Fairy and Portland also provide seasonal calving habitat (SEWPC, 2012). During calving, the whales are generally within 2 km of the shoreline with calving occurring in waters less than 10 m deep (DoEE, 2018g) (refer **Figure 5-17**). At Logan's Beach (Warrnambool), up to 6 cow/calf pairs (average 2.4) are resident per season (AMMC, 2009) and tend to be resident for most of the season, whereas at other south-east Victorian sites, they seem to be transiting through and are only seen for a short time (AMMC, 2009). The majority of first sightings in Western Victoria occur in May (54%) and June (42%). The majority of last sightings in western Victoria occurs in September (50%) and October (38%) but there may be an increasing trend towards October with the last sightings occurring in 7 out of the last 10 years (SWIFFT, 2018).

Foraging:

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

Figure 5-17: Coastal aggregation areas for southern right whales (SEWPC, 2012)



Migration:

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

Migration pathways between coastal Australian waters and offshore feeding grounds are not well defined (Gill et al. 2015; SEWPC, 2012). Exactly where whales approach and leave the coast from and to offshore areas is not well understood (SEWPC, 2012). A predominance of westward movements amongst long-rang photo-identification may indicate a seasonal westward movement in coastal habitat (SEWPC, 2012). More or less direct approaches and departures from the coast are also likely (SEWPC, 2012). SRWs are thought to be solitary during migration or accompanied by a dependent calf (SEWPC, 2012). Data obtained on the migratory movements of three adult females (accompanied by calves) implanted with satellite telemetry devices at the HOB during September 2014 by Mackay et al. (2015) identified two whales migrated directly south from the HOB, while one, after a period without data transmissions, moved west from Albany, WA, into the Naturaliste Plateau (refer **Figure 5-18**). All whales had begun migration away from the HOB by the 6th October 2014.

Based on head callosity 'matches,' individual whale movements have been recorded between the Antarctic and the West Australian/South Australian coast (15 animals), between 41-44°S and the West Australian/South Australian coast (2 animals), along the coast between HOB (SA) and West Australia (mainly westward movement - 18/30 animals) and between the Auckland Islands (New Zealand subantarctic) and Head of Bight (3 animals). Two discovery mark returns show summer movement eastwards *south* of the GAB and Tasmania (Tormosov et al., 1998; cited in AMMC, 2012). American whaling logbook data ('Townsend's Charts' - see Bannister, 2001; cited in AMMC, 2012) show a general movement south from the coast from September, with south-easterly movement offshore in summer. In the 1840s, whalers were reported as believing that right whales moved northwards from the south early in the season, approaching Tasmania from about April and continuing on past Victoria and into the Bight. SRWs were also thought to approach the whole coast from the south, striking southward as a body from Cape Leeuwin and working southeast, 2-300 miles from land in October/November. Such a generalised, almost circular, anti-clockwise pattern for right whales south of Australia was suggested by Burnell (2001; cited in AMMC, 2012) from intra-year (95% westerly) and inter-year (75% easterly) movements recorded mainly from HOB (AMMC, 2012).

Tagging studies on SRW at the Auckland Islands (NZ) during July and August 2009 also showed three whales travelled westwards to the south of Southern Australia between 38°-48°, although one whale visited to New Zealand mainland before heading west (Childerhouse et al, 2010). Tagging studies undertaken in South African waters in 2001, showed most coastwise movement on the south coast occurred in a westerly direction. Three whales tagged on the west coast and one tagged on the south coast moved north into St Helena Bay, a probable feeding ground. Five animals tracked after leaving the coast maintained a bearing of 201°–220° before branching out over the southeast Atlantic from 37° to 60° S and between 13° W and 16° E, traveling 3,800–8,200 km (Mate et al, 2011).

BIAs for the species are present at large and small established and emerging aggregation areas used for calving and nursing and coastal connecting habitat (coastal waters) (refer **Figure 5-19**). As identified in that figure, the NCVA (DoEE, 2018b) shows a seasonal aggregation area between Bridgewater Bay, Portland and Logan's Beach, Warrnambool for calving BIA for seasonal calving in shallow waters between May and November. It is also noted that less than 10% of the Australian SRW population is distributed east of Adelaide (DoEE, 2018b). BIAs are present to 3 km from shoreline in the coastal waters surrounding King Island (low use coastal connecting habitat BIA) and the Victorian coastline (migration and resting on migration habitat BIA) which is likely used by the southern right whale between May to November (DoEE, 2018b).

Figure 5-18: Movement of three southern right whales tracked from Head of Bight South Australia [Tag 120944 (Blue); Tag 120949 (Red) and Tag 120 945 (Green)] (Mackay et al. 2015)

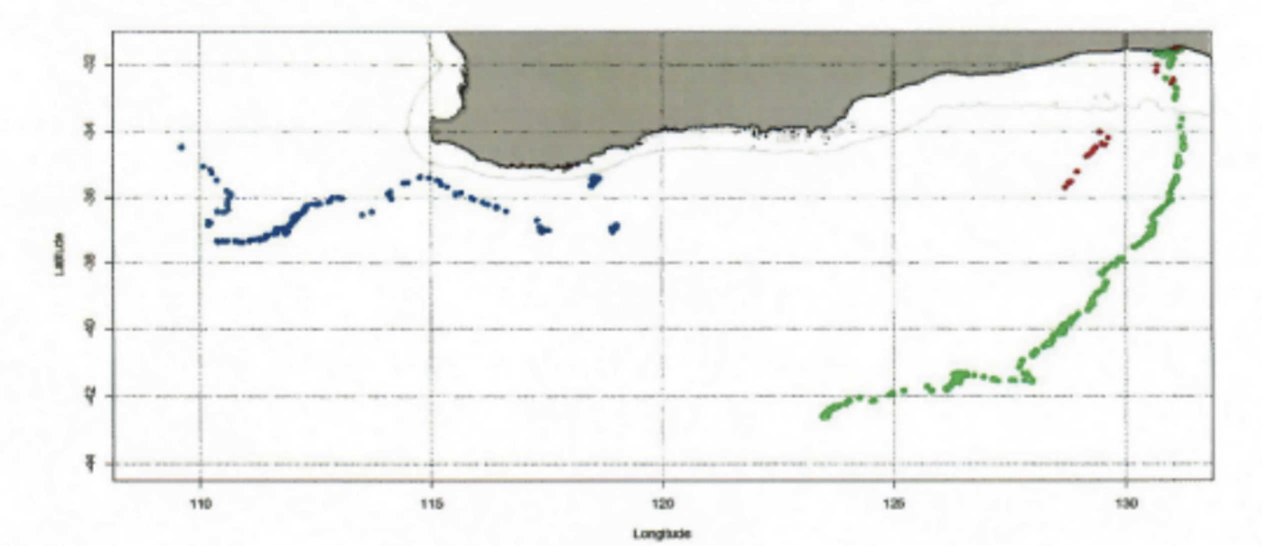
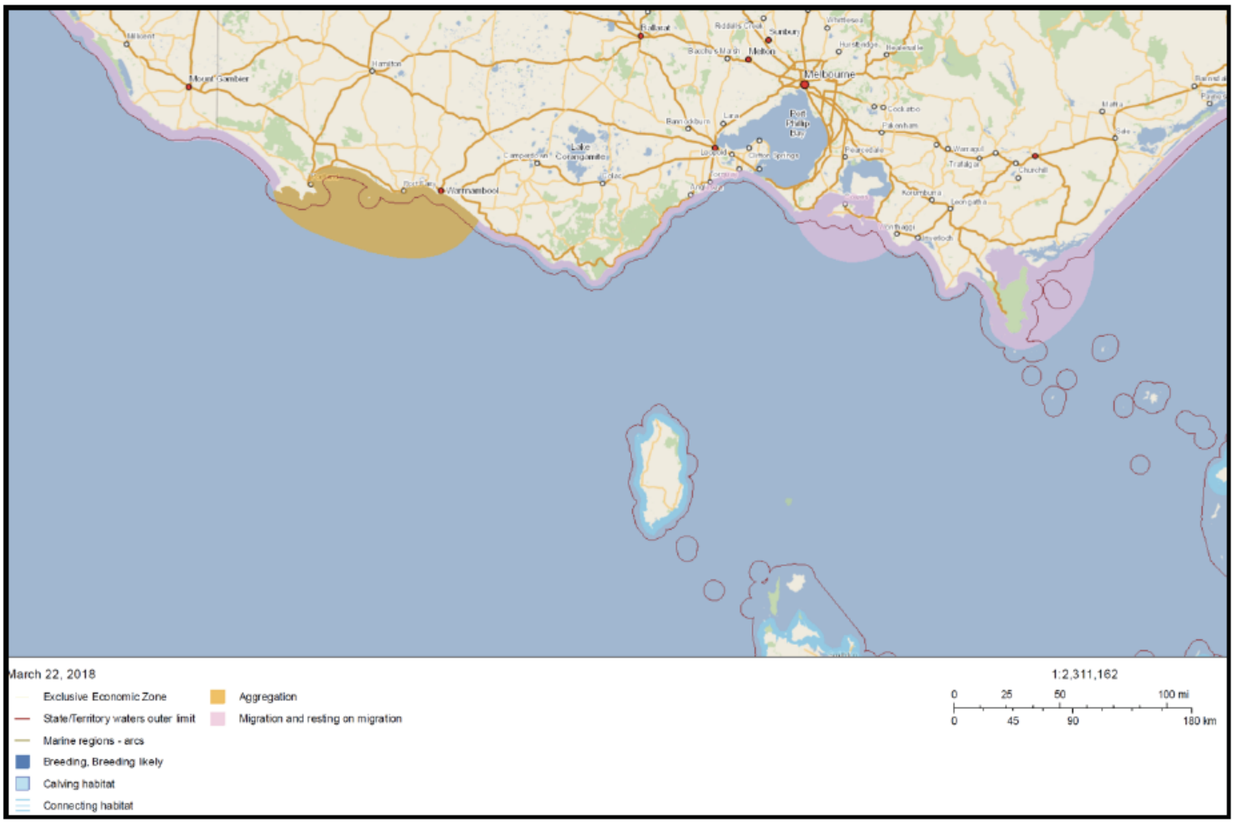


Figure 5-19: Southern right whale BIAs (Victoria and Northern Tasmania) (DoEE, 2018b)



The Dorrigo 3D MSS area does not spatially overlap SRW BIAs however lies adjacent or in proximity to BIA areas for coastal connecting habitat, seasonal aggregations and migration and resting on migration habitat (DoEE, 2018b). As this species is seasonally present in coastal waters between late April and early November, encounter is possible during the September-October timeframe as the species may transit through the Dorrigo MSS area or be present in coastal BIAs.

<u>Conservation Management Plan (Southern right whale):</u>
The Conservation Management Plan for the SRW (SEWPC, 2012) identifies noise interference and vessel disturbance as threats which are relevant to the Dorrigo survey (refer **Table 5-8**). Noise interference is addressed in **Section 7.2** and vessel interference/collision is addressed in **Section 7.11**.

Behavioural impacts to SRW while using biologically important areas (BIA's) is biologically relevant because these coastal habitats are necessary for essential life functions including calving and nursing, and migration through connecting this coastal habitat (SRW CMP pg28-29). The current level of scientific information available on SRW populations in the Bass Strait region show that known areas for migration, resting and aggregating occur along parts of the Australian mainland coastline (Figure 5-19). The BIA that occurs around King Island has been identified as such because it may be coastal connecting habitat (Figure 5-19A). The SRW CMP defines coastal connecting habitats as habitat "which may also serve a migratory function or encompass locations that will emerge as calving habitat as recovery progresses (some locations within connecting habitat are occupied intermittently but do not yet meet criteria for aggregation areas)" (CMP pg 29). In addition, the authors of this EP are unable to find data to support that this habitat is used for calving/resting. Nonetheless, the SRW CMP highlights seismic noise as a temporary interference that needs to be considered in disturbing the use of this BIA (CMP pg36). The actions to be implemented under the SRW CMP that are relevant to seismic activities and this EP are detailed in Table 5-8.

Figure 5-19A: Southern right whale BIAs (King Island) (DoEE, 2018b)

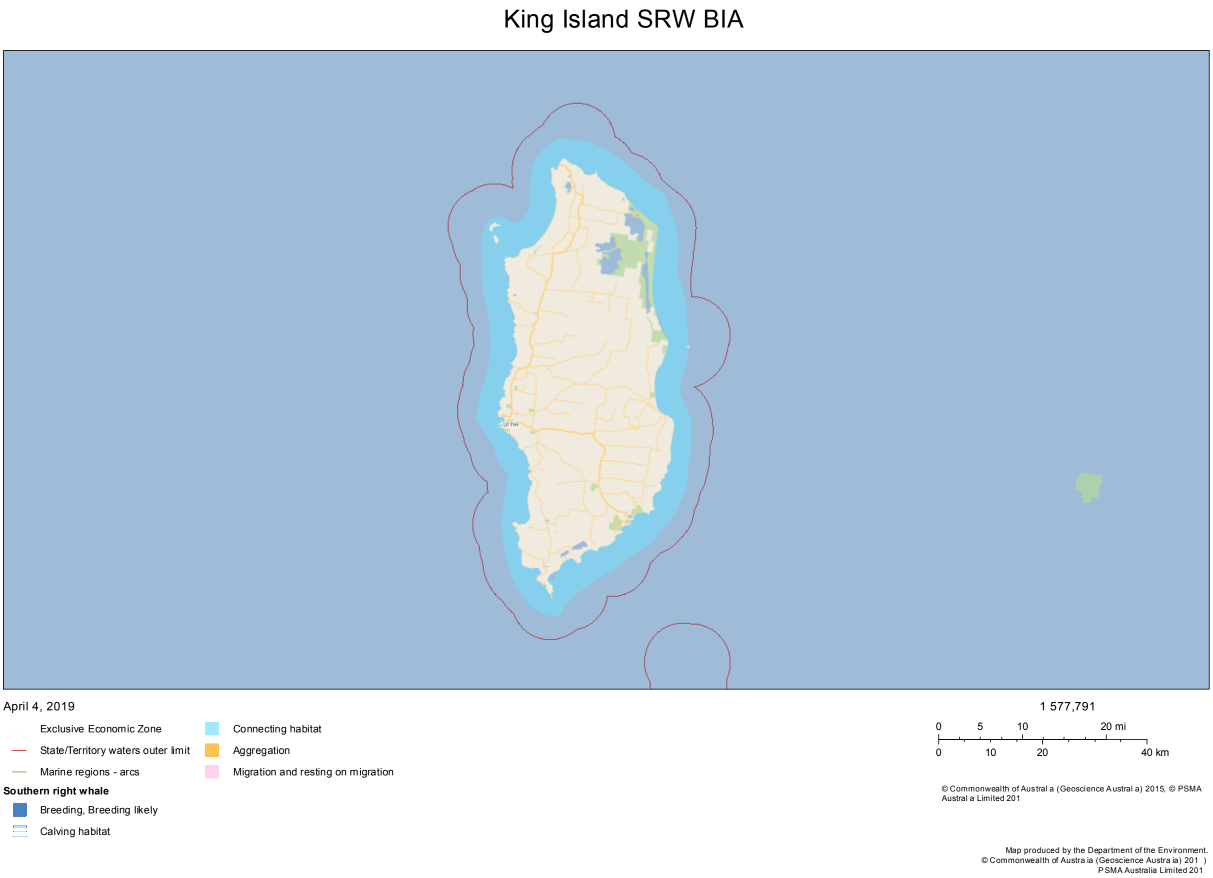


Table 5-8: Conservation management plan for the southern right whale (SEWPC, 2012) – Threats relevant to activity

Relevant Threat	Action Objective	Relevant Actions
Noise Interference	Management practices included in the Seismic Guidelines (EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales) focus on the prevention of temporary or permanent injuries to the hearing of large baleen whales. In respect to behavioural impacts, rather than specific management practices, the seismic guidelines advise that seismic surveys should be undertaken outside of biologically important areas at biologically important times, otherwise they may require further assessment under the EPBC Act.	EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales 2008 (Seismic Guidelines) provides: – practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations – a framework to minimise risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important habitat areas or during critical behaviours
Vessel Collisions	Develop a national ship strike strategy (that quantifies vessel movements within the distribution ranges of southern right whales and outlines appropriate mitigation measures that reduce impacts from vessel collisions.	Implement requirements of the Strategy for mitigating vessel strikes of marine megafauna.

5.2.5.4 Fin whale

The fin whale (*Balaenoptera physalus*), a migratory species listed as vulnerable, is a cosmopolitan species and occurs from polar to tropical waters but is rarely sighted in inshore waters. Fin whales show well defined migratory movements between polar, temperate and tropical waters which are essentially north–south with little longitudinal dispersion. Fin whales regularly enter polar water however unlike blue whales and minke whales, fin whales are rarely seen close to ice (DoEE, 2018h). It is likely that fin whales migrate between Australian waters and the following external waters: Antarctic feeding areas (the Southern Ocean); Subantarctic feeding areas (the Southern Subtropical Front); and tropical breeding areas (Indonesia, the northern Indian Ocean and south-west South Pacific Ocean waters) (DoEE, 2018h).

Breeding occurs between May-July and the location of breeding areas is unknown (DoEE, 2018h). While Australian Antarctic waters are important feeding grounds for fin whales, the species also feeds in the Bonney upwelling during summer/autumn sometimes in the company of blue and sei whales (DoEE, 2018h). Areas of upwelling and interfaces with mixed and stratified waters may be an important feature of fin whale feeding habitat (DEH, 2005b) with the species feeding on planktonic crustacea, krill, some fish and cephalopods (DoEE, 2018h). Fin whales frequently lunge or skim feed at or near the surface and they are known to dive to 230 m to feed (DoEE, 2018h).

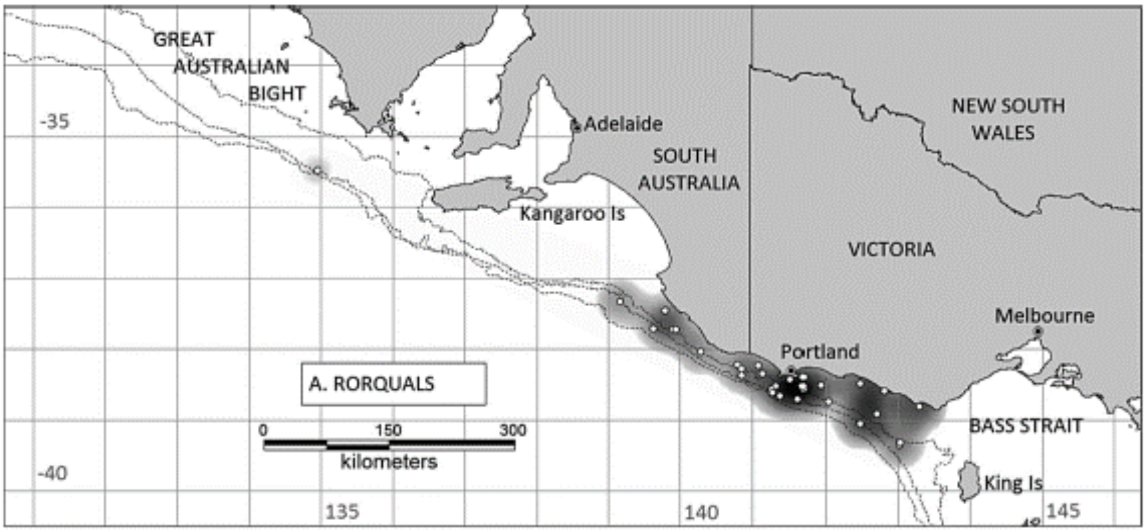
The NCVA does not identify any BIA for the fin whale within Australian waters (DoEE, 2018b).

Gill et al. (2015) reported 8 individual fin whales in 7 sightings between November and May for the survey period 2002 to 2013. The mean group size was 1.1 ± 0.4 individuals and the mean depth distribution in shelf waters of 162 ± 90 m. The species was observed to be feeding indicating the region is used at least opportunistically. **Figure 5-20** provides density kernels and point sightings for rorquals during this survey period. Recorded encounter data for the months in which the fin whale was observed is as follows (all months not listed the encounter was zero):

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

- October – 0 whales sighted/1000 km survey distance;
- November – 0.1 whales sighted/1000 km survey distance;
- December – 0.14 whales sighted/1000 km survey distance;
- January – 0.07 whales sighted/1000 km survey distance; and
- February – 0.08 whales sighted/1000 km survey distance.

Figure 5-20: Density kernels and point sightings (white dots) for rorqual cetacean group in southern Australia 2002-2013. Kernel shading indicates the relative probability of encountering a rorqual species at a given point (black is highest density). The 100m, 200m and 1000m isobaths (dashed lines) are provided to indicate shelf and slope depth (Gill et al. 2015)



It is unlikely, based on available sighting and upwelling data that this species will be encountered during the proposed Dorrigo survey activities (September 1 to October 31).

<u>Recovery Plan (Fin whale):</u>
There is no recovery plan in place for the fin whale (*Balaenoptera physalus*). The recovery plan (DEH, 2005b) ceased to be in effect from 1 October 2015.

<u>Conservation Advice (Fin Whale)</u>:
Information from the conservation advice for the Fin whale (TSSC, 2015d) identifies the following threats as relevant to the Dorrigo survey:

- Anthropogenic noise and acoustic disturbance;
- Vessel strike.

Conservation and management actions identified for these threats from the Conservation Advice are detailed in **Table 5-9**. Noise interference is discussed in **Section 7.2** and vessel disturbance/collision in **Section 7.11**.

Table 5-9: Conservation advice for the Fin Whale (TSSC, 2015b) – Threats relevant to activity

Relevant Threat/ Objectives	Conservation and Management Action	Action taken within EP
Assessing and addressing anthropogenic noise	Once the spatial and temporal distribution (including biologically important areas) of fin whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development) should be undertaken on this species. If required, additional management measures should be developed and implemented to ensure the ongoing recovery of fin whales.	Dorrigo survey has considered the presence of Fin Whales and selected a period where the species has not been observed. EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales will be applied.
Minimising Vessel Collisions	Develop a national vessel strike strategy that investigates the risk of vessel strikes on fin whales and also identifies potential mitigation measures. Ensure all vessel strike incidents are reported in the National Vessel Strike Database	Reporting requirement to be included within **Section 8-11** of this EP.

5.2.5.5 Sei whale

The sei whale (*Balaenoptera borealis*), a migratory species listed as vulnerable, is considered a cosmopolitan species, ranging from polar to tropical waters, but tends to be found more offshore than other species of large whales. They show well defined migratory movements between polar, temperate and tropical waters (Mackintosh 1965; cited in DoEE, 2018i) with migration movements essentially north-south with little longitudinal dispersion (DoEE, 2018i). Sei whales move between Australian waters and Antarctic feeding areas; Subantarctic feeding areas (e.g. Subtropical Front); and tropical and subtropical breeding areas (DoEE, 2018i).

The species feeds on planktonic crustacea, particularly copepods and amphipods. Below the Antarctic convergence sei whales feed exclusively upon krill (*Euphausia superba*) though, as a proportion of their diet, krill makes up a much smaller component of diet than the other rorquals. Sei whales feed by swimming horizontally near the surface skimming pelagic crustaceans and will feed on concentrations of food that are thought inadequate for other rorquals. Sei whales sink rather than dive and tend to be shallow swimmers with their heads seldom emerging and with no positive arching when diving (DoEE, 2018i).

There is no known mating or calving areas in Australian waters (DoEE, 2018i).

Sei whales have been sighted 20–60 km offshore on the continental shelf in the Bonney Upwelling opportunistically feeding (Gill et al. 2015). Gill et al. (2015) observed 14 individual whales in 12 sightings between November and May for all surveys undertaken between 2002 to 2013. The mean group size was 1.3 ± 0.5 individuals and the mean depth distribution in shelf waters was 160 ± 137 m. The species was observed to be feeding during the surveys indicating the region is used for foraging at least opportunistically. Recorded encounter data, for the months the sei whale was observed, is as follows:

- September – 0 whales sighted/1000 km survey distance;
- October – 0 whales sighted/1000 km survey distance;
- November – 0.25 whales sighted/1000 km survey distance
- December – 0.07 whales sighted/1000 km survey distance;
- January – 0.04 whales sighted/1000 km survey distance
- February – 0.84 whales sighted/1000 km survey distance;

- March – 0.19 whales sighted/1000 km survey distance;
- April – 0 whales sighted/1000 km survey distance; and
- May – 0.21 whales sighted/1000 km survey distance.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2018b).

It is unlikely, based on available sighting and upwelling data that this species will be encountered during the proposed Dorrigo survey activities (September 1 to October 31).

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

Conservation Advice (Sei whale):

Information from the conservation advice for the sei whale (TSSC, 2015c) identifies the following threats as relevant to the Dorrigo survey:

- Anthropogenic noise and acoustic disturbance;
- Vessel strike.

Conservation and management actions identified for these threats from the Conservation Advice are detailed in **Table 5-10**. Noise interference is discussed in **Section 7.2** and vessel disturbance/collision in **Section 7.11**.

Table 5-10: Conservation advice for the sei whale (TSSC, 2015e) – Threats relevant to activity

Relevant Threat/ Objectives	Conservation and Management Action	Action taken within EP
Assessing and addressing anthropogenic noise	Once the spatial and temporal distribution (including biologically important areas) of sei whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development) should be undertaken on this species. If required, additional management measures should be developed and implemented to ensure the ongoing recovery of fin whales.	Dorrigo survey has considered the presence of Fin Whales and selected a period where the species has not been observed. EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales will be applied.
Minimising Vessel Collisions	Develop a national vessel strike strategy that investigates the risk of vessel strikes on sei whales and also identifies potential mitigation measures. Ensure all vessel strike incidents are reported in the National Vessel Strike Database	Reporting requirement to be included within **Section 8-11** of this EP.

5.2.5.6 Other migratory whale species

Antarctic minke whale (baleen): The Antarctic minke whale (*Balaenoptera bonaerensis*) has been found in all Australian states except the Northern Territory (NT) and occupies offshore and pelagic habitats between 20ºS and 65°S (Bannister et al, 1996). In summer, the species is pelagic in waters from 55°S to the Antarctic ice edge. During winter, most species retreat to breeding grounds between 10-30ºS, occupying oceanic waters exceeding 600m depth and beyond the continental shelf break (DoEE, 2018j). Mating occurs from June through December, with a peak in August and September and calving peaks occur during late May and early June in warmer waters north of the Antarctic Convergence (DoEE, 2018j). The species primarily feeds in the Antarctic during summer on Antarctic krill and does not appear to feed much while in the lower latitudes (DoEE, 2018j).

Gill et al. (2015) reported one sighting of an Antarctic minke whale for surveys undertaken in the period 2002 to 2013. The depth of the species in shelf waters was 93 ± 79 m.

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2018b).

As the Dorrigo MSS period is September 1 to October 31, given the observed species encounter rate, it is unlikely this species will be encountered transiting through the MSS area during survey activities.

Pygmy right whale (Baleen): The pygmy right whale *(Caperea marginata)* is found in temperate and subantarctic waters in oceanic, pelagic and inshore location habitats between 32º and 47ºS preferring water temperatures between 5ºC and 20ºC. The species distribution is found close to coastal upwellings and further offshore it appears that the Subtropical Convergence (between 39ºS and 49ºS (DoEE, 2018k)) may be an important area for regulating the species distribution (Bannister et al, 1996). There is no evidence of large-scale migratory movements of pygmy right whales, with coastal strandings recorded throughout the year along the Australian coastline (DoEE, 2018k). Key localities for the species include Bass Strait, south-eastern Tasmania, Kangaroo Island, southern Eyre Peninsula and possibly south-western Western Australia (Bannister et al, 1996). Little is known about calving seasons and location or species movement in Australian waters (DoEE, 2018k).

The species do not appear to be deep divers as recorded dive times are short implying that they primarily inhabit the pelagic zone of oceanic waters (DoEE, 2018k). The species have primarily been recorded in areas associated with upwellings and with high zooplankton abundance, particularly copepods and small euphausiids which constitute their main prey (DoEE, 2018k).

Gill et al. (2015) reported a single pod of pygmy right whales with 100 individuals for surveys undertaken during the period 2002 to 2013. This single observation occurred during June leaving June with a calculated encounter rate of 19.8 whales sighted per 1000 km of survey distance.

The NCVA does not identify any BIAs for this species within Australian waters (DoEE, 2018b).

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

Killer whale (odontocete): The killer whale *(Orcinus Orca),* a migratory species, has a distribution from polar to equatorial regions; has been recorded in all states except the Northern Territory and is frequently sighted in South Australia, Tasmania and Victoria.

The species is oceanic, pelagic and coastal in both warm and cold waters. While thought to be more common in cold, deep waters, killer whales are often seen along the continental shelf particularly near seal colonies (DoEE, 2018l). Although groups of up to several hundred individuals have been observed, group size is usually less than 30, and several studies outside Australian waters have reported mean pod sizes of less than 10 (DoEE, 2018l). The specific diet of Australian killer whales is not known but are top-level carnivores with reports of attacks on dolphins, young humpback whales, blue whales, sperm whales, dugongs, Australian sea lions and white sharks (Bannister et al, 1996; Bruce & Bradford, 2011). Literature indicates that this species moves seasonally to areas of food supply (Bannister et al, 1996). No key localities (calving, etc.) are known for killer whales within continental Australian waters, however, the Australian sub-Antarctic territory, Macquarie Island, may be a key locality (Bannister et al, 1996).

Gill et al. (2015) reported for aerial survey events (2002 to 2013) six pods of the species (21 individuals). The mean group size was 3.5 ± 2.8 individuals which were located predominantly on the shelf close to the shelf break at a mean water depth of 171 ± 135 m. Recorded encounter data for the species is as follows (months not listed had a zero-encounter rate):

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

The NCVA does not identify any BIA for this species within Australian waters (DoEE, 2018b).

Killer whales may transit through the proposed Dorrigo MSS area to seasonal food supplies, however the survey area is not considered to contain habitat critical to the survival of the species (i.e. feeding, breeding or aggregation areas). The likelihood of encounter is considered low.

Sperm whale (Odontocete): The sperm whale (*Physeter macrocephalus*), a migratory mid-frequency cetacean, has a worldwide distribution; has been recorded in all Australian states; and is a pelagic species usually found in the deep water off the continental shelf. Sperm whales inhabit offshore areas with a water depth of 600 m or more and are uncommon in waters less than 300 m deep (DoEE, 2018m). The species is usually present in waters where sea surface temperatures are greater than 15°C (DoEE, 2018m).

Key locations for the species include the area between Cape Leeuwin to Esperance (WA); south-west of Kangaroo Island (SA); deep waters of the Tasmanian west and south coasts; areas off southern NSW (e.g. Wollongong) and Stradbroke Island (Qld) (DoEE, 2018m). Concentrations of sperm whales are generally found where seabeds rise steeply from a great depth (i.e. submarine canyons at the edge of the continental shelf) associated with concentrations of food such as cephalopods (DoEE, 2018m). This species also feeds on medium and large size demersal fish including rays, sharks and teleost fish.

Females and young males are restricted to warmer waters (i.e. north of 45°S) and are likely to be resident in tropical and sub-tropical waters year-round. Adult males are found in colder waters and to the edge of the Antarctic pack ice. In southern WA waters (Albany) sperm whales move westward during the year. For species in oceanic waters, there is a more generalised movement south in summer and north in winter (DoEE, 2018m).

Gill et al. (2015) reported for aerial surveys (2002 to 2013) 34 pods of the species (66 individuals) were identified. The mean group size was 1.9 ± 2.2 individuals located predominantly on the lower continental slope at a mean depth of 1,221 ± 628 m. Sperm whale observations did not observe calves which may indicate that the area is not important breeding of rearing young. Of the sightings made, 68% were solitary males, and the remainder were groups of 2-12 similarly sized animals, possibly bachelor schools.

Recorded encounter data[16] is as follows (all months not listed had a zero-encounter rate):

- October – 1.7 whales sighted/1000 km survey distance;
- November – 1.2 whales sighted/1000 km survey distance;
- December – 0.23 whales sighted/1000 km survey distance;
- January – 0.53 whales sighted/1000 km survey distance;
- February – 0.08 whales sighted/1000 km survey distance;
- March – 0.13 whales sighted/1000 km survey distance;
- April – 0.75 whales sighted/1000 km survey distance;
- May – 0.85 whales sighted/1000 km survey distance.

Sperm whales are prolonged and deep divers often diving for over 60 minutes (Bannister et al, 1996) however studies have observed 'sperm whales do rest at, or just below, surface for extended periods (>1hr) (Gannier et al, 2002). In addition, female and juvenile sperm whales in temperate waters have been observed to spend several hours a day at surface resting or socialising (Hastie et al, 2003).

The NCVA does not identify any BIAs for this species within the Dorrigo MSS waters (DoEE, 2018b).

As the water depths within the Dorrigo MSS vessel operating area lie between 80-1420 m, it is possible sperm whales may be encountered in the deeper areas of the survey area.

Dusky dolphin: The dusky dolphin (*Lagenorhynchus obscurus*) a migratory species in the southern hemisphere between latitudes 26-55^{o}S is found across southern Australia from Western Australia to Tasmania (DoEE, 2018n). The species inhabits temperate and subantarctic zones primarily in inshore locations but is pelagic at times. The species is anticipated to be resident inshore for much of the year and seeks out colder water (<18^{o}C) as inshore temperatures rise in summer (Bannister et al. 1996). The species undertakes seasonal movements in Australia which may be linked to the position of the subtropical convergence and with El Niño Southern Oscillation (ENSO) events, which expands the extent of cold waters (DoEE, 2018n).
Calves are born mainly in summer although no calving areas have been identified in Australian waters (DoEE, 2018n). Dusky dolphins eat a diversity of prey, including schooling fish (especially anchovy) and mid-water/benthic prey such as squid and lantern fish. This species is a surface feeder but have been known to dive to depths of 150 m off New Zealand (DoEE, 2018n).

Gill et al. (2015) did not explicitly identify the dusky dolphin during the aerial surveys of 2002-2013 however 384 sightings of unidentified dolphins were recorded. Dolphin species were sighted most consistently over the years and were observed to be widely distributed in shelf waters with a

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

greater probability of occurrence inshore along the shelf (mean depth 134 ± 197 m). **Figure 5-21** provides density kernels and point sightings for all dolphin species observed during the surveys and **Figure 5-22** provides the depth range for dolphin species observed. Dolphins were often observed feeding, either on baitfish schools or in krill surface swarms.

Figure 5-21: Density kernels and point sightings (white dots) for dolphins in southern Australia 2002-2013. Kernel shading indicates the relative probability of encountering a dolphin species at a given point (black is highest density). The 100m, 200m and 1000m isobaths (dashed lines) are provided to indicate shelf and slope depth (Gill et al. 2015)

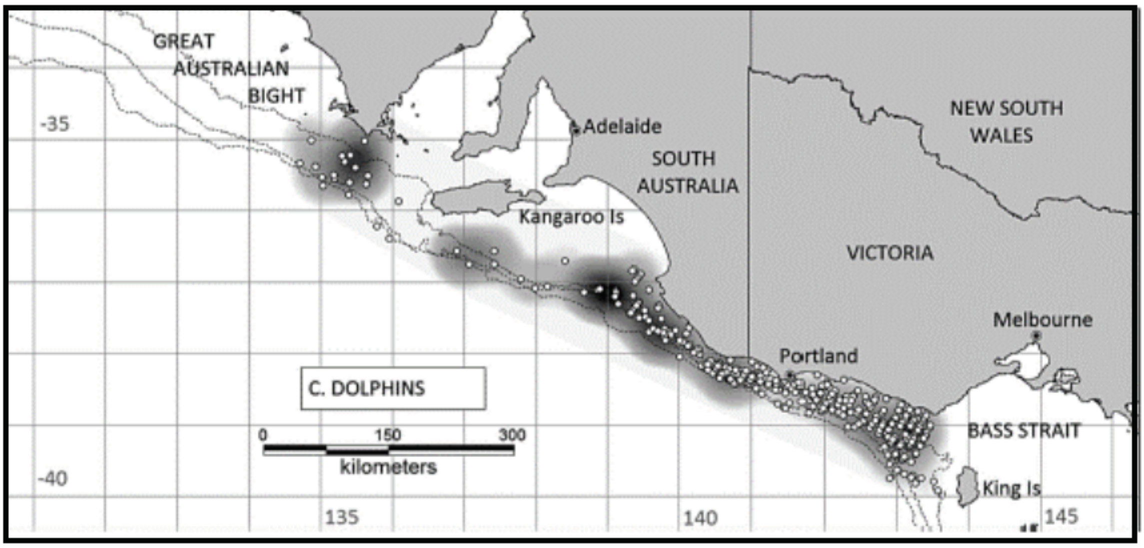
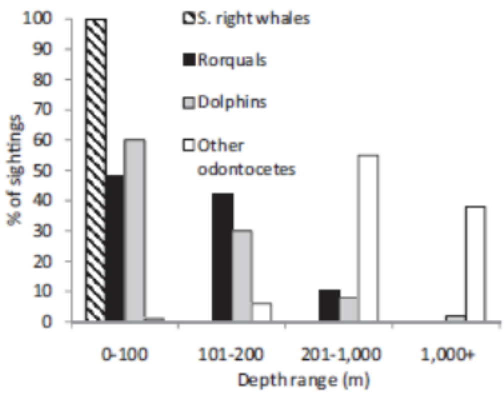


Figure 5-22: Depth range by cetacean species group in southern Australia (2002-2013) (Gill et al. 2015)



The NCVA does not identify any BIA for this species in Australian waters (DoEE, 2018b). Given the species wide distribution within Australian waters and their year-round presence, it is possible the species may be encountered during the survey period, particularly over shelf areas.

5.2.5.7 Other listed whale and dolphin species

Other whale and dolphin species listed within the EPBC Act PMST which may be present in the Dorrigo MSS area is provided in **Table 5-11**.

Table 5-11: Other EPBC Act listed cetacean species

Species	Details
Minke whale	The species is oceanic but not restricted to deep water with extensive migrations between cold water feeding and warm water breeding grounds, however the location of breeding grounds are unknown. Calving is thought to occur between May and July. The species is relatively common in Australia (Bannister et al, 1996). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *This species may be present in the Dorrigo MSS area during the survey period.*
Short-finned pilot whale	Species is circum-global between 45ºN and 41ºS in tropical and temperate waters. Distribution is Australian region includes oceanic waters (edge of continental shelf and over deep submarine canyons) and continental seas with possible offshore-inshore movement due to abundance in spawning prey (squid, cuttlefish, octopus and some fish) (Bannister et al, 1996). It has been hypothesised that the species undertaken deep dives (~600-800m for a maximum of 27 minutes) at dusk and dawn following prey migration and near-surface (~100m) foraging at night. Species is considered to have high abundance in Australian waters (DoEE, 2018o). Calving season is diffuse peaking in July and August however there are no known calving localities in Australia. No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *It is possible, that this species may be encountered in the deeper areas of the Dorrigo MSS area during the survey activities.*
Long-finned pilot whale	Species is distributed throughout the northern and southern hemisphere in circumpolar oceanic temperate and subantarctic waters in zones of higher productivity along the continental slope sometimes venturing into shallower waters on the shelf (<200m) in pursuit of prey species (squid and fish). No key localities in Australia have been identified (Bannister et al, 1996) however they are considered reasonably abundant (DoEE, 2018p). There is some (in-conclusive) evidence that suggests the species moves along the edge of the continental shelf in southern Australian waters (Bannister et al, 1996) in response to prey abundance at bathymetric upper slopes and canyons (DoEE, 2018p). Records from Tasmania indicate mating occurs in spring and summer with 85% of calves born between September and March although births do occur throughout the year. No calving areas are known in Australian waters (DoEE, 2018p). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *It is possible this species may be encountered in the deeper areas of the Dorrigo MSS area during the survey activities.*
Pygmy sperm whale	The species is cosmopolitan and oceanic (except for polar or sub-polar seas) and is not known to migrate or exhibit strong regional movements (Bannister et al, 1996). The species is recorded in all Australian states except the NT and no key localities have been identified in Australia (Bannister et al, 1996). Diet consists of squid, benthic fish and crabs and does not appear to approach inshore areas as does the dwarf sperm whale (refer below). Calving season is reported as spring with no known calving areas identified in Australia with expected calving locations in temperate and tropical seas (Bannister et al, 1996). The species communicates at frequencies between 60 and 200kHz (Simmonds et al, 2004). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *The species may be present in the deeper areas of the Dorrigo MSS area during the survey period.*
Dwarf sperm whale	This species' habitat is similar to the pygmy sperm whale however it is known to approach the coast more often than the pygmy sperm whale species (Bannister et al, 1996). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *This species may be present in the Dorrigo MSS area during the survey period*

Species	Details
False Killer whale	Species is circum-global from equator to 45ºN and 45ºS and widely recorded in all Australian states from stranding data (Bannister et al, 1996). No population estimates available for Australian waters however the species occurs in low abundance (DoEE, 2018q). The species prefers deep, offshore waters and sometimes deep coastal waters. They approach land only where the continental shelf is narrow, possibly attracted to enhanced prey abundance (fish and cephalopods) along the continental slope (Bannister et al, 1996). The movement pattern of false killer whales, inferred from stranding data, is that a seasonal movement inshore or along the continental shelf of the southern and southeast coast occurs between May and September. They appear to be opportunistic feeders (DoEE, 2018q). No calving areas are known in Australian waters and mating/calving occurs throughout the year with no seasonal pattern (Bannister et al, 1996). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *As the species has a low abundance in Australian waters, and given the timeframe of the Dorrigo MSS, encounter is considered unlikely.*
Beaked whales: • Arnoux's • Andrew's • Blainville's • Gray's • Hector's • Strap-toothed • True's • Cuvier's	These species have not been well studied and most are considered rare in Australian waters. All beaked whale species identified by the database are known to be deep oceanic species occurring around close to undersea features such as submarine escarpments and sea mounts which are areas of increased productivity and hence food supply (primarily cephalopods and fish for these species). Beaked whales are recorded in continental slope to the abyssal plain habitats along much of Australia's coastline. In the eastern tropical Pacific beaked whales are generally sighted, on average, 1000km offshore with a range of 40-3750km (DoEE, 2018r; DoEE, 2018s; DoEE, 2018t; DoEE, 2018u; DoEE, 2018v; DoEE, 2018w; DoEE, 2018x, DoEE, 2018y). No BIA for these species is present within the Dorrigo MSS area (DoEE, 2018b). *As the species has a low abundance in Australian waters encounter is considered unlikely during the Dorrigo MSS.*
Risso's Dolphin	Species is recorded in all Australia states except Tasmania and NT with expected depth ranges between 180 to 1500m between 60ºN and 60ºS (DoEE, 2018z). Species has been sighted inshore and offshore; and is generally considered pelagic and oceanic occurring mainly on the steep sections of the upper continental slope usually in water depths deeper than 1000m. The species is abundant in tropical and temperate latitudes throughout the world's oceans (water temperatures ~15-30ºC) and not considered rare. They sometimes extend their range to cooler latitude in summer (DoEE 2018z). No calving areas are known in Australia and the calving and mating season is unknown (DoEE, 2018z). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *This species may be encountered during the Dorrigo MSS.*
Common Dolphin	Species is found in offshore waters (shallow and deep) on the continental shelf, have been recorded in all Australian states and territories but rarely seen in northern waters (prefers water temperatures 10-20ºC). The species have been observed over specific oceanic features such as seamounts, ridges and escarpments and in habitats which contain small epipelagic fish such as anchovies and sardines (DoEE, 2018aa). Two main locations in Australia include one cluster in the southern SE Indian Ocean and the other in the Tasman Sea. Diet consists of epipelagic/mesopelagic fish, squid, cephalopods and crustaceans. Reproduction data, based on international data, indicates that calving occurs year-round with peaks in spring and autumn. No specific calving areas are known in Australia (DoEE, 2018aa). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *This species may be encountered during the Dorrigo MSS.*

Species	Details
Southern right whale dolphin	Species is pelagic found in southern Australian waters generally in deep water or on the outer edges of the continental shelf between the subtropical and subantarctic convergence (DoEE, 2018ab). No key localities have been identified in Australian waters but preferred water temperatures range from approximately 2-20°C (DoEE, 2018ab). Calving areas are not known, however there is evidence that the calving season occurs between November to April (DoEE, 2018ab). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *This species may be encountered during the Dorrigo MSS.*
Bottlenose dolphin	Species has been recorded in Queensland, NSW, Tasmania, SA and SW Western Australia usually in latitudes lower than 45°. They inhabit inshore areas (bays, lagoons, estuaries,), near-shore (open coast) and offshore environments. There appears to be two main locations for the species in Australia – South Pacific Ocean and Southern Indian Ocean (DoEE, 2018ac). Inshore species feed on fish and invertebrates while offshore species feed on mesopelagic fish and oceanic squid (DoEE, 2018ac). Calving season is diffuse, expected to be in summer, but with no known calving areas in Australia (Bannister et al, 1996). No BIA for this species is present within the Dorrigo MSS area (DoEE, 2018b). *This species may be encountered during the Dorrigo MSS.*

5.4.6 Pinnipeds

The EPBC Act PMST (DOEE, 2018a) lists two pinniped species as having habitat within the Dorrigo MSS area. – The Australian fur seal (*Arctocephalus pusillius*) and the New Zealand fur seal (*Arctocephalus forsteri*). **Table 5-5** provides details of these species listed under the EPBC Act within the Dorrigo MSS area and EMBA.

5.4.6.1 Australian fur seal

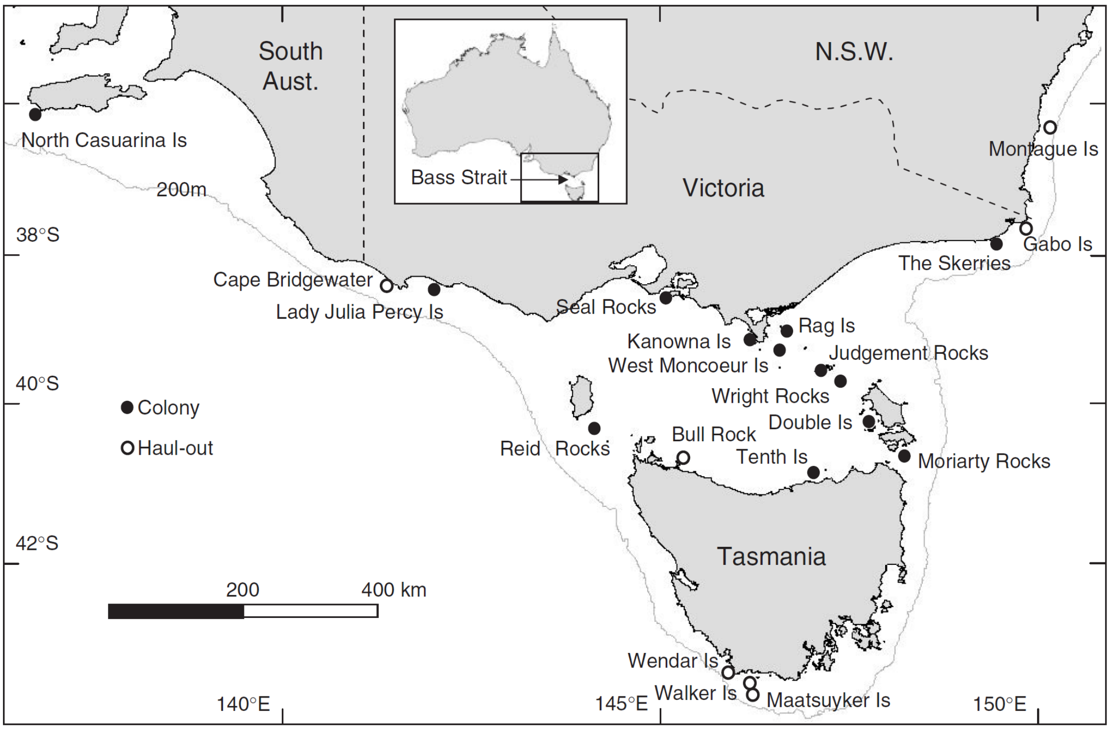
The Australian fur seal (*Arctocephalus pusillius*), an EPBC-listed species (IUCN – least concern), breeds on islands in Bass Strait (four colonies in Victoria and five colonies in Tasmania) with a range that extends from South Australia, to Tasmania and New South Wales (Shaughnessy, 1999). The largest breeding sites are Lady Julia Percy Island (located 145 km NW), Seal Rocks (located 160km NE) in Victoria and at Reid Rocks (located 44 km east) in Tasmania (Shaughnessy, 1999). **Figure 5-23** provides details of Australian fur seal breeding colonies (filled circles) and haul–out sites (empty circles) in 2007 (Kirkwood et al, 2010). Cape Bridgewater (190 km to the NW) is also a regular haul-out and occasional pupping site for the species (Kirkwood et al., 2009).

Colonies are occupied year-round, but activity is greatest during the summer breeding season (late October to late December) (Shaughnessy, 1999). Pups begin to forage in June/July and are generally weaned by September/October (Shaughnessy, 1999). The diet of Australian fur seals is principally fish – red-bait, leatherjackets and jack mackerel (in winter) and cephalopods (in summer) (Shaughnessy, 1999; Littnan et al, 2007). The Australian fur seal can dive to depths of 200m (Australian Museum, 2018) and forages over a wide area in oceanic waters of the continental shelf. The primary squid species taken in Tasmanian waters is Gould's Squid (*Nototodarus gouldi*) (Gales et al. 1993; cited in Shaughnessy, 1999). Dietary analysis of winter foraging has shown that of 25—38 species of fish identified, only a few were specific to any location or found only in a season (Gales & Pemberton 1994; Littnan et al. 2007; cited in Shaughnessy, 1999).

Lactating female Australian fur-seals in the northern Bass Strait have been found to forage exclusively within the shallow waters over the continental shelf of the Bass Strait. The water in this area has a depth of 60–80 m and a sea surface temperature of 16.0–16.8 ºC (Arnould & Kirkwood 2008; cited in DoEE, 2018ad). Due to the mobility and foraging requirements of Australian fur-seals, the species may be encountered up to 500 km from a colony with foraging appearing to peak in autumn and winter (Lyle & Willcox 2008; cited in DoEE, 2018ad), when both males and females are building up their energy reserves for the pupping season and females are maintaining milk reserves for their young which they continue to suckle (DoEE, 2018ad).

The NCVA does not identify any BIAs for this species within Australian waters (DoEE, 2018b). It is expected that the Australian fur seal may be encountered foraging in the marine environment during the Dorrigo MSS.

Figure 5-23: Australian fur seal colonies and haul out sites (Kirkwood et al, 2010)



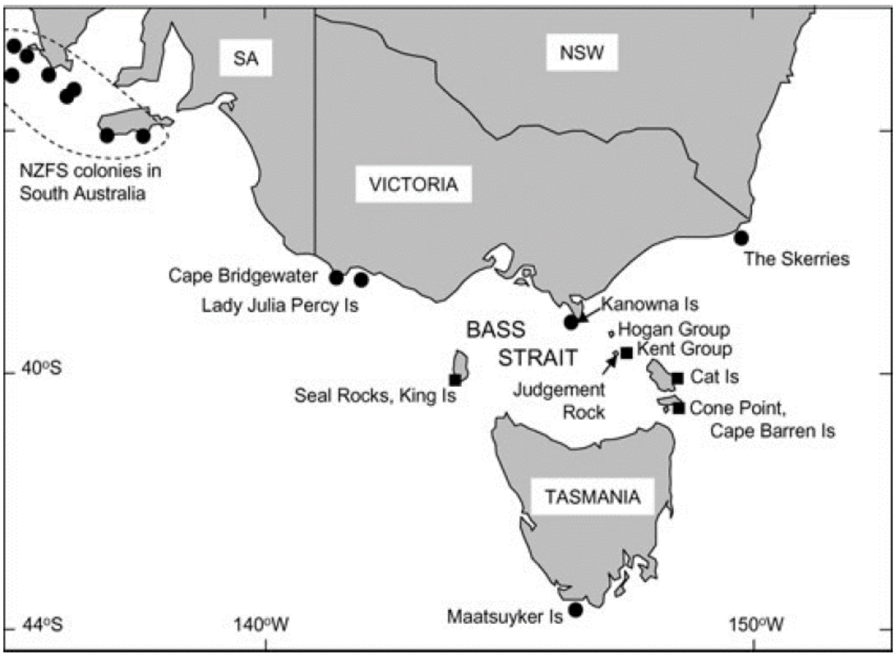
5.4.6.2 New Zealand fur seal

The New Zealand fur seal (*Arctocephalus forsteri*), an EPBC-listed species (IUCN – Least Concern), breeds in New Zealand; on the south coasts of Western Australia (16 sites), South Australia (13 sites); and at Maatsuyker Island (Tasmania), however pups have also been reported on Flinders and Macquarie Islands (Shaughnessy, 1999). Colonies are occupied all year round however pupping season for the species is November to January with peaks in December (Shaughnessy, 1999). During the non-breeding season, February to October, the breeding sites are occupied by pups and young juveniles, whilst adult females alternate between periods at the breeding sites and foraging at sea (SMM, 2012).

Large breeding populations which account for more than 80% of the national pup production for the species area found at North and South Neptune Islands (SA); Kangaroo island (SA) and Liguanea Island (SA) (SEWPC -2012b). Current breeding locations for the NZ Fur Seal have been identified in Victoria at Cape Bridgewater (located 190 km NW); Lady Julia Percy Island (located 145 km NW); Kanowna Island (located 235 km east) and the Skerries (East Gippsland VIC); and in Tasmania at Maatsuyker Island (Kirkwood et al, 2009) (refer **Figure 5-24**). Former New Zealand fur seal sites include Cape Barren Island, Cat Island located in the Furneaux Group, the Kent Group and Seal Rocks (King Island) (shown as squares in **Figure 5-24**). The species prefers the rocky parts of islands with jumbled terrain and boulders and prefers smoother igneous rocks to rough limestone (Shaughnessy et al. 1999). The species forages principally on fish (winter) and cephalopods (summer) (Shaughnessy, 1999). Female fur-seals dive usually to 80m during early lactation and later in their lactation they will dive to depths of 20-200m at distances 80-100km from shore. It is highly likely that the males can dive to over 200m (SMM, 2012).

The NCVA does not identify any BIAs for this species within Australian waters (DoEE, 2018b). Encounter with the New Zealand fur seal is possible during the Dorrigo MSS.

Figure 5-24: New Zealand fur seal colonies in Bass Strait (Kirkwood et al, 2009)



5.4.7 Reptile Species

The EPBC Act PMST (DOEE, 2018a) identified three species of marine reptile possibly occurring in, or in proximity to, the MSS area; the green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*) and leatherback turtle (*Dermochelys coriacea*). Details of these species are provided in **Table 5-12** and discussed further in this section.

Table 5-12: EPBC-Listed reptile species within the MSS area (DoEE, 2018a)

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

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

Definitions: Refer **Table 5-1**
References:
[1] Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017)

5.4.7.1 Green turtle

The green turtle nests, forages and migrates across tropical northern Australia usually between the 20°C isotherms although individuals may stray into temperate waters (DoEE, 2018ae). Green turtles are herbivores, feeding on shallow benthic habitats containing seagrass and/or algae including coral and rocky reefs, and inshore seagrass beds (DoEE, 2018ae). Major nesting areas are found tropical regions of WA, Northern Territory and Queensland (DoEE, 2018ae). The green turtle is considered a rare vagrant in Victorian waters, with these waters considered outside their usual range (EA, 2003).

The NCVA does not identify any BIAs for this species within, or adjacent to, the survey area (DoEE, 2018b). Given the species preferred geographical distribution, encounter with the species is considered remote.

5.4.7.2 Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) has a global distribution throughout tropical, sub-tropical and temperate waters. In Australia, the loggerhead turtle occurs in waters with coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia (DoEE, 2018af). Nesting is mainly concentrated on sub-tropical open, sandy beaches in southern Queensland from Shark Bay to the North West Cape in Western Australia. During nesting periods, females generally remain within 10 km of the rookery (DoEE, 2018af), however foraging areas are more widely distributed (DoEE, 2018af). Loggerhead Turtles choose a wide variety of tidal and sub-tidal habitat as feeding areas and are carnivorous, feeding primarily on benthic invertebrates in habitat ranging from near-shore to 55m (DoEE, 2018af). The loggerhead turtle is considered a rare vagrant in Victorian waters which are considered outside their normal range (EA, 2003).

The NCVA does not identify any BIAs for this species within, or adjacent to, the survey area (DoEE, 2018b). Given the species preferred geographical distribution, encounter with the species is considered remote.

5.4.7.3 Leatherback turtle

The Leatherback Turtle (*Dermochelys coriacea)* is a pelagic feeder, found in tropical, subtropical and temperate waters. It's large body size, high metabolism, a thick adipose tissue layer and regulation of blood flow allows the species to utilise cold water foraging areas unlike other sea turtle species. For this reason, this species is regularly found in the high latitudes of all oceans including waters offshore from NSW, Victoria, Tasmania and Western Australia (DoEE, 2018ag).

Adult turtles are found in both pelagic and coastal waters foraging throughout the water column from the surface to depths of more than 1200m (DoEE, 2018ag). The species has been recorded feeding in all Australian states, and, while no major nesting areas have been recorded in Australia, scattered isolated nesting occurs in southern Queensland and the Northern Territory (DoEE, 2018ag). The Leatherback Turtle is a regular, though rare visitor to Bass Strait. It is mostly a pelagic species, and away from its feeding grounds, is rarely found inshore (EA, 2003). Adult turtles feed mainly on pelagic soft-bodied creatures (e.g. jellyfish) which occur in greatest concentrations at the surface in areas of upwelling or convergence over continental shelf waters (DoEE, 2018ag).

The NCVA does not identify any BIAs for this species within, or adjacent to, the survey area (DoEE, 2018b). Given the species preferred geographical distribution, encounter with the species is possible.

Recovery Plan (Marine Turtles):

The Recovery Plan for Marine Turtle in Australia (DoEE, 2017) identifies marine debris, chemical/terrestrial discharges/spills, light pollution, vessel disturbance and noise interference as being threats to marine turtles which is relevant to the Dorrigo MSS activity (refer **Table 5-13**). Marine oil pollution is addressed in **Section 7.12**, lighting is addressed in **Section 7.1**, marine debris in **Section 7.9**, vessel disturbance/collision in **Section 7.11** and noise interference in **Section 7.2.**

Table 5-13: Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017) – Threats relevant to activity

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

5.4.8 Birds

The EPBC Act PMST search (DoEE, 2018a) has identified 26 bird species possibly occurring in, or in proximity to, the Dorrigo MSS area as having a threatened classification and 22 species as migratory. Bird species within the EMBA have been based upon a search radius of 48 km around the Dorrigo MSS Operational Area established through spill modelling and the distance travelled by a 0.5µm surface oil threshold. **Table 5-14** provides details of the species listed under the EPBC Act (DoEE, 2018a) and the NCVA (DoEE, 2018b) which may be present in the Dorrigo MSS area and the oil spill EMBA. This table excludes birds present in non-coastal/ forested habitats and/or those which do not forage in marine areas. This includes species such as the King Island brown thornbill, King Island scrubtit, Tasmanian wedge-tailed eagle, Australasian bittern, Tasmanian azure kingfisher, swift parrot, green rosella, King Island black currawong, white-throated needletail, yellow wagtail, satin flycatcher, Latham's snipe, marsh sandpiper, fork-tailed swift, great egret and cattle egret.

Important bird areas (IBAs) in north-west Tasmania are located on the north-east coastline of King Island at Lavinia wetlands (resident water birds, Tasmanian endemics, seabirds, orange-bellied parrot); Albatross Island (seabird) located 85 km east of the MSS area; Black Pyramid Rock (seabirds) located 60 km east of the MSS area; Hunter Island Group (seabirds, resident water birds, orange-bellied parrot, Tasmanian endemics) located 92 km east of the MSS area and the north-west Tasmanian coastline (resident water-birds, orange-bellied parrot, Tasmanian endemics) located 95 km from the MSS area (Dutson et al, 2009). These IBAs lie outside the oil spill EMBA for the Dorrigo MSS.

5.4.8.1 Albatross and petrels

Table 5-14 lists albatross and petrel species which may be present in the Dorrigo MSS area. Albatrosses and giant-petrels are among the most oceanic of all seabirds, and seldom come to land unless breeding (SEWPC, 2011c). Many species, such as antipodean albatross, are extremely dispersive, spending most of their time over the pelagic waters of the High Seas while others like adult shy albatrosses, tend to remain sedentary, regularly foraging over coastal waters throughout their adult lives (SEWPC, 2011c). Albatross and giant petrel species exhibit a broad range of diets and foraging behaviours, and hence at-sea distributions are diverse. Combined with their ability to cover vast oceanic distances, all waters within Australian jurisdiction can be considered foraging habitat, however the most critical foraging habitat is those waters south of 25° where most species spend most of their foraging time (SEWPC, 2011c) (refer **Figure 5-25**).

Figure 5-25: Albatross and Petrel tracking database (SEWPC, 2011c)

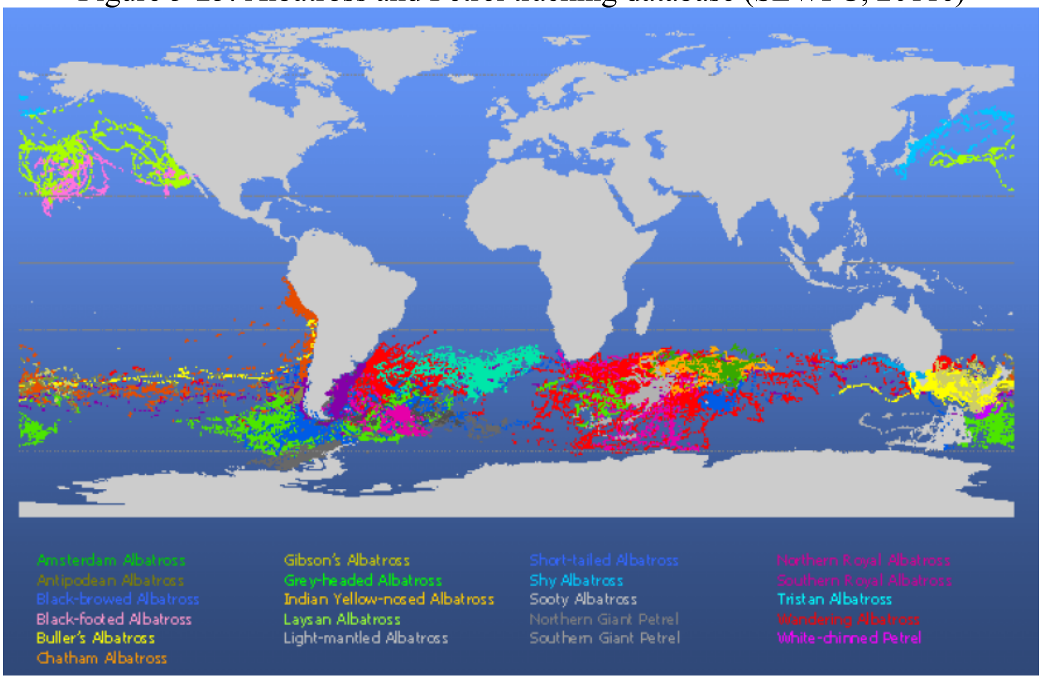


Table 5-14: EPBC-listed marine bird species present in the Dorrigo MSS area (DoEE, 2018a)

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

Present only in EMBA Only

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

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Birds	Actitis hypoleucos	Common sandpiper	L, M	MO	✓	-	✓	-	-
	Ardenna carneipes	Flesh-footed shearwater	M	FLO	✓	-	✓	-	
	Ardenna pacifica	Wedge-tailed shearwater	M	-	✓	✓ (foraging - chick provisioning)	✓	✓ (foraging - chick provisioning)	-
	Ardenna tenuirostris	Short-tailed shearwater	M	-	✓	✓ (foraging)	✓	✓ (foraging)	-
	Arenaria interpres	Ruddy Turnstone	M	-	X	-	✓(KO)	-	-
	Caldris alba	Sanderling	M	-	X	-	✓(KO)	-	-
	Calidris acuminata	Sharp-tailed sandpiper	M	KO	✓	-	✓	-	-
	Calidris canutus	Red Knot	E, M	MO	✓	-	✓	-	✓(REF 1)
	Calidris ferruginea	Curlew Sandpiper	CE, M	MO	✓	-	✓	-	✓(REF 2)
	Calidris ruficollis	Red-necked stint	M	-	X	-	✓(MO)	-	-
	Calidris melanotos	Pectoral sandpiper	M	MO	✓	-	✓	-	-
	Charadrius mongolus	Lesser Sand Plover	E, M	-	X	-	✓ (KO)	-	✓(REF 3)
	Charadrius bicinctus	Double-banded plover	M	-	X	-	✓(KO)	-	-
	Charadrius ruficapillus	Red-capped plover	L	-	X	-	✓(KO)	-	-
	Catharacta skua	Great Skua	L	MO	✓	-	✓	-	-
	Diomedea antipodensis	Antipodean Albatross	V, M	FLO	✓	✓ (foraging)	✓	✓(foraging)	✓(REF 5)
	Diomedea epomophora (sensu stricto)	Southern Royal Albatross	V, M,	FLO	✓	-	✓	-	✓(REF 5)
	Diomedea exulans (sensu lato)	Wandering Albatross	V, M,	FLO	✓	✓ (foraging)	✓	✓ (foraging)	✓(REF 5)
	Diomedea sanfordi	Northern Royal Albatross	E	FLO	✓	-	✓	-	✓(REF 5)
	Eudyptula minor	Little Penguin	L	-	X	-	✓	✓ (breeding, foraging)	-
Birds	Fregatta grallaria grallaria	White-bellied storm petrel	V	LO	✓	-	✓	-	-

Status:
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Present only in EMBA Only

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KO: Species or species habitat known to occur within area
FLO: Foraging/Feeding likely to occur in area
BO: Breeding known to occur in area
RKO: Roosting known to occur

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
	Haliaeetus leucogaster	White-bellied sea eagle	L	-	X	-	✓ (BO)	-	-
	Halobaena caerulea	Blue Petrel	V	MO	✓	-	✓	-	✓(REF 6)
	Pelecanoides urinatrix	Common diving petrel	L	-	✓	✓(foraging)	✓	✓(foraging)	-
	Limosa lapponica baueri	Bar-tailed Godwit (Alaskan)	V, M	-	X	-	✓(KO)	-	✓(REF 7)
	Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE, M	-	X	-	✓(MO)	-	✓(REF 8)
	Macronectes giganteus	Southern Giant-Petrel	E, M,	FLO	✓	-	✓	-	✓(REF 5)
	Macronectes halli	Northern Giant-Petrel	V, M,	MO	✓	-	✓	-	✓(REF 5)
	Morus serrator	Australasian gannet	L	-	X	-	✓	✓(foraging)	-
	Neophema chrysogaster	Orange-bellied parrot	CE	Migration Route	✓	-	✓	-	✓(REF 4)
	Numenius madagascariensis	Eastern Curlew	CE, M	MO	✓	-	✓	-	✓(REF 9)
	Pachyptila turtur subantarctica	Fairy Prion (southern)	V	MO	✓	-	✓	-	✓(REF 10)
	Pandion haliaetus	Osprey	M	-	X	-	✓	-	-
	Pelagodroma marina	White-faced storm petrel	L	-	✓	✓(foraging)	✓	✓(foraging)	-
	Pluvialis fulva	Pacific Golden Plover	M	-	X	-	✓ (KO)	-	-
	Phalacrocorax fuscescens	Black-faced Cormorant	L	-	X	-	✓	✓(foraging)	-
	Phoebetria fusca	Sooty Albatross	V, M	LO	✓	-	✓	-	✓(REF 5)
	Pterodroma leucoptera leucoptera	Gould's petrel	E	MO	✓	-	✓	-	-
	Pterodroma mollis	Soft-plumaged Petrel	V	MO	✓	-	✓	-	✓(REF 11)
	Puffinus carneipes	Flesh-footed shearwater	L	FLO	✓	-	✓	-	-
	Sternula albifrons	Little tern	M	-	X	-	✓(MO)	-	-
	Sternula nereis nereis	Australian Fairy Tern	V	FLO	✓	-	✓	-	✓(REF 12)
	Thalassarche bulleri	Buller's Albatross	V, M	FLO	✓	✓ (foraging)	✓	✓ (foraging)	✓(REF 5)
	Thalassarche cauta cauta	Tasmanian Shy Albatross	V, M	FLO	✓	✓ (foraging)	✓	✓ (foraging)	✓(REF 5)

Status:
E: Endangered
V: Vulnerable
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L:Listed

Present only in EMBA Only

Likelihood of Occurrence:
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FLO: Foraging/Feeding likely to occur in area
BO: Breeding known to occur in area
RKO: Roosting known to occur

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence (OA)	Present in OA	BIA (OA)	Present in EMBA	BIA (EMBA)	Conservation Plan/ Advice
Birds	Thalassarche carteri	Indian yellow-nosed albatross	V, M	NA	✓	✓ (foraging)	✓	✓ (foraging)	✓(REF 5)
	Thalassarche cauta steadi	White-capped Albatross	V, M	FLO	✓	-	✓	-	✓(REF 5)
	Thalassarche chryostoma	Grey-headed albatross	E, M	MO	✓	-	✓	-	✓(REF 5)
	Thalassarche impravida	Campbell Albatross	V, M	FLO	✓	✓ (foraging)	✓	✓ (foraging)	✓(REF 5)
	Thalassarche melanophris	Black-browed Albatross	V, M	FLO	✓	✓ (foraging)	✓	✓ (foraging)	✓(REF 5)
	Thalassarche salvini	Salvin's albatross	V, M	FLO	✓	-	✓	-	✓(REF 5)
	Thalassarche sp.nov	Pacific albatross	V	FLO	✓	-	✓	-	✓(REF 5)
	Thinornis rubicollis rubiciollis	Hooded Plover	V	-	X	-	✓ (KO)	-	✓(REF 13)
	Tringa nebularia	Common greenshank	M	-	X	-	✓(LO)	-	-

References:

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

The listed albatross species have a widespread distribution throughout the southern hemisphere. They feed mainly on cephalopods, fish and crustaceans, using surface feeding or plunge diving to seize their prey (ACAP, 2012). Albatrosses are colonial, usually nesting on isolated islands and foraging across oceans in the winter months with most observations along the edge of the continental shelf (DEWHA, 2007). Of the species listed, the wandering albatross, black-browed albatross, grey-headed albatross and shy albatross breed in Australian jurisdictions (SEWPC, 2011c). The remaining species forage in Australian waters. No breeding colonies or nesting areas for listed albatross species are located within, or adjacent to, the proposed Dorrigo MSS area. The closest breeding island to the survey area is Albatross Is (TAS) [shy albatross] (86 km east); and Macquarie Island [black-browed albatross, grey-headed albatross & wandering albatross] (1940 km southeast) (ACAP, 2012; SEWPC, 2011c).

The listed petrel species are oceanic and have a widespread distribution throughout the southern hemisphere. They are colonial and breed on sub-Antarctic and Antarctic islands in a circumpolar band generally between 40^{O}S and 60^{O}S. Petrel species feed on small fish, cephalopods (octopus, squid & cuttlefish) and crustaceans along the edge of the continental shelf and open waters (DEWHA, 2007). No breeding colonies or nesting areas for listed petrel species are located within or adjacent to the proposed Dorrigo MSS area. The closest breeding island to the survey area is Maatsukyer Is (TAS) [soft plumaged petrel] (~ 420 km SE) and Macquarie Island [blue petrel, northern & southern giant petrels] (~ 2940 km SE) (ACAP, 2012; SEWPC, 2011c).

The Dorrigo MSS spatially overlaps the following BIAs for albatross and petrel species:

- Albatross (foraging BIAs): Wandering albatross; antipodean albatross; Tasmanian shy albatross; Buller's albatross; Campbell albatross; black-browed albatross and Indian yellow-nosed albatross.
- Petrels (foraging BIASs): Common diving petrel and white-faced storm petrel.

Albatross and petrels may overfly and forage within the Dorrigo MSS area during the survey period.

The Recovery Plan for Threatened Albatross and Giant Petrels (2011-2016) (SEWPC, 2011c) has been assessed for the Dorrigo MSS activity with marine oil pollution and marine debris was identified as a threat to these species (refer **Table 5-15**). Marine oil pollution is addressed in **Section 7.12** and marine debris is addressed in **Section 7.9**. The blue petrel conservation advice has been assessed and no threats are considered relevant to the Dorrigo MSS activities (TSSC, 2015e).

Table 5-15: Threatened Albatross and Giant Petrels (2011-2016) (SEWPC, 2011c) and Blue Petrel Conservation Advice (TSSC, 2015e) – Threats relevant to activity

Relevant Threat/Objective	Action	Relevant EP Action
Marine Pollution (oil and marine debris) S03: Quantify and reduce marine based threats to the survival and breeding parameters of albatrosses and giant petrels foraging in waters under Australian jurisdiction	C11.1: Where feasible, population monitoring programs also monitor, in a standardised manner, the incidence of: i) oiled birds at the nest; ii) marine debris ingestion / entanglement at the nests; and iii) egg shell thinning.	**Oil Pollution Monitoring:** No identified nesting locations are located within the predicted oil spill EMBAs. Given the location of the nesting locations, and the small number of birds which might be affected by an oil spill, monitoring of populations is not considered feasible. **Marine Debris:** Implement legislative requirements for discharge of garbage to the marine environment to prevent ingestion of marine debris from MSS activities.

5.4.8.2 Other birds (within MSS area)

Other bird species within the Dorrigo MSS area include the following:

- **Flesh-footed Shearwater** (*Puffinus carneipes*): From early September to late May, this species may forage offshore along the continental shelf and slope. The species breeds at 41 islands in south-west WA, on Smith Island (~150 pairs) off the south-east coast of the Eyre Peninsula and Lord Howe Island. The flesh-footed shearwater feeds on small fish, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp), other soft-bodied invertebrates and offal. It obtains most of its food by surface plunging or pursuit plunging. It also regularly forages by settling on the surface of the ocean and snatching prey from the surface ('surface seizing'), momentarily submerging onto prey beneath the surface ('surface diving') or diving and pursuing prey beneath the surface by swimming ('pursuit diving')(DOE, 2018ah).

  No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *Encounter with this species is possible during survey activities.*

- **Orange-bellied Parrot** (*Neophema chrysogaster*): This species is endemic to south-eastern Australia. The Dorrigo MSS area is identified within the 'probable migration route' for the species (DoE, 2016). Critical habitats for the species are eucalyptus forest, saltmarshes, coastal dunes, pastures, estuaries and islands usually within 10 km of the coast (DoE, 2016). Holes in eucalypts are used for nesting and the species feeds almost exclusively on seed and fruits mainly from sedges and salt-tolerant coastal and salt march plants (DoE, 2016). Orange-bellied parrots depart breeding grounds in Tasmania from January to April, spend winter on the mainland and depart for Tasmania between September and November (DoE, 2016). No BIA for this species lies within the Dorrigo MSS area or EMBA.

  While orange-bellied parrots may overfly the Dorrigo MSS area during their southern migration, no impacts to the species are expected from MSS activities.

- **Short-tailed Shearwater** (*Ardenna Tenuirostris*): This species spends the southern winter at sea in the northern Pacific off Japan, Siberia and Alaska. The species is found in coastal waters and, in summer months, is the most common shearwater along the south and south-east coast of Australia, their breeding grounds. The nest is a leaf-lined chamber at the end of a burrow in the ground. The short-tailed shearwater feeds on krill, small fish and other small marine creatures. Food is caught mostly on the surface of the water but sometimes birds are seen diving for food. King Island is an IBA for the species with >1% of the population with breeding occurring from October to May (DoEE, 2018b). The species breeds on King Island at New Year Island (120,000 burrows), Christmas Island (48,000 burrows) (18 km east), at Whistler Point (61,000 burrows) located 20 km east, Cape Farewell (24,650 burrows) located 27 km east, Cape Wickham Lighthouse (8362 burrows), Cape Wickham (14,800 burrows) 29 km east, Badger Box Creek (15,850 burrows) 21 km east, Cataraqui Point (9760 burrows) 22 km east and Seal Rocks (82,650 burrows) 21 km east (DoEE, 2018b). The species does not carry any threatened conservation status (Birdlife Australia, 2018a).

  The Dorrigo MSS area lies within a BIA (foraging) for this species (DoEE, 2018b). *Encounter with this species is likely during survey activities.*

- **Wedge-tailed Shearwater** (*Ardenna pacifica*): This migratory marine bird species breeds on the east and west coasts of Australia, on off-shore islands and is widespread across the Indian and Pacific Oceans. While no breeding areas are identified within the Dorrigo MSS or EMBA, a foraging BIA (provisioning for young) is present in the northern section of the Dorrigo MSS area (DoEE, 2018b). Species return to their colonies in early August with a pre-laying exodus in mid November (Reid et al, 2002). The species breeds throughout its range mainly on vegetated islands, atolls or cays. Approximately 25% of breeding occurs in the Great Barrier Reef (DoEE, 2018ai). The wedge-tailed shearwater is pelagic, in tropical and subtropical waters (DoEE – 2018ai). The species tolerates a range of surface-temperatures and salinities, but is most abundant where temperatures are greater than 21 °C. When feeding, wedge-tailed shearwaters fly less than ten metres above the surface of the ocean and dive to a depth of two to three metres. Food is taken by contact-dipping, dipping, surface-seizing and, rarely, deep-plunging wedge-tailed shearwater birds are known to mostly consume fish, some cephalopods, insects, jellyfish and prawns (DoEE, 2018ai).

The Dorrigo MSS area lies within a BIA (foraging) for this species (DoEE, 2018b). *This species may be present foraging during Dorrigo survey activities*.

- **Fairy prion** (*Pachyptila turtur subantarctica*): This species is a listed as vulnerable, are often beach-cast on the south-eastern coast of Australia and seen foraging offshore over the continental shelf and pelagic waters. Data from the south-eastern Australian Seabird Atlas confirm this pattern, with 83% (of 24,505 individuals) seen over the continental slope, 9% over continental shelf and only 8% over open ocean. The southern fairy prion is found flying over the ocean where sea surface temperatures are 8.6° to 20.2° C (Reid et al. 2002). The species is common in southern Australia and is recorded breeding on subantarctic and cool temperate islands (Bass Strait islands, Tasmania, Macquarie Island) between September and early March. Fairy prion eat mostly euphausiids and other small crustaceans, but also eat small quantities of fish and pteropods (free-swimming sea snails and slugs). The species flies just above the surface of the ocean hunting by surface-seizing, dipping, pattering or surface-plunging (Reid et al, 2002).

  No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *This species may be present along adjacent coastline or may forage in the survey area during the survey*.

  Fairy prion conservation advice: The recovery plan for this species ceased to be in effect from 1 October 2015. Threats listed in the Conservation advice for the species (TSCC, 2015g) include interference from pest species (at Macquarie Island), soil erosion affecting suitable nesting sites and fires affecting breeding success. These threats (impacts) are not present from the Dorrigo MSS.

- **Australian fairy tern** (*Sternula nereis nereis*): This species is listed as vulnerable and is present along the coasts of Victoria, Tasmania, South Australia and Western Australia. It is a fish-eating bird and nests on sheltered sandy beaches, spits and banks above the high tide mark and below shoreline vegetation where the substrate is sandy and the vegetation sparse. The fairy tern is an aerial diver for bait-sized fish in shallow, inshore waters often observed near the shoreline and is rarely found out of the sight of land. The species forages by working against the tidal flow in estuaries, periodically hovering 5-15 m above the water surface (Pulham & Wilson, 2013). The species can also feed on plant material, molluscs and crustaceans in inshore waters and undergoes long distance movements within Australia. It is reported that there are only a few pairs in Victoria (Birdlife International, 2016). The species breeds between October and February and is very vulnerable to extreme weather events such as storms, floods, high-tide or wind-blown events (DoEE, 2018aj).

No BIA for this species lies within the Dorrigo MSS area or oil spill EMBA (DoEE, 2018b), however nesting sites are known on Christmas Island and Yellow Rock Beach (NW coast of King Island) (Threatened Species Section, 2012). *This species is expected to be present along adjacent King Island coastline or may forage in the survey area during the survey.*

Conservation Advice (Australian Fairy Tern): The conservation advice for the Australian fairy tern (TSSC, 2011) identifies the following as threats (refer **Table 5-16**):

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

These threats may have relevance to the Dorrigo MSS activity with respect to oil spills and any oil spill response activities initiated (refer **Section 7.14**). Marine oil pollution is addressed in **Section 7.12**.

Table 5-16: Conservation advice for the Australian Fairy Tern (TSSC, 2011) – Threats relevant to activity

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

- **Curlew Sandpiper** (*Calidris ferruginea*): This species is listed as a critically endangered, migratory wetland species with habitat which may occur in the MSS area. This coastal species breeds in the Arctic in June and July. The southern migration commences in July with arrival on Australian northern waters in late August/early September with northern migration commencing in March. Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast. Curlew Sandpipers forage on mudflats and nearby shallow water at the edges of shallow pools, intertidal mudflats and sandy shores. At high tide, they forage among low sparse emergent vegetation, such as saltmarsh, and sometimes forage in flooded paddocks or inundated salt-flats. Occasionally they forage on wet mats of algae or waterweed, or on banks of beach-cast seagrass or seaweed. Prey include worms, molluscs, crustaceans, and insects, as well as seeds (DoEE, 2018ak).

  No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *This species may be present along adjacent coastline during the survey.*

  Conservation Plan for Curlew Sandpiper: While a conservation plan is not available for the species, the conservation advice for the species (TSSC, 2015a) lists human disturbance, habitat loss and degradation from pollution, changes to water regime and invasive plants as threats to the species. Marine oil pollution from survey activities is addressed in **Section 7.12** and oil spill response in **Section 7.14.**

- **Eastern Curlew** (*Numenius madagascariensis*): This species is a listed marine migratory and critically endangered wetland species. Within Australia, the eastern curlew is primarily coastal. The species breeds in Russia, Mongolia and north-eastern China from early May to late June, arrives in Australia in late July and leaves between late February and March-April. In the non-breeding season, the eastern curlew is associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The eastern curlew is carnivorous mainly eating crustaceans (including crabs, shrimps and prawns), small molluscs, and some insects (TSSC, 2015f).

No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *This species may be present along adjacent coastline during the survey.*

Conservation Plan for Eastern Curlew: While a conservation plan is not available for the species, the conservation advice for the species (TSSC, 2015f) lists human disturbance, habitat loss due to coastal development and pollution around settled areas reducing availability of food as threats to the species. Marine oil pollution from survey activities is addressed in **Section 7.12** and oil spill response in **Section 7.14.**

- **Red knot** (*Calidris canutus*): This species is listed as threatened (endangered), breeds in the northern hemisphere in June and July and is a non-breeding visitor to Australia. In Australasia, the species mainly roosts on inter-tidal mud flats, sandflats and sandy beaches of sheltered coasts in estuaries, bays and inlets (DoEE, 2018al). The species forages in soft substrate near the edge of the water eating mostly worms, bivalves, gastropods, crustaceans and echinoderms (DoEE, 2018al).

  The species may be present along sheltered embayments adjacent to the Dorrigo MSS area however this does not represent important habitat for the species. No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *This species may be present along adjacent coastline during the survey.*

  Conservation advice for the red knot: Threats to the global population of the red knot relevant to the Dorrigo MSS include pollution/contamination impacts and disturbance (TSSC, 2016a). Marine oil pollution from survey activities is addressed in **Section 7.12** and oil spill response in **Section 7.14.**

- **Great skua** (*Catharacta skua*): This species has a far-ranging distribution, circumpolar from mid to high latitudes. In Australia the species extends from Brisbane along the southern coastline and west to Exmouth (WA). Great skuas are seen in small numbers throughout their ranges, but especially over shelf-break waters of NSW, eastern Tasmania and Bass Strait (Reid et al, 2002). The species breeds in summer (November to January) on nested elevated grasslands or sheltered rocky areas adjacent to penguin colonies on sub-Antarctic islands. Most adult birds leave colonies during winter and scavenge on other seabirds, fish, molluscs and crustaceans (Reid et al, 2002).

  No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *This species may be present along adjacent coastline during the survey.*

- **Common sandpiper** (*Actitis hypoleucos*): This migratory marine species is found along all coastlines of Australia with major populations concentrated in northern and western Australia from July to May (DoEE, 2018am). The species breeds in Europe, Asia and Russia. In Australia, the species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores, rarely on mudflats (DoEE, 2018am). The species is carnivorous, eating molluscs such as bivalves, crustaceans such as amphipods and crabs and a variety of insects.

No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *This species may be present along adjacent coastline during the survey*.

- **Sharp-tailed sandpiper** (*Calidris acuminate*): This migratory species is widespread in both inland and coastal locations in both freshwater and saline habitats (DoEE, 2018an). The species breeds in northern Siberia and migrates to Australia arriving August/September and departing in April (DoEE, 2018an). The sharp-tailed sandpiper forages on seeds, worms, molluscs, crustaceans and insects at the edge of the water of wetlands or intertidal mudflats, either on bare wet mud or sand, or in shallow water. They also forage among inundated vegetation of saltmarsh, grass or sedges. They may forage on coastal mudflats at low tide and move to freshwater wetlands near the coast to feed at high tide.

  No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *It is not expected that this species will be encountered within the MSS area or along adjacent coastline during the survey*.

- **Pectoral sandpiper** (*Calidris melanotos*): This migratory species is very rare in Tasmania however records exist for Cape Portland, Orielton Lagoon-Sorell, Barilla Bay, Clear Lagoon, Cameron Inlet and Flinders Island (DoEE, 2018ao). The pectoral sandpiper breeds in northern Russia and North America and in Australasia is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands. The pectoral sandpiper is omnivorous, consuming algae, seeds, crustaceans, arachnids and insects (DoEE, 2018ao).

  No BIA for this species lies within the Dorrigo MSS area or EMBA (DoEE, 2018b). *It is not expected that this species will be encountered within the MSS area or along adjacent coastline during the survey.*

5.4.8.3 Other birds (within EMBA)

Other bird species within the Dorrigo oil spill EMBA include the following:

- Hooded plover (*Thinornis rubicollis rubicollis*): The hooded plover is sedentary and inhabits sandy ocean beaches feeding on tiny invertebrates (insects, sand-hoppers, small bivalves and soldier crabs) from the sand near the water's edge. The species lays their eggs in shallow scrapes in the sand either on the upper beach (above high tide mark) or adjacent backing sand dune. The highest densities of hooded plover occur on broad, flat and wide wave-washed zone with large amounts of beach-washed seaweed. Densities are lowest on narrow steep beaches where there are few or no dunes (Birdlife Australia, 2018b). The species captures its prey by running across the surface for marine worms, molluscs, crustaceans, insects, water plants and seeds. They nest in solitary pairs and defend their breeding territories (ranging from 400-1,800 m near the shoreline) from August to March (Barton *et al*., 2012). The King Island coastline supports hooded plover populations at Yellow Rock Beach and Christmas Islands (PWS, 2018b; Threatened Species Section, 2012) and at sandy beach locations along the west King Island coastline (Tasmanian Government, 2019).

No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species is expected to be present along adjacent King Island sandy coastlines during the survey.*

The conservation advice for the hooded plover identify the following threats as being relevant to the Dorrigo MSS (TSSC, 2014):

- Human disturbance causing direct destruction of eggs;
- Oil spills which may threaten the species breeding habitat; and
- Entanglement and ingestion of marine debris.

Marine oil pollution is addressed in **Section 7.12**, oil spill response strategies are addressed in **Section 7.14** and marine debris is addressed in **Section 7.9**.

Table 5-17: Conservation advice for the Hooded Plover (TSSC, 2014) – Threats relevant to activity

Relevant Threat	EP Actions
Human Disturbance	Manage the use of (and access to) key beaches for recreation when plovers are breeding – e.g. implement temporary beach closures; erect fencing to prevent people entering.
Oil Spill	Prepare oil spill response plans to ensure effective rehabilitation of oiled birds.
Marine Debris	Reduce in-shore marine debris, including educating fishers and the public to properly dispose of fishing lines.

- <u>Lesser Sand Plover (*Charadrius mongolus*):</u> The lesser sand plover usually occurs in coastal littoral and estuarine environments roosting in large inter-tidal sand flats or mudflats in sheltered bays, estuaries and occasionally sandy ocean beaches. It is a non-breeding visitor to Australia with nationally important areas located in NSW (Richmond and Shoalhaven Rivers, Botany Bay and Alva Beach (Ayr, Queensland). The species roosts near foraging areas – on beaches, banks and spits and eats invertebrates, such as molluscs (especially bivalves), worms, crustaceans (especially crabs) and insects (DoEE, 2018ap). The species departs for northern hemisphere breeding grounds in April and return in September. Threats to this species include pollution and human disturbance interrupting feeding or roosting habitats which are relevant to Dorrigo MSS activities.

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present along adjacent coastline during the survey.*

  Conservation actions include the management of "disturbance" activities (vehicle access, horse riding and dogs on beaches) at important sites (TSSC, 2016b). Marine oil pollution is addressed in **Section 7.12** and oil spill response activities in **Section 7.14**.

- <u>Little Tern (*Sternula albifrons*):</u> Little terns are widespread, migratory and occur around the Australian coastline from Broome, around the northern coastline to south-eastern South Australia. They inhabit sheltered coastal environments (lagoons, estuaries, river mouths and deltas, exposed sand spits or sandbanks and exposed ocean beaches (least preferred)). Breeding occurs between September and February in a shallow scrape in the sand sometimes laced next to debris (driftwood, etc.) above the high-tide mark (DoEE, 2018aq). The species forages in shallow waters of estuaries, coastal lagoons and lakes and frequently over channels next to spits and banks or entrances on small fish crustaceans, insects and molluscs taken by plunge diving. They forage along open coasts, less often at sea and usually within 50 m of the shore.

No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present along sandy shorelines on the adjacent King Island coastline during the survey period and are known to inhabit Christmas island and Yellow Rock Beach (NW coast of King Island) (Threatened Species Section, 2012).*

- Ruddy Turnstone (*Arenaria interpres*): The ruddy turnstone is widespread within Australia during its non-breeding period (September to March). The Ruddy Turnstone breeds on the coasts of Europe, Asia and North America, generally north of 60° latitude. It is found in most coastal regions and strongly prefers rocky shores or beaches where there are large deposits of rotting seaweed mainly foraging between lower supra-littoral and lower littoral zones of foreshores (from strand-line to wave-zone). The species eats insects, worms, crustaceans, molluscs, and spiders. It has occasionally been known to eat fish, birds' eggs and carrion and human food scraps (DoEE, 2018ar).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present on the adjacent King Island shoreline during MSS activities*.

- Sanderling (*Calidris alba*): The sanderling, a migratory wetland species, is almost always found on the coast, mostly on open sandy beaches exposed to open sea-swell, and also on exposed sandbars and spits, and shingle banks, where they forage in the wave-wash zone and amongst rotting seaweed. Sanderlings also occur on beaches that may contain wave-washed rocky outcrops. They roost on bare sand high on the beach, clumps of washed-up kelp, coastal dunes and rocky reefs and ledges (DoEE, 2018as). The species is non-breeding in Australia and forage on plants, seeds, worms, crustaceans, spiders, insects, and occasionally on medusae, fish and larger molluscs and crustaceans taken as carrion (DoEE, 2018as).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present on the adjacent King Island shoreline during MSS activities.*

- Red-necked stint (*Calidris ruficollis*): The red-necked stint is recorded in all Australian coastal regions with large densities on Victorian and Tasmanian coastlines. The species breeds in Siberia and Alaska arriving in Australia from August and returning to breeding grounds in March/April (DoEE, 2018at). The species forages on plant seeds and on a range of marine worms, molluscs, shrimps, spiders, beetles, flies and ants on inter-tidal and near coastal wetlands (DoEE, 2018at).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *The species may be present on the adjacent King Island shoreline during MSS activities*.

- Black-face cormorant (*Phalacrocorax fuscescens*): The black-faced cormorant is Australia's only cormorant that does not occur at terrestrial wetlands and is confined to inshore marine habitats. The species occurs along two sections of Australia's southern coastline, Eden (NSW) to the Head of Bight (SA) (including Tasmania) and south-western Western Australia near Albany, where it breeds throughout the year in large colonies on dozens of rocky offshore islands. Nests are built from seaweed and driftwood on bare rock. Black-faced cormorants have a breeding colony located on Christmas Island (21 breeding pairs) part of the King Island IBA with supports less than 1% of the world population (DoEE, 2018b). The cormorants forage by diving to depths of up to 12 m in pursuit of small fish. They often roost in the company of other birds, especially gulls and other species of cormorants. The black-faced cormorant frequents coastal waters and are found in flocks in large bays, deep inlets, rocky headlands and islands. They seldom visit beaches (Birdlife Australia, 2018c).

The Dorrigo MSS oil spill EMBA contains a foraging BIA for the species which extends 13 km from Christmas Island (DoEE, 2018b). *This species may be present foraging in coastal King Island waters during the Dorrigo MSS period.*

- Osprey (*Pandion haliaetus*): The breeding range of the osprey extends around the northern coast of Australia (including many offshore islands) from Albany in Western Australia to Lake Macquarie in NSW; with a second isolated breeding population on the coast of South Australia, extending from Head of Bight east to Cape Spencer and Kangaroo Island. The total range (breeding plus non-breeding) around the northern coast is more widespread, extending from Esperance in Western Australia to NSW, where records become scarcer towards the south, and into Victoria and Tasmania, where the species is a rare vagrant. Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands and mainly feed on fish, especially mullet where available (DoEE, 2018au).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *It is possible, however unlikely this species will be present on adjacent King Island shorelines during MSS activities*.

- Pacific Golden Plover (*Pluvialis fulva*): This species is a non-breeding visitor to Australia, usually occurs on beaches, mudflats and sandflats in sheltered areas including harbours, estuaries and lagoons. This species forages on sandy or muddy shores or margins of sheltered areas such as estuaries and lagoons, though it also feeds on rocky shores, islands or reefs and roosts near foraging areas, on sandy beaches and spits or rocky points occasionally among or beneath vegetation including mangroves or low saltmarsh, or among beachcast seaweed. Pacific Golden Plovers mainly eat molluscs, polychaete worms, insects and insect larvae, spiders and crustaceans and very occasionally eat seeds, leaves, lizards, birds' eggs and small fish (DoEE, 2018av).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present in sheltered areas on the adjacent King Island coastline during MSS activities*.

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

No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present in protected areas along the King Island coastline during survey activities.*

Conservation Advice (Bar-tailed godwit): The conservation advice for the Bar-tailed godwit (TSSC, 2016c; TSSC, 2016d) identifies threats to the species to include ongoing human disturbance as well as habitat loss and degradation from pollution, changes to the water regime and invasive plants. These threats are not relevant to the Dorrigo MSS.

- Common greenshank (*Tringa nebularia*): The Common Greenshank breeds in Eurasia and Siberia arriving in Australia from August and returns to breeding groundsa in April. In Australia is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species eats molluscs, crustaceans, insects, and occasionally fish and frogs (DoEE, 2018aw).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present in protected areas along the King Island coastline during survey activities.*

- Red-capped plover (*Charadrius ruficapillus*): This species is the most common and widespread of Australia's beach-nesting shorebirds and occurs along the entire Australian coastline. They usually inhabit wide, bare sandflats or mudflats at the margins of saline, brackish or freshwater wetlands where they forage by using their characteristic 'stop-run-peck' method, taking small invertebrates from the surface. The nest site of the red-capped plover is a shallow scrape on a beach or stony area, nearly always close to water (Birdlife Australia, 2018d). This species has been recorded along the west coast of King island (Tasmanian Government, 2019).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may be present in on the adjacent King Island coastline during MSS activities.*

- White-bellied sea eagle (*Haliaeetus leucogaster*): The white-bellied sea eagle is distributed along the coastline in coastal lowlands with breeding from Queensland to Victoria in coastal habitats and terrestrial wetlands in temperate regions. 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 (DoEE, 2018ax). 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. The species is widespread and makes long-distance movements (DoEE, 2018ax).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may forage and be present along the adjacent King island coastline during the survey.*

- Little penguin (*Eudyptula minor*): The little penguin is an iconic species that usually mates between August to October, with eggs laid in September/October. From this point until the chick hatches, the eggs are incubated with parents alternating between incubation duties and foraging. Chick feeding occurs during November/December (PFPI, 2018). Nesting colonies occur in burrows on sandy or rock islands often at the base of cliffs or in sand dunes adjacent to marine areas (Birdlife International, 2018e). Moulting occurs in February-April, during which time individual penguins are unable to go to sea for at least 17 days therefore losing a considerable amount of weight. The winter period is important for little penguins as individuals gain the weight lost during the moult and prepare for the upcoming breeding season (Gormley & Dann, 2009).

The Tasmanian population of little penguins range from 110,000 to 190,000 (PWS, 2018a). Penguin breeding colonies known to occur in the EMBA include Christmas Island (11,883 breeding pairs) (DoEE, 2018b) located 18 km from the nearest Dorrigo MSS operational boundary. Other colonies are present at Grassy Harbour King Island and Councillor Island (26 breeding pairs) (located on eastern shores of King Island); Black Pyramid Rock located 60 km east (13 breeding pairs); Albatross Island located 85 km east (350 breeding pairs), Three Hummocks Island located 107 km east (2059 breeding pairs); Steep Island located 91 km east (2000-3000 breeding pairs); Bird Island located 95 km east (3,000 breeding pairs); and in the Furneaux Group, located at least 350 km from the survey area is Forsyth (147,318 breeding pairs), Preservation (2100 burrows), Passage (1500 breeding pairs), Goose (7036 breeding pairs), Chalky (21,218 breeding pairs) & Gull Islands (11,500 breeding pairs) (DoEE, 2018b).

All colonies other than Christmas Island and Currie Harbour are located outside the oil spill EMBA. A 10km foraging BIA for the little penguin surrounds Christmas Island within the Dorrigo oil spill EMBA.

The species feeds mainly on pelagic shoaling fish (pilchards, anchovies), cephalopods and occasionally crustaceans (PFPI, 2018). Prey is captured by pursuit diving typically to a depth of 10-20 m for an average of 24 seconds but dives as deep as 72 m has been recorded (PFPI, 2018). The species forages within a radius of 8-15 km (5-10 miles) from their burrow during breeding season; and generally, within 20 km (12.5 miles) of shore in non-breeding season, however longer trips of up to 700 km may occur in non-breeding season (Australian Wildlife, 2014). Tracking studies of 93 penguins from the London Arch colony located on the Otway coastline during 2011 and 2012 breeding seasons (Arnould and Berlincourt, 2013) identified mean foraging trip durations of 13.9 to 15.2 hours. Birds travelled mean total distances of between 26.7 and 47.2 km and travelled from 12.2 up to 20.5 km from the colony (Arnould & Berlincourt, 2013).

- Australasian gannet (*Morus serrator*): Breeding populations (12,339 breeding pairs) of the Australasian gannet are present at Black Pyramid Rock located approximately 60 km east of the Dorrigo MSS area. This represents more than 15% of the species global population. Birds are present year-round breeding between July and March (DoEE, 2018b). A 40 km foraging BIA exists around Black Pyramid Rock for this species (DoEE, 2018b). The species generally feeds over continental shelves or inshore waters, seldom far from land. Its diet is comprised mainly of pelagic fish, especially pilchard, anchovies and jack mackerel, but also squid and garfish. Prey is caught mainly by plunge-diving, Adults tend to stay within the vicinity of the colony after breeding with young birds dispersing (DoE, 2015).

  No BIA for this species lies within the Dorrigo EMBA (DoEE, 2018b). *This species may forage in the Dorrigo MSS ares during the survey.*

5.4.9 Marine Pests

Invasive marine species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and can survive, reproduce and establish in other locations. More than 200 non-indigenous marine species including fish, molluscs, worms and a toxic alga have been detected in Australian coastal waters (AMSA, 2010). It is widely recognised that IMS can become pests 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, 2006).

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:

Key known pest species in the South-East Marine Region include (NOO, 2001):

- Northern pacific sea star (*Asterias amurensis*);
- Fan worms (*Sabella spallanzannii* and *Euchone* sp);
- Bivalves (*Crassostrea gigas* (Pacific oyster), *Corbula gibba* and *Theora fragilis*);
- Crabs (*Carcinus maenas* (European shore crab) and *Pyromaiatuberculata*);
- Macroalgae (*Undaria pinnatifida* (Japanese giant kelp) and *Codium fragile* ssp.*tormentosoides*; and
- The introduced New Zealand screw shell (*Maoricolpus roseus*), known to form extensive and dense beds on the sandy sea-floor in eastern Bass Strait spreading to the 80 m depth contour off eastern Victoria and NSW (Patil et al., 2004).

Other introduced species tend to remain confined to sheltered coastal environments rather than open waters (Hayes *et al*., 2005).

The Marine Pests Interactive Map (Commonwealth of Australia, 2018) indicates that the ports likely to be used by survey vessels (Portland or Geelong) harbour the European green shore crab (prefers bay/estuary shorelines up to 60m water depths), the Northern Pacific sea-star (habitats to approximately 25 m water depths); European fan worm (sheltered water habitats to 30 m depth); Japanese kelp (inter-tidal to 20 m water depth); Asian date mussel (soft sediments to 20 m water depth); European shell clam (inter-tidal to 150 m water depth) and New Zealand screw shell (inter-tidal to 130 m water depth). These pests are translocated if they come in physical contact with equipment or remain in port too long for hulls to become contaminated.

5.5 Conservation Values

The conservation values in and around the Dorrigo 3D MSS area are described in this section. **Table 5-18** providing an outline of the conservation categories included.

Table 5-18: Conservation Values within the EMBA

Category	Conservation Classification	Section
Tasmanian Protected Marine Areas	Marine National Parks/Sanctuaries	Section 5.5.2

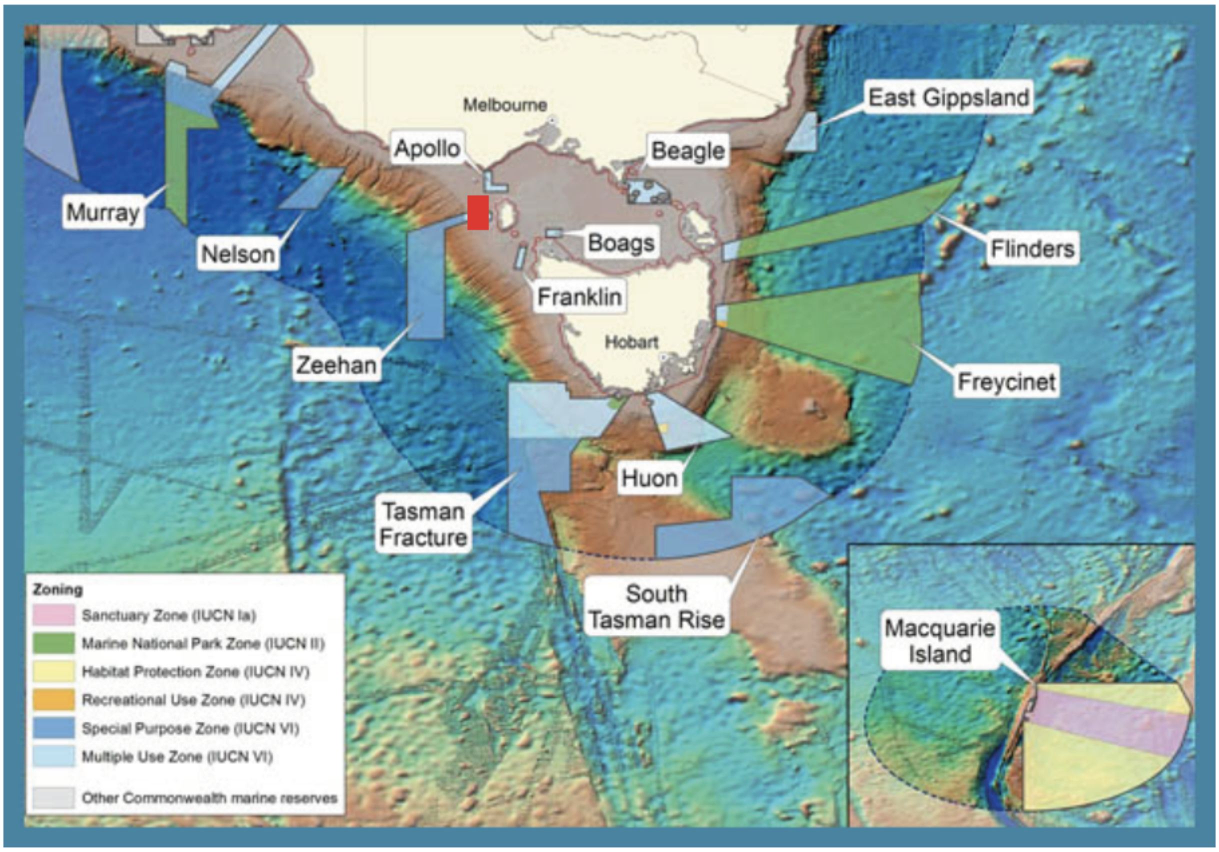
Tasmanian Protected Terrestrial Areas (Shoreline)	National and Coastal Parks	Section 5.5.2
Commonwealth Marine Protected Areas	Commonwealth Marine Reserves	Section 5.5.1
Commonwealth Heritage	Commonwealth Heritage List	Section 5.5.4
EPBC Act: Matters of National Environmental Significance (MNES)	World Heritage Properties	Section 5.5.3
	National Heritage Places	Section 5.5.4 & 5.6.1
	Wetlands of National Importance (RAMSAR)	Section 5.5.5
	Threatened species	Section 5.4
	Threatened ecological communities (TEC)	Section 5.5.6
	Migratory Species	Section 5.4
	Commonwealth Marine Environment	Section 5
	Great Barrier Reef Marine Park	N/A
	Nuclear Actions	N/A
	A water resource (in relation to coal seam gas development and large coal mining)	N/A
Other Important Commonwealth Conservation Features	Key Ecological Features (KEFs)	Section 5.5.7
	Nationally Important Wetlands	Section 5.5.5

5.5.1 Commonwealth Marine Protected Areas

Commonwealth Marine Parks (CMPs) in proximity to the Dorrigo MSS area are found in **Figure 5-26.**

The Dorrigo MSS spatially overlaps the multi-use zone of the Zeehan CMP and lies adjacent to the Apollo CMR (complete CMP is zoned multi-use – IUCN VI). Mining activities (including MSS activities) are permitted within these zones in accordance with the conditions attached to a Class Approval for mining activities (refer **Table 5-19**). 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 maty be authories provided they area consistent with the IUCN management principles and will not have an unacceptable impact on the values of the area (DNP, 2013).

Figure 5-26: South-east Commonwealth Marine Reserve Network (DoEE, 2018)



The management principles for IUCN VI areas are to manage mainly for the sustainable use of natural ecosystems based on the following (DNP, 2013):

- The biological diversity and other natural values of the reserve or zone are protected and maintained in the long-term;
- Management practices should be applied to ensure ecologically sustainable use of the reserve or zone; and
- Management of the reserve or zone should contribute to the regional and national development to the extent that it is consistent with these principles.

Management prescriptions for these reserves are detailed in the South-east Commonwealth Marine Reserves Network Management Plan 2013-2023 (DNP, 2013) and are observed in the Dorrigo MSS activity.

Table 5-19: Class Approval Conditions (applicable to seismic operations).

No:	Condition
1	Mining operations must only be carried on in Approved Marine Park Zones
2	Mining operations must be conducted in accordance with: a. the EPBC Act; b. the Network Management Plan; c. the EPBC Regulations; d. any prohibitions, restrictions or determinations made under the Regulations; and

No:	Condition
	e. other applicable Commonwealth and State laws (to the extent those laws are capable of operating concurrently with the laws and instruments described in paragraphs a. to d.).
3	Mining operations subject to the Offshore Petroleum and Greenhouse Gas Storage Act 2006 must be conducted in accordance with an Environment Plan accepted under the Act for those operations.
5	The Director of National Parks must be notified at least 14 days prior to the conduct of any operations in the Network. The following contact details should be used – marinereserves@environment.gov.au
6	If required by the Director of National Parks, provide information on operations authorised by this approval
7	All employees, servants, agents and contractors engaged in the conduct of mining operations in the Network must be fully informed of these conditions before commencing to take part in the operations.

Zeehan Commonwealth Marine Park:
The Zeehan CMP covers a depth range from 50 m (coastal shelf) to 3000 m (abyssal plain). A significant feature of this reserve is a series of four submarine canyons that incise the continental slope, extending from the shelf edge to the abyssal plain. The CMP includes a variety of seabed habitats, including exposed limestone, that support animal communities of large sponges and other, permanently fixed, invertebrates on the continental shelf. There are also extensive 'thickets' of invertebrate animals, such as lace corals and sponges, on the continental slope. The rocky limestone provides important habitats for a variety of commercial fish species, including the giant crab. The major conservation values for the Zeehan CMP are (DNP, 2013):

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

Apollo Commonwealth Marine Park:
The Dorrigo 3D MSS operational area lies approximately 3 km south of the Apollo CMP. The CMP has a water depth of less than 50 m near Cape Otway and extends to 100 m along the Otway Depression - a deep undersea valley joining the Bass Basin to the open ocean. The waters of the reserve are exposed to large swell waves generated from the south-west and strong tidal flows. The sea floor has many rocky reef patches interspersed with areas of sediment and, in places, has rich, benthic fauna dominated by sponges. Seabirds, dolphins, seals and white shark forage in the reserve, and blue whales migrate through Bass Strait (DNP, 2013). The major conservation values for the CMP are (DNP, 2013):

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

This CMP lies within the oil spill EMBA of the Dorrigo MSS.

The following CMPs also lie in proximity to the Dorrigo 3D MSS area however are not expected to be affected by MSS activities:

- Franklin CMR (IUCN VI) ~55 km east; and
- Boags CMR (IUCN VI) ~102 km east.

5.5.2 Tasmanian Protected Areas

Marine:
There are no Tasmanian marine reserves located in proximity to the Dorrigo MSS area. The closest Tasmanian marine reserve is the Kent Group Marine Reserve located approximately 315 km east (PWS, 2018c).

Terrestrial:
King Island has the following state reserves (PWS, 2009) (refer **Figure 5-27**):

- *Lavinia State Reserve*, a listed RAMSAR Wetland of International Importance, located on the NE side of King Island, contains a significant lagoon and wetland system. This reserve is not expected to be affected by Dorrigo MSS activities;
- *Cape Wickham State Reserve,* located ~ 29 km east of the Dorrigo MSS operational area, contains a lighthouse, gravesite of victims from the Loch Leven shipwreck and cairn from the old Victorian Cove settlement which used to be present at the site. This reserve is not expected to be affected by Dorrigo MSS activities;
- *Seal Rocks State Reserve* located ~21 km east of the Dorrigo MSS operational area contains a 7000-year calcified forest and spectacular cliffs at Seal Rocks. Seabird rookeries are present at this location (Threatened Species Section, 2012).

The west coast of King Island contains the following shoreline conservation areas (refer **Figure 5-27**):

- Cape Wickham Conservation Area (Cape Wickham to Cape Farewell) (IUCN V);
- Porky Beach Conservation Area (Quarantine Bay to Peerless point) (IUCN VI);
- Cataraqui Point Conservation Area (Stingray Bay to Sea Rocks State Reserve) (IUCN VI); and
- Stokes Point Conservation Area (Sunrise Point to Stokes Point) (IUCN V).

Island reserves surrounding King Island include:

- *Christmas Island Nature Reserve* (95Ha) (IUCN 1a), located ~18 km east of the Dorrigo MSS operational boundary, contains seabird rookeries and important nesting areas for little terns and hooded plovers (Threatened Species Section, 2012);
- *New Year Island Game Reserve* (130Ha) (IUCN VI) located ~18 km east of the Dorrigo MSS operational boundary is a granite island lying to the north-west of King Island allowing for the sustainable hunting of game species (i.e. short-tailed shearwaters) (hunting season is April) (DPIPWE, 2018g). The island forms part of the King Island IBA due to breeding seabirds and waders. Species include the short-tailed shearwater, fairy prion, pacific gull, silver gull and sooty oystercatcher (Threatened Species Section, 2012).
- *Councillor Island Nature Reserve* (11Ha) located on the eastern side of King Island and not expected to be affected by Dorrigo MSS activities (Threatened Species Section, 2012).
- *Reid Rocks Nature Reserve* (IUCN 1a) located ~ 45 km east of the Dorrigo MSS boundary is the only breeding colony for Australian fur seals in western Bass Strait and is not expected to be affected by Dorrigo MSS activities (DPIWE, 2000).

The oil spill EMBA does not enter Victorian state waters or affect Victorian marine protected areas.

5.5.3 World Heritage Properties

There are no World Heritage Properties within the EMBA. The closest sites are onshore in Melbourne (Royal exhibition Building and Carlton Gardens), Victoria (200 km northeast) and the Tasmanian Wilderness area (approx. 240 km southeast).

5.5.4 Commonwealth and National Heritage Places

The nearest places of Commonwealth and National Heritage to the Dorrigo MSS area are located onshore and do not have marine or shoreline components (DoEE, 2018az):

- Cape Wickham Lighthouse located ~29 km east;
- Great Ocean Road (VIC) located ~70 km north; and
- Western Tasmania Aboriginal Cultural landscape located ~ 150 km southeast.

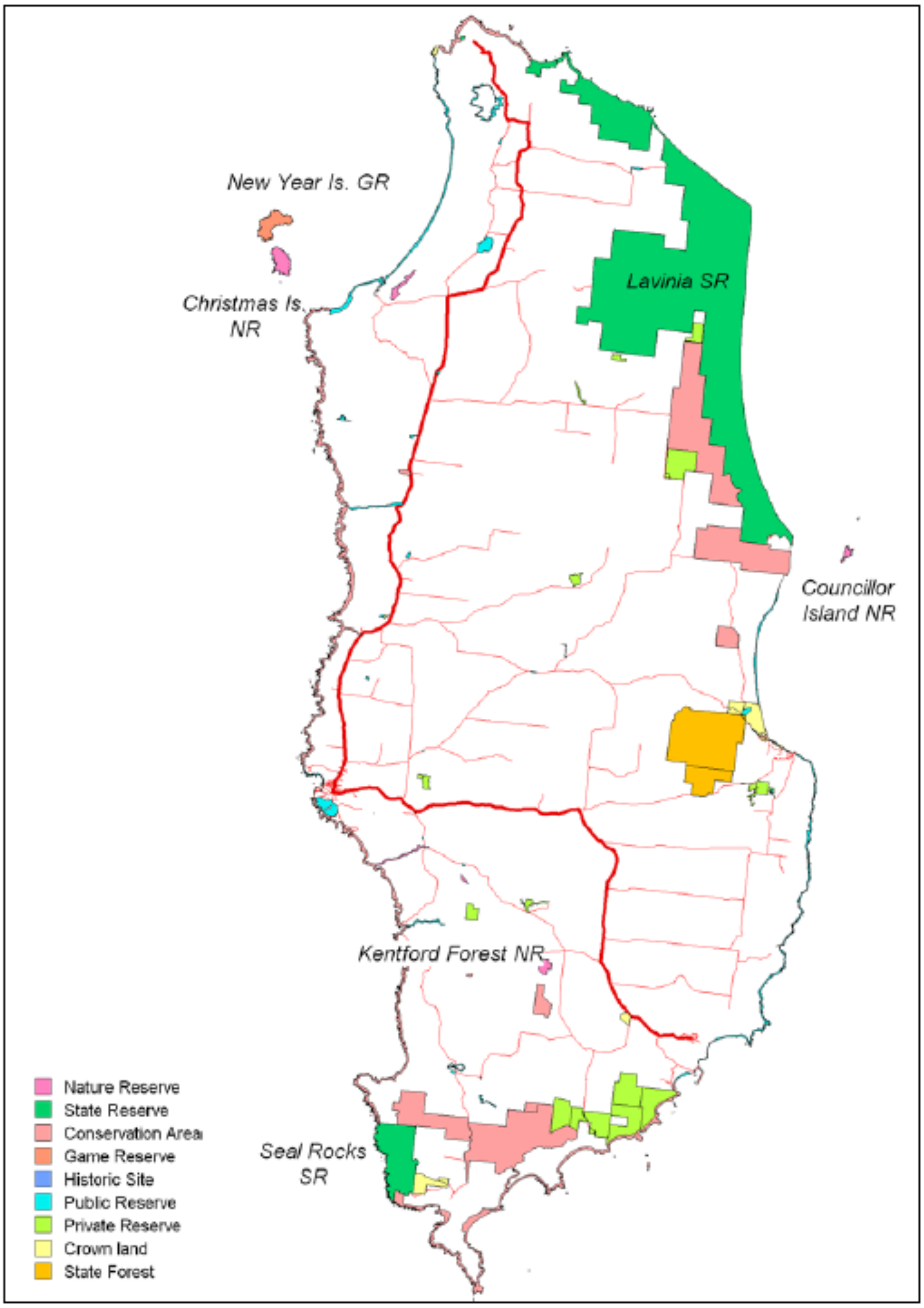
5.5.5 Wetlands of International and National Importance

There are no coastal Wetlands of National Importance within the EMBA. The closest site is Lavinia Reserve located ~ 33 km east of the nearest Dorrigo MSS boundary on the north-east of King Island (DoE, 2013d).

Nationally important wetlands 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 nay native plant or animal taxa or for its outstanding historical or cultural significance. Wetlands of National Importance in proximity to the survey area are Lake Flannigan, Bungaree Lagoon and Pearshape Lagoon 1 which are all located inland on King Island (DoEE, 2018a).

Given the location of these wetlands impacts from Dorrigo survey activities are not predicted.

Figure 5-27: King Island Reserve Network (Threatened Species Section, 2012)



5.5.6 Threatened Ecological Communities (TEC)

Threatened Ecological Communities (TECs) provide wildlife corridors and/or habitat refuges for many plant and animal species, and listing a TEC provides a form of landscape or systems-level conservation (including threatened species). The giant kelp marine forests of South East Australia and Subtropical and Temperate Coastal Saltmarsh are the only listed TECs in the EMBA and is protected under the EPBC Act.

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

Giant kelp is the largest and fastest growing marine plant. Their 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 southern rock lobster (*Jasus edwardsii*). The large biomass and productivity of the giant kelp plants also provide a range of ecosystem services to the coastal environment. Giant kelp is a cold-water species and as sea surface temperatures have risen on the east coast of Australia over the last 40 years, it has been progressively lost from its historical range (SEWPC, 2012).

Giant kelp requires clear, shallow water no deeper than approximately 35 metres (Edyvane, 2003; Shepherd and Edgar, 2012; cited in TSSC, 2012b). They are photo-autotrophic organisms that depend on photosynthetic capacity to supply the necessary organic materials and energy for growth. O'Hara (in Andrew, 1999) reported that giant kelp communities in Tasmanian coastal waters occur at depths of 5 to 25 m. The largest extent of the ecological community is in Tasmanian coastal waters from Eddystone Point in the north-east of Tasmania along the eastern coastline to Port Davey. It is also known to develop intermittently on the northern and western coasts of Tasmania (SEWPC, 2012b). The listing advice for the TEC identifies that in Tasmania, patches of the TEC are predominantly found in sheltered embayments associated with rocky reefs on the south and east coasts. Patches are rare on the west and northern coasts but do occur in sheltered areas where substrata and water conditions are favourable for growth (TSSC, 2012) (refer **Figure 5-28**).

Subtropical and Temperate Coastal Saltmarsh:
This TEC occurs on the coastal margin, along estuaries and coastal embayments and on low wave energy coasts. It is typically restricted to the upper intertidal environment, occurring in areas within the astronomical tidal limit, often between the elevation of the mean high tide and the mean spring tide (TSSC, 2013).

The ecological community consists of dense to patchy areas of mainly salt-tolerant vegetation (halophytes) including: grasses, herbs, sedges and shrubs that may also include bare sediment as part of the mosaic). It is inhabited by a wide range of in-faunal and epi-faunal invertebrates such as prawns, fish and birds. It often constitutes an important nursery habitat for fish and prawn species and insects are abundant (TSSC, 2013). Saltmarsh and its adjacent mudflats are used by migratory birds, stabilises the coast and contributes significant amounts of organic matter to estuaries. Saltmarshes in the north-west of Tasmania and on King island are important food sources for the endangered orange-bellied parrot (*Neophema chrysogaster*) (DPIPWE, 2018h). On King Island saltmarsh is restricted to the estuary and lower reaches of the Sea Elephant (east coast) and Yellow Rock Rivers (west coast) (Donaghey, 2003) (refer **Figure 5-29**). Oil spills are a potential threat to this TEC.

A priority conservation action listed for oil spill threats is to *identify Coastal Saltmarsh as an important habitat in oil spill contingency planning and monitor the application of protocols on the management of spills involving saltmarsh* (TSSC, 2013).

Figure 5-28: Giant Kelp Marine Forests of SE Australia Ecological Community (SEWPC, 2012)

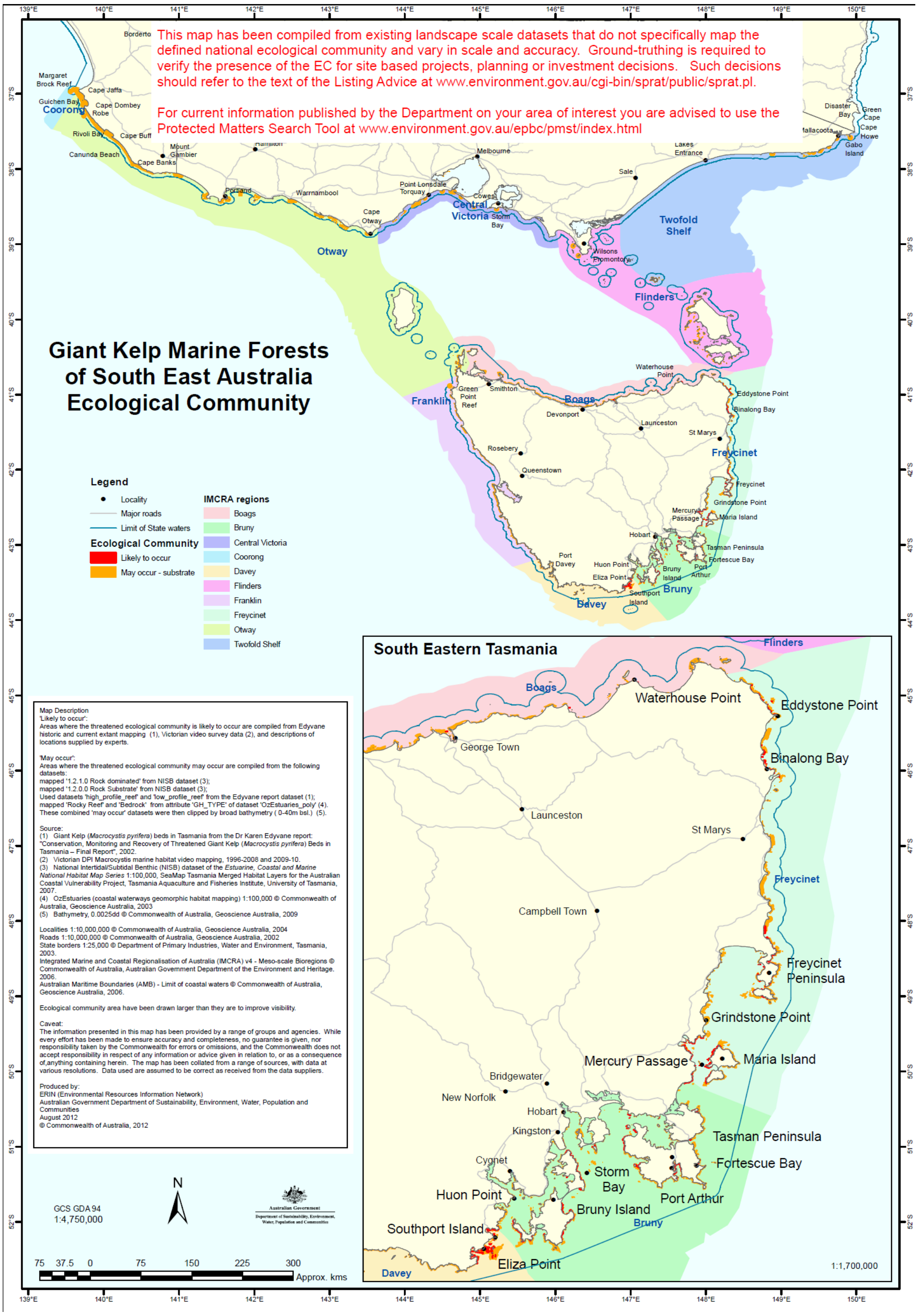
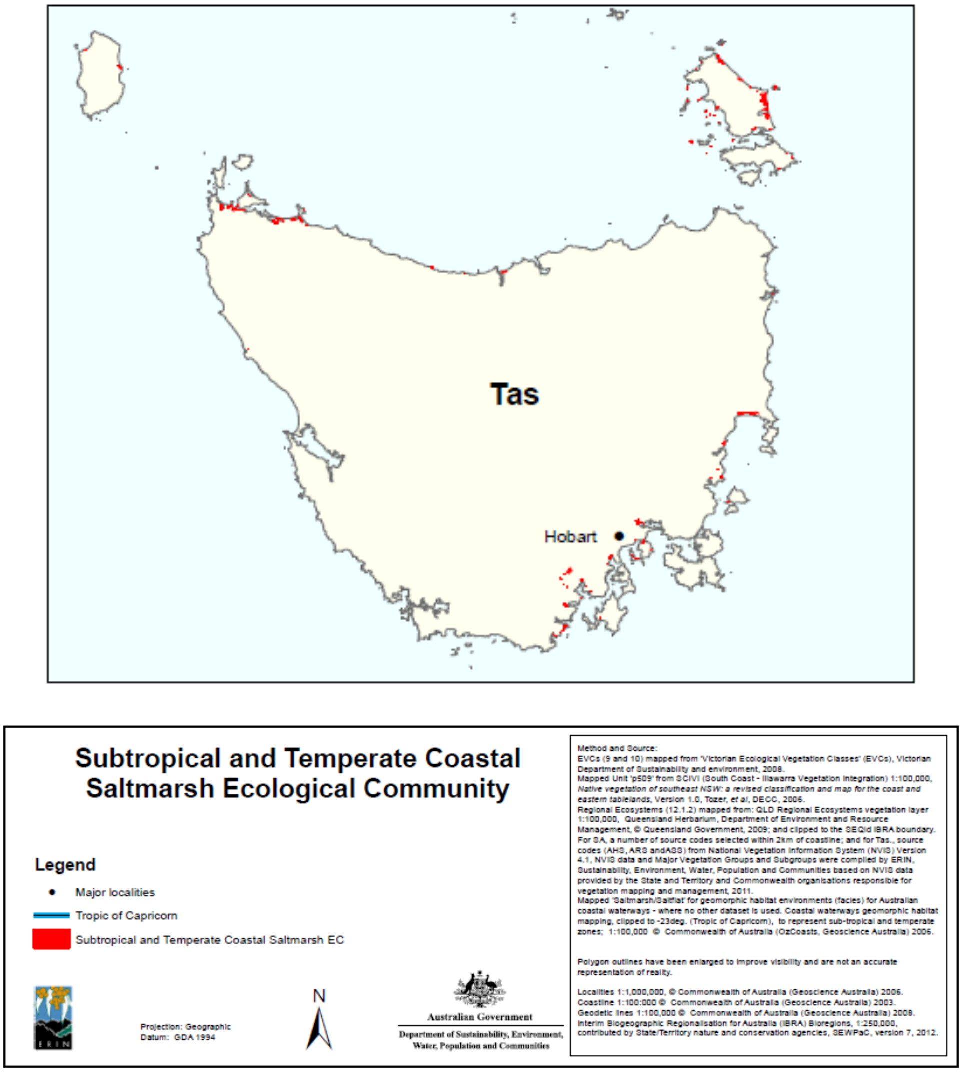


Figure 5-29: Subtropical and Temperate Coastal Saltmarsh Ecological Community (SEWPC, 2013)



5.5.7 Key Ecological Features

The following KEFs may have a presence in the Dorrigo MSS area oil spill EMBA:

- **West Tasmanian canyons** (*high productivity, aggregations of marine life*): The West Tasmania canyons are located on the edge of the continental shelf offshore of the north-west corner of Tasmania and as far south as Macquarie Harbour. These canyons can influence currents, act as sinks for rich organic sediments and debris, and can trap waters or create upwellings that result in productivity and biodiversity hotspots. For example, plumes of sediment and nutrient-rich water can be seen at or near the heads of canyons. Sponges are concentrated near the canyon heads, with the greatest diversity between 200 m and 350 m depth. Sponges are associated with abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts (DoE, 2015).
- **Shelf rocky reefs and hard substrates** (*high productivity, aggregations of marine life*): Rocky reefs and hard grounds are not spatially defined, however are located on the South-east Marine Region continental shelf including Bass Strait, from the sub-tidal zone shore to the continental shelf break. The continental shelf break generally occurs in 50 m to 150–220 m water depth. The shallowest depth at which the rocky reefs occur in Commonwealth waters is approximately 50 m. On the continental shelf, rocky reefs and hard grounds provide

attachment sites for macroalgae and sessile invertebrates, increasing the structural diversity of shelf ecosystems. The reefs provide habitat and shelter for fish and are important for aggregations of biodiversity and enhanced productivity (DoE, 2015).

The Dorrigo MSS areas lies at least 135 km from the Bonney upwelling KEF boundary (refer **Section 5.4.2**).

5.6 Cultural Heritage

5.6.1 Maritime Archaeological Heritage

Two laws protect the remains of shipwrecks in Commonwealth and Tasmanian waters. The Commonwealth *Historic Shipwrecks Act 1976* applies to Australian Commonwealth waters extending from the low water mark to the outer edge of the continental shelf. The Tasmanian *Historic Cultural Heritage Act 1995* applies to shipwrecks that lie in the state waters of Tasmania. Under these Acts, all shipwrecks and their associated artefacts lost over 75 years ago are automatically protected. Shipwrecks that occurred less than 75 years ago may also be individually protected under these Acts if considered significant. In special circumstances when a shipwreck is considered highly significant or vulnerable a 'Protected Zone' may be declared around the site, requiring a permit from the management authority to enter. There are currently no 'Protected Zones' in Tasmania.

King Island located in the centre of the western entrance to Bass Strait and exposed to the “roaring forties winds” is the location of over 60 known shipwrecks with 40 lying along its western coastline (DoEE, 2018ba). The strong waves, rocky reefs and cliffs of the region contributed to the loss of these ships. The wrecks represent recreational (i.e., diving) opportunities for tourists. Significant shipwrecks along the coast of King Island which forms part of the King Island Maritime Trail (Shipwrecks and Safe Havens) include the following (refer **Figure 5-30**):

- Blencathra (1875);
- British Admiral (1874);
- Carnarvon Bay (1910);
- Cataraqui (1845);
- Loch Leven (1871);
- Netherby (1866);
- Neva (1935);
- Sea Elephant Bay (1802); and
- Shannon (1906).

The Australian National Shipwreck Database does not record any historic shipwrecks or shipwreck protection zones within the Dorrigo MSS area (DoEE, 2018ba).

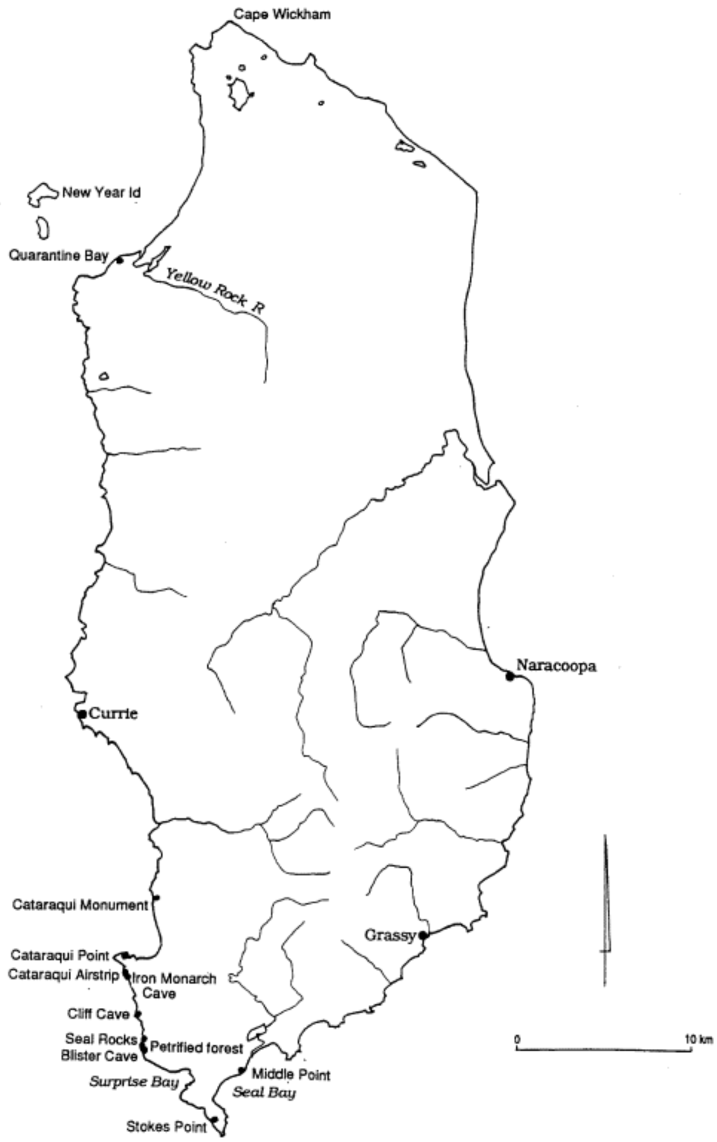
Figure 5-30: King Island Maritime Trail (King Island Tourism, 2018)

5.6.2 Aboriginal Heritage

Archaeological evidence suggests that the island was inhabited by aboriginals during the Pleistocene when King Island was connected to Tasmania, however by the time of earliest European occupation in the early 18th Century, no aboriginal inhabitants were observed (Huys, 2012). Stone artefacts have been recorded on the island along southwestern coastal cliffs, at the Petrified Forest (refer **Figure 5-31**) and elsewhere on the island in different dune formations. Aboriginal heritage sites on King Island typically contained low density stone artefact scatters with isolated midden finds. These sites are mostly located in close proximity to freshwater sources, particularly freshwater lagoons found in numerous locations on the island (Sim, 1991). On King Island there is less visibility of aboriginal heritage in coastal areas as the west and southwest coast has been inundated by dune formation with middens (shellfish and bones) only exposed through dune blowouts (Sim, 1991).

Locations on King Island where aboriginal middens have been observed include Cataraqui Monument (a quarry site 500 m from the Cataraqui Point headland), Quarantine Bay (shellfish midden located 15 m above sea level and 350m inland), Seal Bay at Middle Point (warrener shell midden located 30 m inland and 5 m above sea level) and New Year Island (Sim, 1991). Sea caves (Cliff Cave, Iron Monarch and Blister Cave) examined for aboriginal heritage indicate caves were not used in pre-historic times, except one possible artefact at the entrance to Iron Monarch. Human remains dating to 14,270 BC have been found in the Cliff Cave at a depth of 2.9 m and on New Year Island resulting from a dune blowout in the 1970s (Sim, 1991).

Figure 5-31: Relevant Locations of Aboriginal Heritage (Sim, 1991)



5.7 Socio-economic Environment

5.7.1 Settlements

King Island is located to the north-west of Tasmania, about 80-90 kilometres from both Victoria and Tasmania. King Island is surrounded by Bass Strait. King Island is predominantly rural, with three small townships. About half of the population live in the township of Currie, located on the west coast with two smaller townships at Grassy and Naracoopa located on the east coast. The Island enjoys a reputation for excellence in the production of food products. Beef and dairy farms cover the island. There is a small fishing industry, mostly southern rock lobster and a small number of abalone divers working from the island. King Island Dairy and JBS Australia are the two major employers on the Island. Kelp Industries is a major part of the Island economy and tourism has become the growth industry over recent times (KIRDO, 2014). The island's population is declining falling from about 1,800 in 1991 to less than 1,592 in 2016 (.idcommunity, 2018).

5.7.2 Tourism

King Island is situated off the North West tip of Tasmania approximately half way between Tasmania and Victoria with a resident population was 1,563 in 2011 with the local economy supporting 708 jobs (Nicol et al, 2013). The Island's main industries include agriculture and fishing which employed 164 people and manufacturing 130 in 2011 (Nicol et al, 2013). Of the 708 people employed in King Island, it is estimated that tourism supports 34 jobs (4.9% of King Island employment) (Nicol et al, 2013). The following tourism statistics are available for King Island (King island Council, 2016):

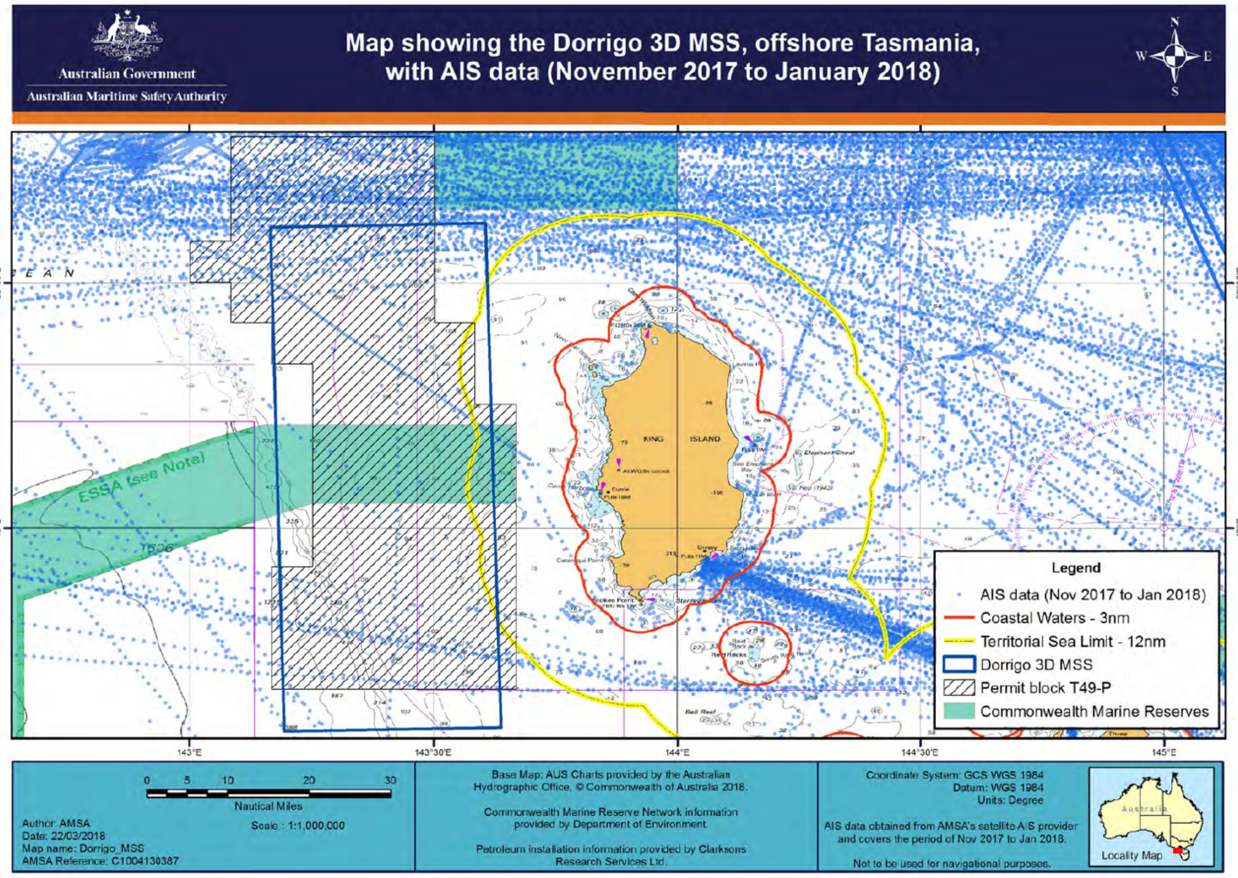
- Total visitors to the island during 2015/16 was approximately 13,500 with 64% of this population staying 3 nights or less (short-break holiday);
- Purpose of visit: Business (33%), holiday (49%) and visiting relatives (16%);
- Origin of visitors: Victoria (39%), Tasmania (29%) and NSW (16%) with international visitors (3%);
- High season for tourism on the island is mid-October to mid-April;
- Activities undertaken on the island during visits included recreational walks (29%); visiting arts and crafts shops (21%); food related festivals/tourism (16%); bird watching particularly penguins (9%); golf (8%); game bird hunting (6%); surfing (3%) and diving/snorkelling (2%);
- Places most visited were Lavinia Beach/Penny's Lagoon and the Calcified Forest/Seal Rocks Reserve.

The tourism sector is estimated to generate $5M in annual economic output from a total output of $190.6M (Nicol et al, 2013). The King Island tourism sector is estimated to contribute just over 0.2% of the Tasmanian tourism output (Nicol et al, 2013).

5.7.3 Commercial Shipping

AMSA have advised that the Dorrigo MSS area lies to the south of the main shipping route which runs east/west along Australia's southern coastline. The survey vessel when operating in the northern sections of the survey area will encounter heavier concentrations of transiting commercial shipping. A smaller route used by vessels that transit east/west into Bass Strait between King Island and the Fleurieu Group of islands is also present. AMSA (2018) advises that while these are the main shipping routes in and around the Dorrigo MSS area, vessels could be encountered anywhere in the survey area (refer **Figure 5-32**).

Figure 5-32: Commercial Shipping in and around Dorrigo MSS Area (AMSA, 2018)



5.7.4 Recreational Fishing

5.7.4.1 General

Since 2000 there has been a general decline in participation in recreational fishing (both in absolute and relative terms) (Lyle et al, 2014). Recreational fishing is a popular past-time for Tasmanians with one in four people over the age of 5 engaged in some type of recreational fishing activity (Lyle et al, 2009). During 2012-13 recreational fishers accounted for about 507,000 person-days of effort, with an average of 5.5 days per fisher. At the individual level, the majority fished for relatively few days (< 5 days) whereas a small proportion of particularly keen or avid fishers contributed disproportionately to the total effort (and catch). For instance, just 20% of fishers accounted for over half (55%) of the total fishing effort (Lyle et al, 2014).

The concentration of fishing effort within the Tasmanian recreational fishery was inshore coastal (58% fisher days) and estuarine waters (20% fisher days) (refer **Figure 5-33**). Comparatively little fishing effort was in waters greater than 5 km offshore (Lyle et al, 2014) and effort within the north-west region (includes King Island) was almost entirely by local residents. Line fishing was the main method used to catch fish with other methods including set-line and beach-seine (refer **Figure 5-34**). Flathead, Australian salmon and mullet dominated catches with a range of other finfish of secondary importance (Lyle et al, 2014). From these statistics, recreational fishing is not expected within the Dorrigo MSS area, but may be present in King Island coastal waters (< 5 km from shore).

Figure 5-33: Fishing effort (fisher days) by water body type for Tasmanian residents aged > 5 years who fished in Tasmania during 2012-13 (Lyle et al, 2014)

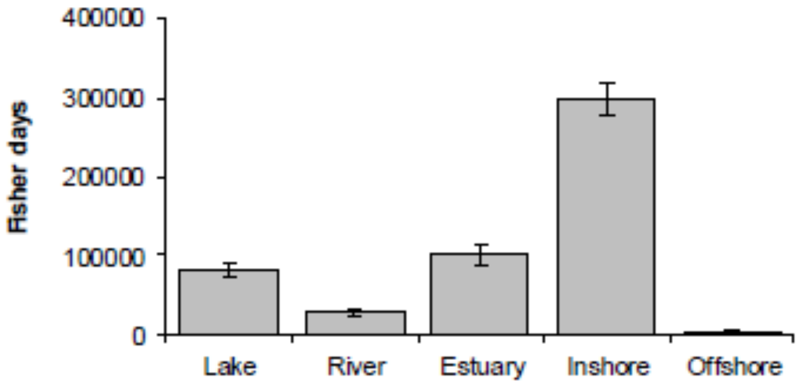
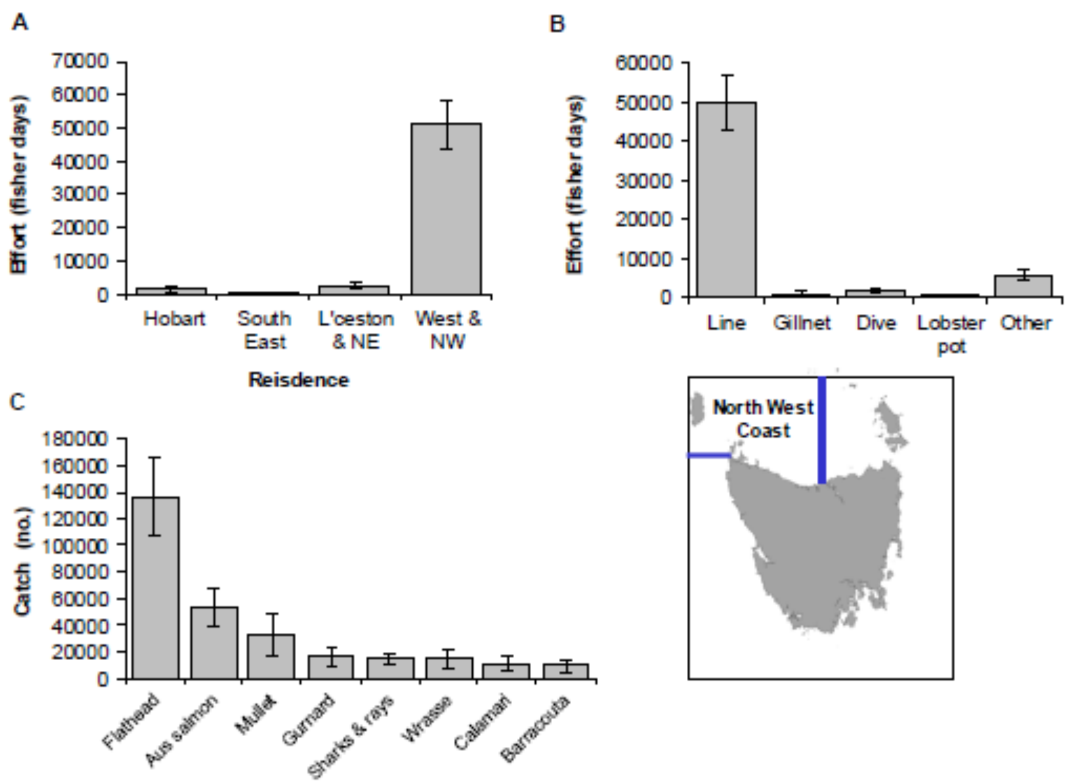


Figure 5-34: Recreational fishing characteristics of the North West based upon 2012-13 fishing activity a) fishing effort (fisher-days) based upon region of residence; b) effort (fisher days) by platform; c) catch (numbers) for the key species (Lyle et al, 2014)

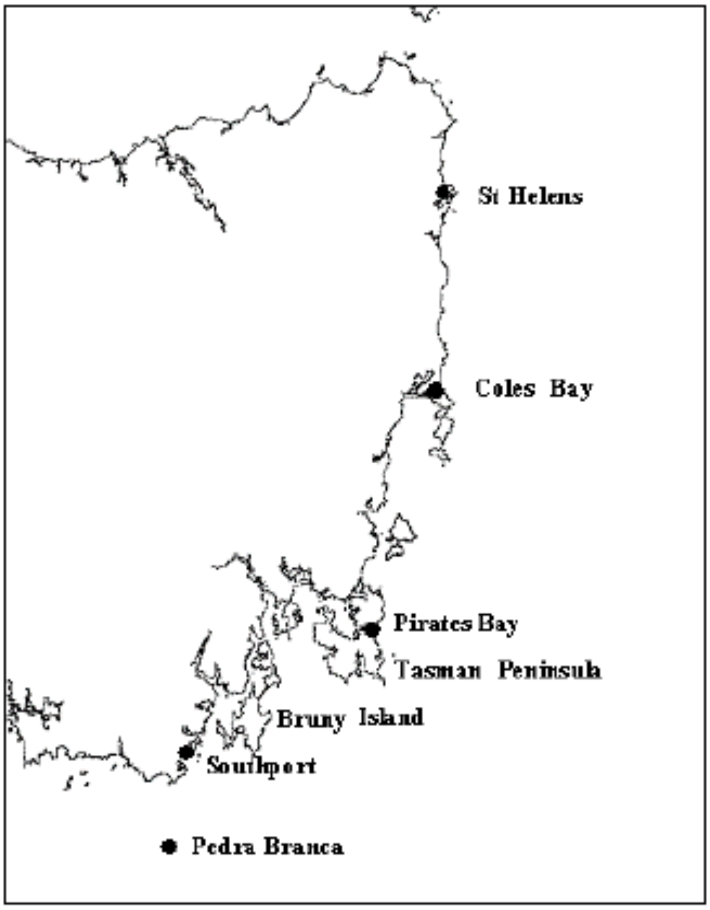


5.7.6.2 Game Fishing

Game-fishing represents a relatively minor and specialised component of the overall recreational fishery, however in social and economic terms the fishery is significant. Through direct expenditure, game-fishing is generally considered to provide disproportionately high financial inputs into regional economies, particularly the north east (St Helens) and south east (Tasman Peninsula) coastal regions (Forbes et al, 2009). The game-fishing season in Tasmania is typically limited to between January and June and is concentrated in waters extending out to the shelf break along the north-east, east and south coasts. St Helens in the north-east, Eaglehawk Neck (Pirates Bay) in the south-east and Southport in the south are recognised as regional epicentres of game-fishing activity. Game-fishing activity also occurs off Flinders Island (refer **Figure 5-35**) (Forbes et al, 2009).

The fishery targets several large pelagic species including; yellowfin tuna (*Thunnus albacares*), southern bluefin tuna (*Thunnus maccoyii*), albacore (*Thunnus alalunga*) and skipjack tuna (*Katsuwonus pelamis*) and mako shark (*Isurus oxyrinchus*). Catches of black marlin (*Makaira indica*) and striped marlin (*Tetrapturus audax*) are also occasionally taken (Forbes et al, 2009).

Figure 5-35: Important Game Fishing Locations around Tasmania (Forbes et al, 2009)



5.7.5 Commercial Fishing

The Dorrigo MSS area lies within three fishing management jurisdictions – Commonwealth, Victoria and Tasmania. **Figure 5-36** provides details of the Victorian/Tasmanian fishery boundary relative to the Dorrigo MSS area. Within the 4360 km^2 Dorrigo operational area, 2630 km^2 lies within Victorian waters and 1720 km^2 lies within Tasmanian waters. On a total acquisition basis (1580 km^2), 919 km^2 lies in Victorian waters and 664 km^2 lies within Tasmanian waters.

Table 5-20 provides a summary of the Commonwealth, Victorian and Tasmanian fishing management areas which intersect or lie adjacent to the Dorrigo MSS area; if the fishery is active within the Dorrigo MSS area or in the oil spill EMBA.

For fisheries which actively fish within the Dorrigo MSS area, further information is provided in this section. Catch and effort data for these fisheries has been obtained from the Victorian Fisheries Authority (VFA), the Australian Institute for Marine Science (AIMS) (Hobart) for Tasmanian Fisheries and the Australian Fisheries Management Authority (AFMA) for Commonwealth fisheries. Data has been independently complied by the South-east Trawl Fishing Industry Association (SETFIA) and Fishwell Consulting for 3D Oil.

Figure 5-36: Victoria/Tasmania Fishing Management Boundary

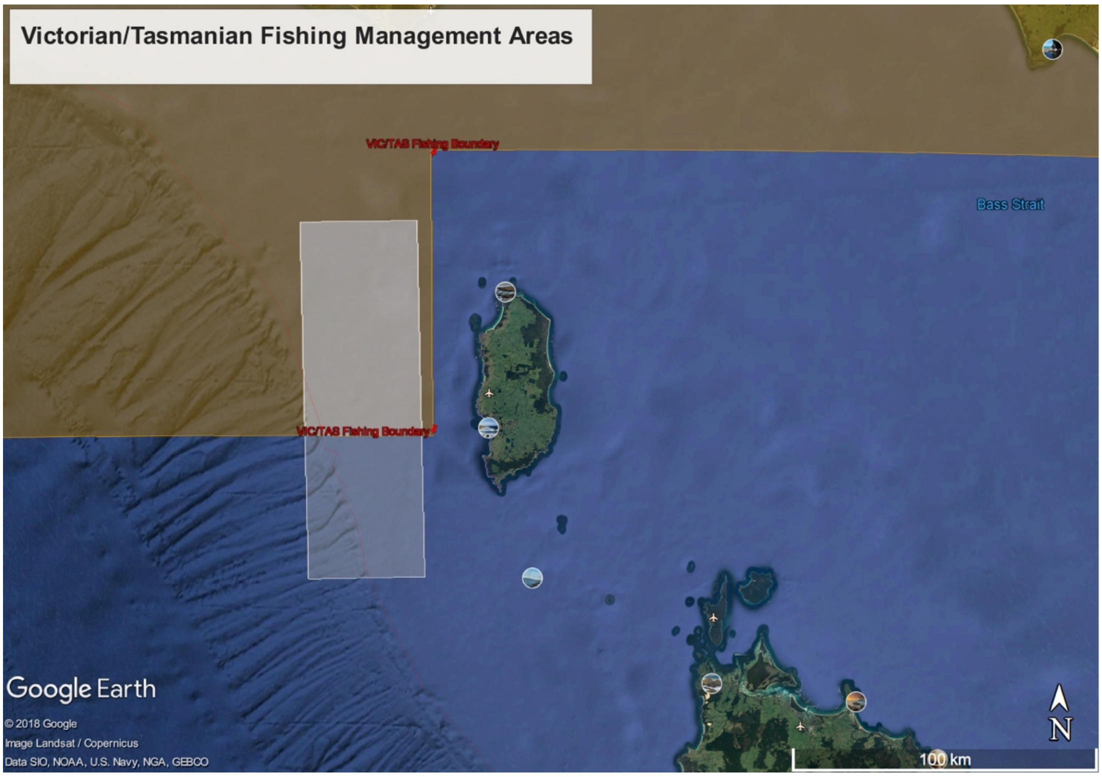
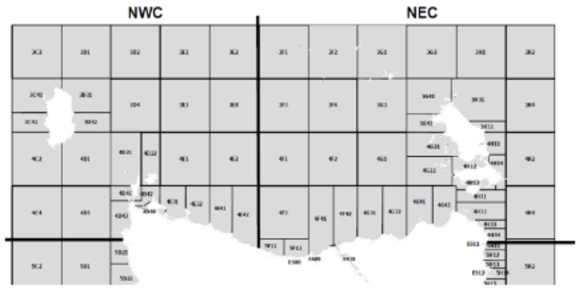


Table 5-20: Fishing Management Areas within the Dorrigo MSS Area

Fishery	Fishery Management Area	Active Fishing		Reference	Additional Details
		Dorrigo Operational Area	Dorrigo EMBA		
Commonwealth					
Bass Strait Central Zone Scallop Fishery	20-200nm from Victorian and Tasmanian coastlines (excludes King Island coastline)	No (All catch taken to east of King island or north of Flinders Island)	No	Patterson et al (2018)	NA
Eastern Tuna and Billfish Fishery	South Australia/ Victoria border, around east coast of Australia to Cape York, including waters around Tasmania	No (All catch taken along NSW, Qld, southern Tasmanian and western Victorina coastlines)	No	Patterson et al (2018)	NA
Skipjack Fishery (Eastern)	Extends from the border of Victoria and South Australia to Cape York, Queensland.	No (No active fishing in the fishery since 2008-09)	No	Patterson et al (2018)	NA
Small Pelagic Fishery	The Western sub-area extends from near Wilson Promontory National Park west to north of Perth out to 200 nm.	No (All fishing occurs off the NSW coastline)	No	Patterson et al (2018)	NA
Southern and Eastern Scale-fish and Shark Fishery (SESSF) - Commonwealth Trawl Sector [CTS]	CTS: 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.	Yes (Otter-board Trawl) (Confidential and low fishing intensity around shelf-break area)	Yes	Patterson et al (2018)	Section 5.7.5.1
Southern and Eastern Scale-fish and Shark Fishery (SESSF) – Scale-fish Hook Sector	Scale-fish Hook Sector: Includes all waters off South Australia, Victoria and Tasmania from 3 nm to the extent of the Australian Fishing Zone	Yes (Confidential Fishing on shelf area)	Yes	Patterson et al (2018)	Section 5.7.5.2

Fishery	Fishery Management Area	Active Fishing		Reference	Additional Details
		Dorrigo Operational Area	Dorrigo EMBA		
Southern and Eastern Scale-fish and Shark Fishery (SESSF) – Shark Gillnet and Hook sectors	Shark Hook and Gillnet Sector: Waters from the NSW/Victorian border westward to the SA/WA border, including the waters around Tasmania to the extent of the AFZ.	Yes (Low/Confidential Fishing on shelf area for Gillnet; Confidential for shark hook sector)	Yes	Patterson et al (2018)	Section 5.7.5.2
Southern Bluefin Tuna Fishery	The fishery extends throughout all waters in the AFZ	No (Fishing effort in SA and along NSW coastline and southern Tasmania)	No	Patterson et al (2018)	NA
Southern Squid Jig Fishery	The fishery extends from the SA/WA border east to southern Queensland.	Yes (Low level fishing around King Island and Victorian coastline)	Yes	Patterson et al (2018)	Section 5.7.5.3
Victorian					
Rock Lobster Fishery	The fishery extends from the Victorian coastline to latitude 40°S (between 140° 57.9'S and 143° 40' E) and 39° 12'S (between 143° 40'E and 150° 20'E). The Dorrigo MSS lies within the Western Zone (Apollo Bay to the SA/Vic border).	Yes	Yes	VFA (2018b)	Section 5.7.5.4
Giant Crab Fishery	The fishery extends from the Victorian coastline to latitude 40°S (between 140° 57.9'S and 143° 40' E) and 39° 12'S (between 143° 40'E and 150° 20'E). The Dorrigo MSS lies within the Western Zone (Apollo Bay to the SA/Vic border).	Yes	Yes	VFA (2018a)	Section 5.7.5.5
Abalone Fishery	The Dorrigo MSS lies within the Victorian Central Abalone Zone is located between Lakes Entrance and the mouth of the Hopkins River.	No (Diving in fishery is normally undertaken in state water depths less than 30 m).	No	VFA (2018c) DEDJTR, 2015	NA

Fishery	Fishery Management Area	Active Fishing		Reference	Additional Details
		Dorrigo Operational Area	Dorrigo EMBA		
Scallop Fishery	Fishery includes the waters of Victoria which extend out to 20 nm from the Victorian high-water mark excluding bays and inlets along the coast. Most fishing activity has occurred in the eastern waters of the state with most vessels launching from the ports of Lakes Entrance and Welshpool.	No	No	VFA (2018d)	Fishery is not within Dorrigo MSS Area
Wrasse Fishery	The commercial fishery extends along the entire length of the Victorian coastline out to 20 nm (except in marine reserves).	No	No	VFA (2018)	Fishery is not within Dorrigo MSS Area
Sea Urchin Fishery	The sea urchin fishery lies in State coastal waters only. The only zones which have been allocated quota are Port Phillip Bay and the Eastern Zone (near Mallacoota).	No	No	VFA (2018)	Fishery is not within Dorrigo MSS Area
Tasmanian					
Rock Lobster Fishery	The Tasmanian Rock Lobster Fishery operates in state and Commonwealth waters surrounding Tasmania. The Tasmanian Government has had jurisdiction of the fishery in waters south of 39° 12' (east of and including King island) and 40°S (west of King Island) and out to 200 nautical miles from the coastline.	Yes	Yes	TRLFA (2018)	Section 5.7.5.6
Giant Crab Fishery	The Tasmanian giant crab fishery operates in state and Commonwealth waters surrounding Tasmania. The Tasmanian Government has had jurisdiction of the fishery in waters south of 39° 12' (east of and including King island) and 40°S (west of King Island) and out to 200 nautical miles from the coastline.	Yes	Yes	DoE (2014)	Section 5.7.5.7
Abalone Fishery	The Tasmanian abalone fishery operates in state and Commonwealth waters surrounding Tasmania and lies adjacent to the Dorrigo MSS area.	No	Yes	DPIPWE (2018)	Section 5.7.5.8

Fishery	Fishery Management Area	Active Fishing		Reference	Additional Details
		Dorrigo Operational Area	**Dorrigo EMBA**		
Scale-fish Fishery	The Tasmanian scale-fish fishery operates in state and Commonwealth waters surrounding Tasmania (northwest & northeast zone shown below). 	No	Yes	SETFIA (2018)	Section 5.7.5.9
Abalone Fishery	The Tasmanian abalone fishery operates in state and Commonwealth waters surrounding Tasmania and lies adjacent to the Dorrigo MSS area.	No	Yes	DPIPWE (2018)	Section 5.7.5.9
Scallop Fishery	The area of the fishery extends from the high-water mark to 20 nm into Bass Strait (does not apply to waters around King Island) and from the highwater mark out to 200 nm of the rest of the state of Tasmania.	No	No	DPIPWE (2018) FRDC (2018)	Fishing effort is primarily concentrated in Bass Strait (northwest coast) and on the east and south-east coast of Tasmania
Octopus Fishery	The Tasmanian Octopus fishery operates in state and Commonwealth waters surrounding Tasmania	No	No	Bradshaw et al (2018)	Fishing effort is present to the east of King Island and within Central Bass Strait.

Fishery	Fishery Management Area	Active Fishing		Reference	Additional Details
		Dorrigo Operational Area	Dorrigo EMBA		
Commercial Dive Fishery	The commercial dive fishery, focussing on the sea urchin and periwinkles, encompasses all Tasmanian state waters in three separate zones – Central eastern zone (Friendly Point to the southern tip of Tasman Island); south-eastern zone (Tasman island to Whale Head) and an undeveloped zone (remaining 75% of state waters). Fishing Effort is concentrated in the central and south-eastern zones while the undeveloped zone is largely unexplored.	No	No	SEWPC (2011)	Sea urchins are abundant in shallow rocky reef habitats (DPI, 2008) and are collected via divers using hookah out of small vessels (< 10m in length) (DPIWE, 2005).
Shellfish Fishery	The commercial shellfish fishery includes *Venerupis* clams in Georges Bay, *Katelysia* cockles in Ansons Bay, native oysters *(Ostreaangasi)* in Georges Bay and wild Pacific oysters. It is a near-shore fishery also located on inter-tidal flats (DPIWE, 2007).	No	No	DPIWE (2007)	Oyster farming is undertaken at Sea Elephant River on the eastern side of King island (KIRDO, 2018).
Aquaculture					
Seaweed Fishery	The Commercial Seaweed Industry is a land-based fishery collecting and harvesting bull kelp, introduced and red and brown seaweeds (DPIPWE, 2018).	No	Yes	DPIPWE (2018)	Section 5.7.5.10

5.7.5.1 Commonwealth Trawl Sector

The Commonwealth trawl sector (CTS) of the SESSF lies in Australian Fishing Zone (AFZ) waters extending from Cape Jervis (SA) around the Victorian, Tasmanian and NSW coastlines northward to Barranjoey Point (refer **Figure 5-37** and **Figure 5-38**). This sector utilises demersal otter-board trawl and Danish seine equipment to target demersal species as detailed in **Table 5-21**. The waters west of King island are fished by the otter-board sector. No Danish seine vessels were present in west coast waters during 2017-18 (Patterson et al, 2018), however small effort occurred in 2015-16. Otter-board trawl effort is focussed along the shelf-break in the south of the survey area with little fishing on the shelf in the vicinity of the Dorrigo MSS (SETFIA/Fishwell Consulting, 2018). Fishery catch statistics for this sector are provided in **Table 5-21**. As assessment of fishery biomass sustainability based upon the stock affected by the Dorrigo MSS and fishery total catch compared with TAC by target species is provided in **Table 5-22.**

Figure 5-37: CTS – Otter-board Trawl Fishing Intensity (2017-18) (Patterson et al., 2018)

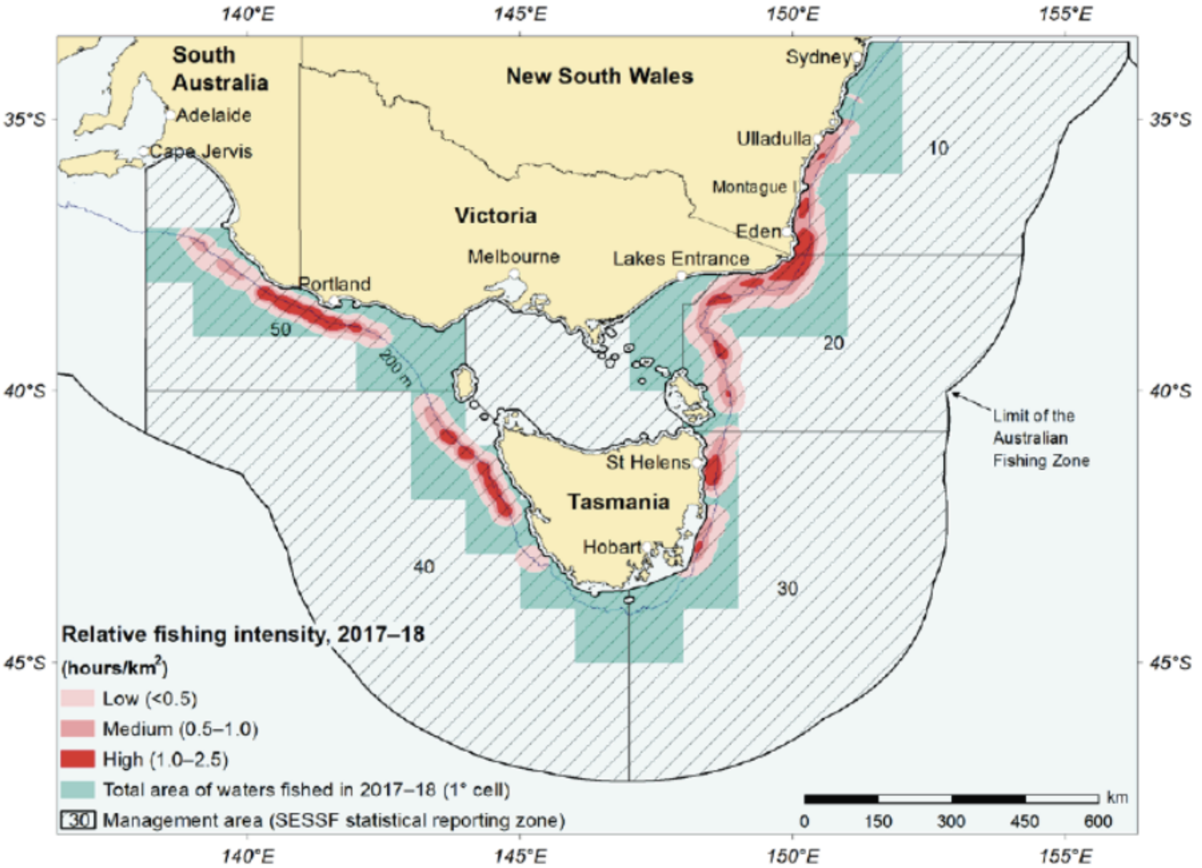


Figure 5-38: CTS – Danish Seine Fishing Intensity (2017-18) (Patterson et al., 2018)

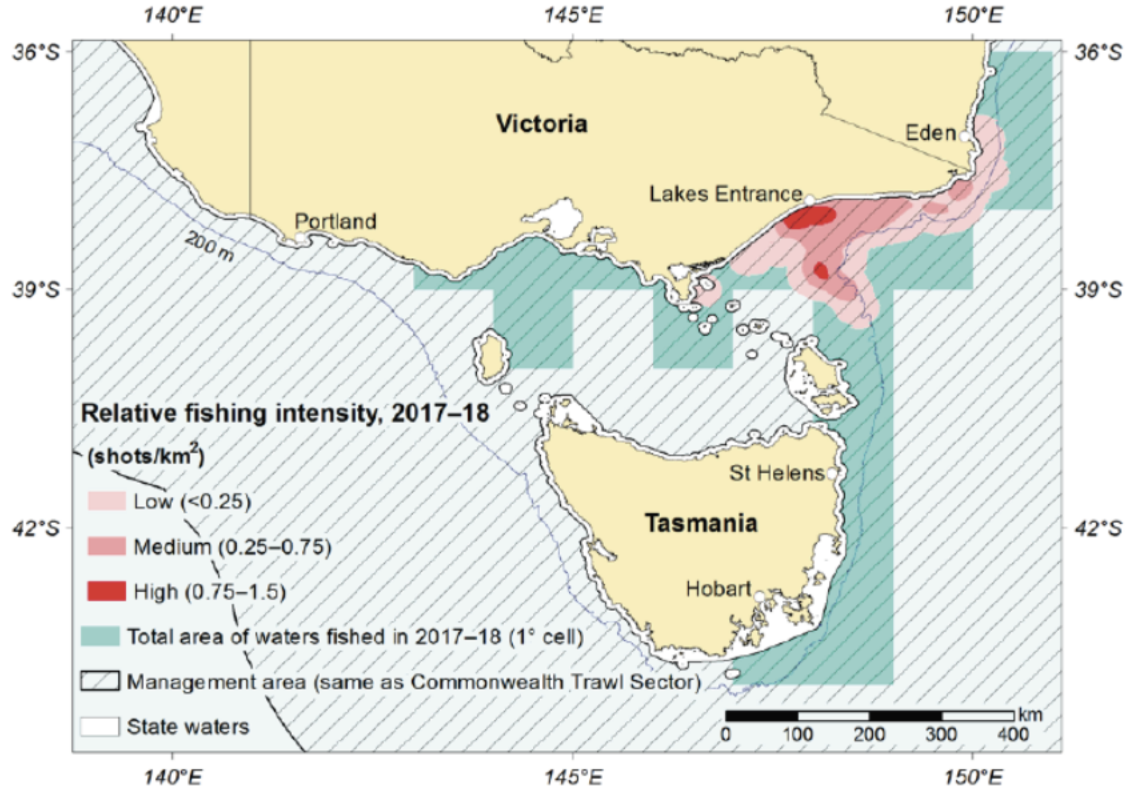
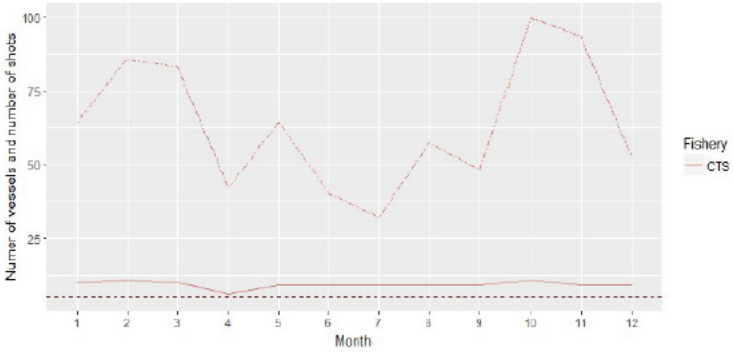


Table 5-21: Main Features and Statistics for the Commonwealth Trawl Sector (Patterson et al., 2018)

Aspect	Description Note: Information provided in Table is from Patterson et al (2018) except where otherwise referenced.
Primary Landing Port	Eden, Sydney and Ulladulla (NSW); Hobart (Tas); Lakes Entrance and Portland (Vic)
Management Method	Input Controls: Limited entry, gear restrictions, closure areas Output controls: Individual transferrable quotas (ITQs), total allowable catch (TAC), trip limits
Industry Representation	The Southeast Trawl Fishing Industry Association (SETFIA) represents the CTS fishery (SETFIA/Fishwell Consulting, 2018).
Fishing Season	1 May to 30 April Effort in the areas is highest during October to March over the past 10 years with a peak of 100 shots during October. Effort was lowest during July [redacted] The monthly catch trend reflects the pattern of effort with highest catches taken during February and March (SETFIA/Fishwell Consulting, 2018) (refer figure below – number of vessels recording effort (solid line) and number of shots recorded by CTS).

	
Encounter Rate in Dorrigo MSS	Since 2008, between [redacted] and [redacted] CTS vessels (including [redacted] Danish seine) have recorded fishing in the Dorrigo MSS area. Annual effort recorded by those vessels has fluctuated from [redacted] in 2017 to [redacted] in 2010 (SETFIA/Fishwell Consulting, 2018). [redacted]
Licences	Trawl (57), Danish seine (37)
Active Vessels (2016-17)	Trawl (32), Danish seine (18)
Catch Effort in Dorrigo MSS	Annual landings recorded by the CTS from the area of AFMA data request range from 34 tonnes (2011) to 90 t (2010). Over the 10-year period of 2008-17, a total of 574 tonnes of fish was caught by CTS in the Dorrigo MSS area with a value of just over $2M and in 2017 just under **<u>60 tonnes of fish</u>** was landed with a value just over $0.2M. The catch was dominated by slope-dwelling species including blue grenadier (55%), silver warehou (18%), King dory (12%), Pink ling (11%) and platypus shark (6%) (SETFIA/Fishwell Consulting, 2018).

Fishery Statistics	**TAC (tonnes)**		**Catch (tonnes)**		**Value ($M)**	
Bolded species are species likely to be caught in the Dorrigo MSS area (SETFIA/ Fishwell Consulting, 2018)	**2016-17**	**2017-18**	**2016-17 TOTAL (CTS Catch)**	**2017-18 TOTAL (CTS Catch)**	**2016-17 Total**	**2017-18**
Blue-eye trevalla	410	458	[redacted]	[redacted]	[redacted]	NA
Blue grenadier	8810	8810	[redacted]	[redacted]	[redacted]	NA
Blue warehou	118	118	[redacted]	[redacted]	[redacted]	NA
Deepwater shark eastern zone	47	46	[redacted]	[redacted]	[redacted]	NA
Deepwater shark western zone	215	215	[redacted]	[redacted]	[redacted]	NA
Eastern school whiting	868	986	[redacted]	[redacted]	[redacted]	NA
Flathead (several species)	2882	2712	[redacted]	[redacted]	[redacted]	NA
Gemfish, eastern zone	100	100	[redacted]	[redacted]	[redacted]	NA
Gemfish, western zone	247	199	[redacted]	[redacted]	[redacted]	NA
Jackass morwong	474	513	[redacted]	[redacted]	[redacted]	NA

John dory	167	175	[redacted]	[redacted]	[redacted]	NA
Mirror dory	325	235	[redacted]	[redacted]	[redacted]	NA
Ocean perch	190	190	[redacted]	[redacted]	[redacted]	NA
Orange roughy, cascade plateau	500	500	[redacted]	[redacted]	[redacted]	NA
Orange roughy, eastern zone	465	465	[redacted]	[redacted]	[redacted]	NA
Orange roughy, southern zone	66	66	[redacted]	[redacted]	[redacted]	NA
Orange roughy, western zone	60	60	[redacted]	[redacted]	[redacted]	NA
Smooth oreodory cascade plateau	150	150	[redacted]	[redacted]	[redacted]	NA
Smooth oreodory non-cascade plateau	90	90	[redacted]	[redacted]	[redacted]	NA
Other oreodories	128	128	[redacted]	[redacted]	[redacted]	NA
Pink ling	1144	1154	[redacted]	[redacted]	[redacted]	NA
Redfish	100	100	[redacted]	[redacted]	[redacted]	NA
Ribaldo	355	355	[redacted]	[redacted]	[redacted]	NA
Royal red prawn	387	384	[redacted]	[redacted]	[redacted]	NA
Silver Trevally	588	613	[redacted]	[redacted]	[redacted]	NA
Silver warehou	1209	605	[redacted]	[redacted]	[redacted]	NA
TOTAL (excludes sharks)	**20,095**	**19,382**	[redacted]	[redacted]	[redacted]	**NA**

Table 5-22: CTS Stock Assessment Impacts from Dorrigo MSS

Target Species	TAC (2017-18) (t)[17]	Catch (2017-18) (t) Total (CTS)	Dorrigo MSS Stock Affected (t) [18]	TOTAL (stock affected + fishery catch) (t)
Blue-eye trevalla	458	[redacted]	6	[redacted]
Blue grenadier	8810	[redacted]	33	[redacted]
Blue warehou	118	[redacted]	6	[redacted]
Flathead (several species)	2712	[redacted]	6	[redacted]
Gemfish, western zone	199	[redacted]	6	[redacted]
Jackass morwong	513	[redacted]	6	[redacted]
John dory	175	[redacted]	6	[redacted]
Mirror dory	235	[redacted]	6	[redacted]
Ocean perch	190	[redacted]	6	[redacted]
Pink ling	1154	[redacted]	6.6	[redacted]

[17] More than 100 species are regularly landed in the SESSF but only the main species are managed under quotas. At present, there are [redacted] species subject to TACs within the fishery (SETFIA/Fishwell Consulting, 2018). Accordingly, the 2017 catch figures identified for King dory ([redacted]) and platypus shark ([redacted]) area not managed via TAC given their small 'take' from the fishery does not need to be managed to maintain sustainability of stock.

[18] This is based upon the catch predicted to be affected by the survey (i.e. 60 t) and the proportion of catch by species identified by SETFIA/Fishwell Consulting (2018). Note that the residual 10% not allocated by SETFIA/Fishwell Consulting (2018) (i.e. 6 t) has been attributed to all other target species likely to be caught in the Dorrigo MSS as a conservative measure to assess possible biomass impacts.

Target Species	TAC (2017-18) (t)[17]	Catch (2017-18) (t) Total (CTS)	Dorrigo MSS Stock Affected (t) [18]	TOTAL (stock affected + fishery catch) (t)
Ribaldo	355	[redacted]	6	[redacted]
Silver Trevally	613	[redacted]	6	[redacted]
Silver warehou	605	[redacted]	6	[redacted]

5.7.5.2 Commonwealth Gillnet Hook & Trap Sector (including Scale-fish Hook Sector)

The Gillnet Hook and Trap Sector (GHTS) consists of the scale-fish hook sector (SHS) (refer **Figure 5-39**); the shark gillnet sector (refer **Figure 5-40**) and shark hook sector (refer **Figure 5-41**). The shark gillnet and shark hook sector use demersal gillnets and longlines to target gummy sharks and are restricted to waters shallower than 183 m (SETFIA/Fishwell Consulting). The scale-fish hook sector uses demersal longlines to target pink ling, and blue-eye trevalla restricted to waters deeper than 183 m (SETFIA/Fishwell consulting). Fishery catch statistics for this sector are provided in **Table 5-23** and breeding characteristics for the shark gillnet and hook target species are provided in **Table 5-24**. As assessment of fishery biomass sustainability based upon the stock affected by the Dorrigo MSS and fishery total catch compared with TAC by target species is provided in **Table 5-25**.

Figure 5-39: Scale-fish hook sector fishing intensity (2017-18) (Patterson et al., 2018)

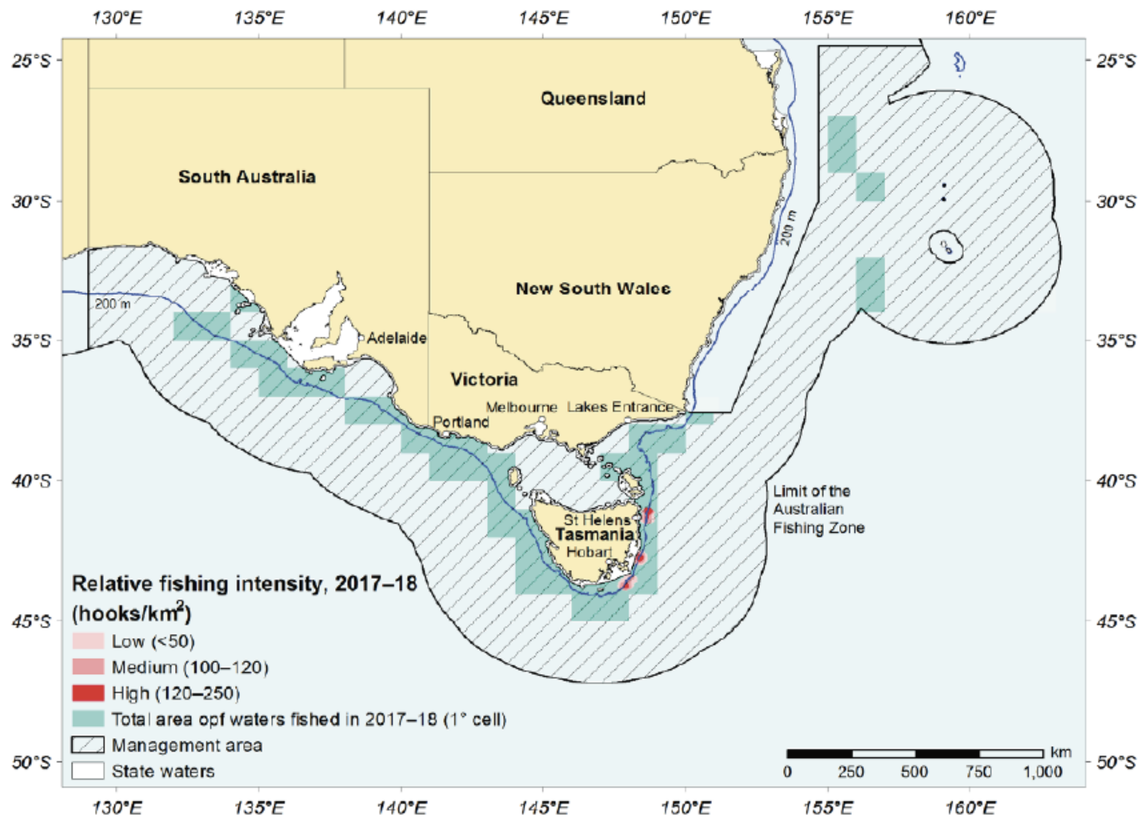


Figure 5-40: Shark hook sector fishing intensity (2017-18) (Patterson et al., 2018)

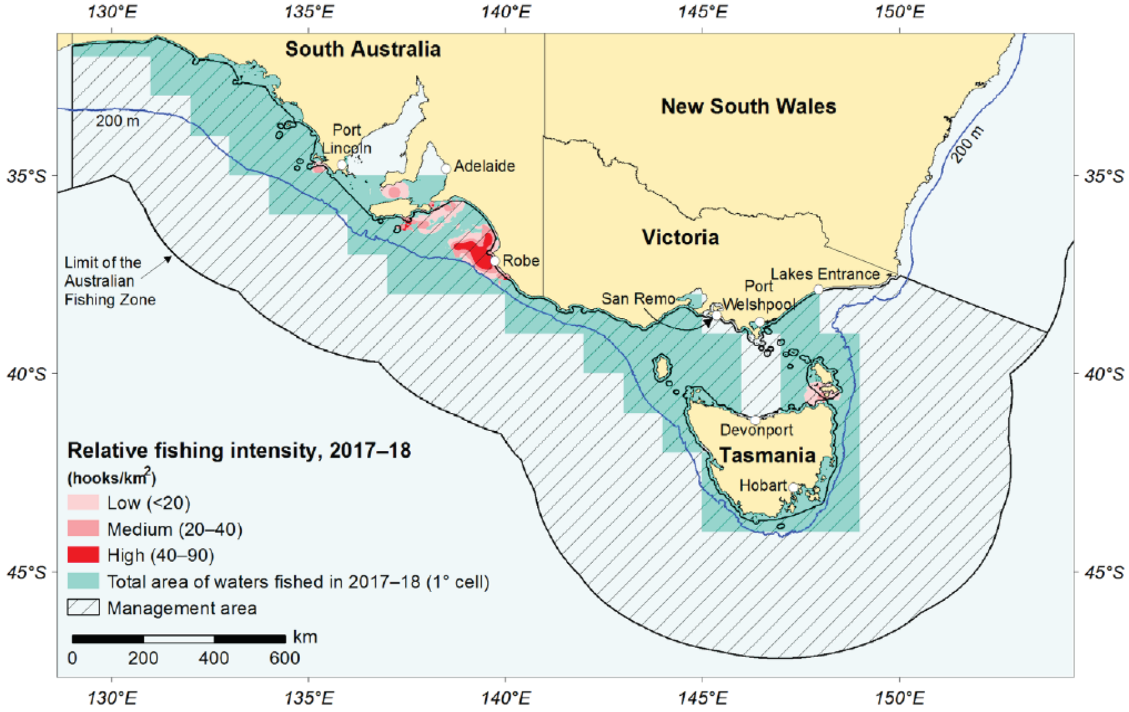


Figure 5-41: Shark Gillnet Sector Fishing Intensity (2017-18) (Patterson et al., 2018)

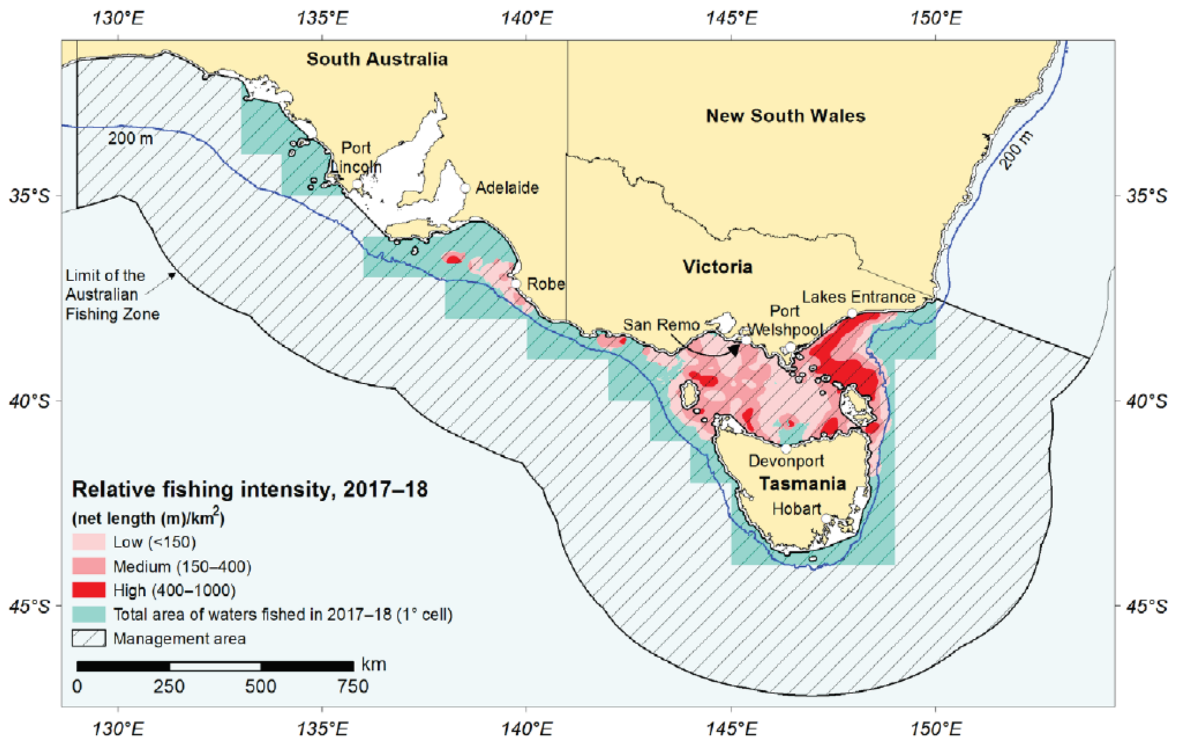


Table 5-23: Main Features and Statistics for the GH&T Fishery

Aspect	Description **Note: Information provided in Table is from Patterson et al (2018) except where otherwise referenced.**
Primary Landing Port	Adelaide, Port Lincoln, Robe (SA); Lakes Entrance, San Remo, Port Welshpool (Vic); Devonport, Hobart (Tas)
Management Method	Input Controls: Limited entry, gear restrictions, closure areas Output controls: Individual transferrable quotas (ITQs), total allowable catch (TAC), trip limits
Industry Representation	Two industry associations represent the sector – the Sustainable Shark Fishing Association (SSFA) and the Southern Shark Industry Alliance (SSIA) (SETFIA/ Fishwell Consulting, 2018).
Fishing Season	1 May to 30 April Seasonal catch distribution (green bars) and number of vessels (red line) by GHAT sector 2008-17 is shown in the figure below (SETFIA/Fishwell Consulting, 2018). Effort is highest during September to April when most of the catch is taken (SETFIA/Fishwell Consulting, 2018). [redacted]
Encounter Rate in Dorrigo MSS	Over 2008-2017, a total of [redacted] different GHAT vessels have fished in the Dorrigo MSS area. Total shots within that period summed to [redacted]. Disaggregation in year or month contravenes confidentiality policy (SETFIA/Fishwell Consulting, 2018). • For the scale-fish hook sector (2017-18): Vessels < 5 (confidential) • For the shark hook sector (2017-2018): Vessels < 5 confidential • For shark gillnet sector (2017-18): Vessels – low intensity (shelf areas).
Licences	Scale-fish Hook (37); Shark Gillnet (61); Shark Hook (13)
Active Vessels (2016-17)	Scale-fish hook (17); Shark Gillnet (27); Shark Hook (17)
Catch in Dorrigo MSS	Catch from AFMA is aggregated over the period 2007-2018 and during that period [redacted] vessels have fished in the Dorrigo MSS area. From [redacted] shots these fishers took [redacted] tonnes of fish values at ~ $[redacted] over the period 2007-2018. Main species caught were school shark (33%), gummy shark (29%) and pink ling (14%). [redacted] Because of the small number of species dominating the catch, value follows catch trends from about $[redacted] (2014) to just under $[redacted] in 2017 (SETFIA/Fishwell Consulting, 2018). Annual retained catch by GH&T within data request area is shown below. Number of vessels is annotated on bars (SETFIA/Fishwell Consulting, 2018).

	[redacted]					
Fishery Statistics	**TAC (tonnes)**		**Catch (tonnes)**		**Value ($M)**	
	2016-17	**2017-18**	**2016-17** **Total (GHTS tonnage)**	**2017-18** **Total (GHTS tonnage)**	**2016-17**	**2017-18**
Shark Hook and Gillnet Sector						
Gummy Shark	1836	1916	[redacted]	[redacted]	[redacted]	NA
Elephant fish	163	122	[redacted]	[redacted]	[redacted]	NA
Sawshark	482	481	[redacted]	[redacted]	[redacted]	NA
School shark	215	215	[redacted]	[redacted]	[redacted]	NA
TOTAL	**2696**	**2734**	[redacted]	[redacted]	[redacted]	**NA**
Scalefish Hook Sector (includes target species where GHaT > 1 tonne)						
Blue-eye trevalla*	410	458	[redacted]	[redacted]	[redacted]	NA
Blue Grenadier*	8810	8765	[redacted]	[redacted]	[redacted]	NA
Flathead (several species)*	2882	2712	[redacted]	[redacted]	[redacted]	NA
Gemfish (western zone)*	247	199	[redacted]	[redacted]	[redacted]	NA
Jackass morwong *	475	513	[redacted]	[redacted]	[redacted]	NA
Ocean perch*	190	190	[redacted]	[redacted]	[redacted]	NA
Pink ling*	1144	1154	[redacted]	[redacted]	[redacted]	NA
Ribaldo*	355	355	[redacted]	[redacted]	[redacted]	NA
TOTAL (GH&T + CTS)	**20,095**	**19,282**	[redacted]	[redacted]	[redacted]	**NA**

** Species likely to be caught in the Dorrigo MSS area (SETFIA/Fishwell Consulting, 2018)*

Table 5-24: Shark gillnet and hook target species spawning details

Species	**Spawning/Breeding Details**
Gummy shark	Adults are demersal on the continental shelf from inshore to approximately 80 m although sometimes found on the slope to 350m (Last & Stevens, 2009). Species is broadly distributed around southern coastline between Geraldton and Townsville. Records show long distance movements across southern Australia. Pupping frequency in SE Australia occurs every two years. Species does not have well defined nursery areas. Pups are generally born in shallow coastal areas. (Bruce et al. 2002). Species is viviparous giving birth to up to 14 pups in December (Last & Stevens, 2009).
Elephant fish	Species distributed throughout continental shelf areas (cool and temperate regions) to depths of at least 200m and distributed from Sydney to Esperance. Adult elephant fish migrate to shallower waters (generally <40m) of estuaries and bays in spring to breed (Bruce et al. 2002). Egg cases are large (about 25 cm long by 10 cm wide) (Last & Stevens, 2009).

Species	Spawning/Breeding Details
Saw shark	Species is distributed demersal on continental shelf from Caloundra (Qld) to Jurien Bay (WA) along the southern coastline and occurs in depths between 40-630m. (Bruce et al. 2001). Gestation/embryo development occurs between October & January. No details are available on breeding locations (Kailola et al. 1993). Viviparous with litters of 11 pups biennially (Last & Stevens, 2009).
School shark	Conservation-dependent species. Threats to the species is fishing pressure (over-fished). Sound is not identified as a threat to species recovery (TSSC, 2009). Species has widespread distribution in temperate waters from Brisbane to Perth mostly on the continental shelf to 800 m. Remains at depths of around 500 m during the day and moving up to around 100 m at night and moves extensively throughout waters of southern Australia (TSCC, 2009). The species is not endemic to Australia and is long-lived with low fecundity (every 2-3 years) reproducing in December and January off southern Australia (TSSC, 2009). Pupping areas have been confirmed in parts of Victoria, eastern and southern Tasmania (Bruce et al. 2002) and inshore coastal areas in parts of South Australia (TSCC, 2009). Viviparous with litters of 30 pups in December/January (Last & Stevens, 2009).

Table 5-25: GHaT Stock Assessment Impacts from Dorrigo MSS

Target Species	TAC (2017-18) (t)	Catch (2017-18) (t) Total (GHaT)	Dorrigo MSS Stock Affected (t) [19]	TOTAL (stock affected + fishery catch) (t)
Shark Hook & Gillnet Sector				
Gummy Shark	1916	[redacted]	4.4	[redacted]
Elephant fish	122	[redacted]	3.6	[redacted]
Sawshark	481	[redacted]	3.6	[redacted]
School shark	215	[redacted]	5	[redacted]
Scale-fish Hook Sector				
Blue-eye trevalla*	458	[redacted]	3.6	[redacted]
Blue Grenadier*	8765	[redacted]	3.6	[redacted]
Flathead (several species)*	2712	[redacted]	3.6	[redacted]
Gemfish (western zone)*	199	[redacted]	3.6	[redacted]
Jackass morwong *	513	[redacted]	3.6	[redacted]
Ocean perch*	190	[redacted]	3.6	[redacted]
Pink ling*	1154	[redacted]	2.1	[redacted]
Ribaldo*	355	[redacted]	3.6	[redacted]

19 This is based upon the catch predicted to be affected by the survey (i.e. 15 t) and the proportion of catch by species identified by SETFIA/Fishwell Consulting (2018). Note that the residual 24% not allocated by SETFIA/Fishwell Consulting (2018) (i.e. 3.6 t) has been attributed to all other target species likely to be caught in the Dorrigo MSS as a conservative measure to assess possible biomass impacts.

5.7.5.3 Commonwealth Southern Squid Jig Fishery

The Southern Squid Jig Fishery (SSJF) lies in AFZ waters extending from the Queensland/NSW border to the SA/WA border (excluding coastal waters) targeting arrow squid by squid jig methods (refer **Figure 5-42**). Fishing is carried out in continental shelf waters in depths targeting 50-120 m (AFMA, 2014). Waters outside of Port Phillip Bay is usually fished in February and early March and in western Victoria from January to June with highest catches traditionally concentrated in April and May (ABARES, 2008). The squid are present sporadically in high abundances in Tasmanian state waters in late summer/early autumn (FRDC, 2018). The success of squid jigging is greatly affected by weather; heavy winds and swells in Bass Strait in winter effectively halt the jig fishery. Moon phase also influences the catchability of Gould's squid with lower catch rates close to the full moon (ABARES, 2008). Squid are also caught by the Commonwealth Trawl Sector (CTS) and the GABTS and in recent years more squid has been landed by these fisheries than the SSJF. Most fishing takes place off Portland (March to June) at might between depths of 60 and 120 m (Patterson et al, 2018). Fishery catch statistics for the SSJF are provided in **Table 5-26** and breeding characteristics of Gould's squid is provided in **Table 5-27**.

Figure 5-42: Southern Squid Jig Fishery (2017) (Patterson et al., 2018)

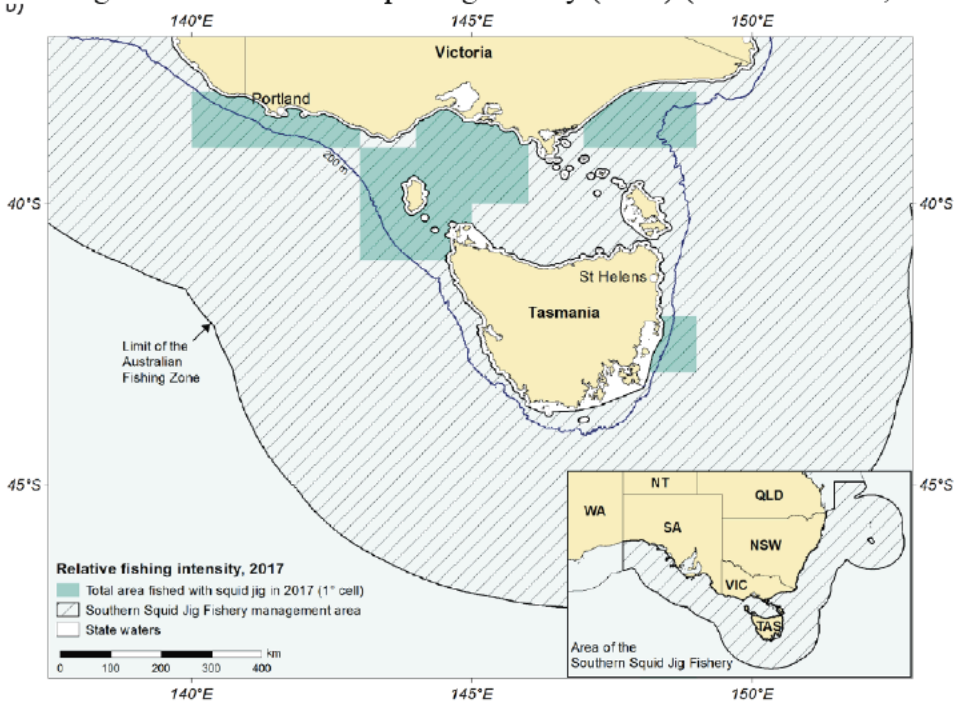
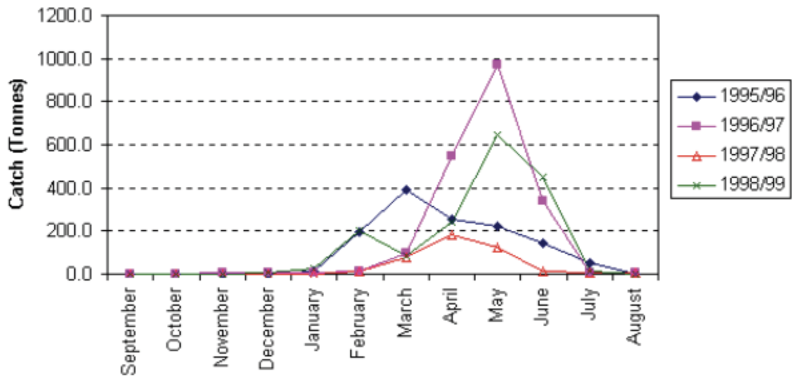
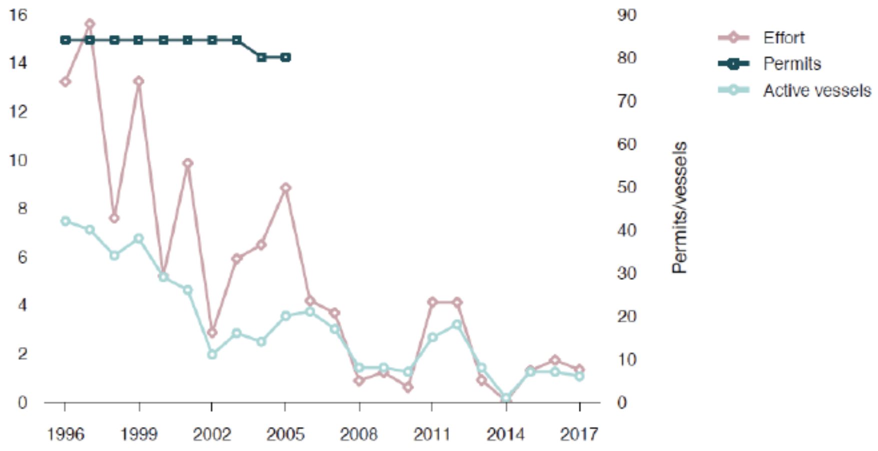


Table 5-26: Main Features and Statistics for the SSJF

Aspect	Description **Note: Information provided in Table is from Patterson et al (2018) except where otherwise referenced.**
Primary Landing Port	Portland, Queenscliff (Vic); Triabunna (Tas) (AFMA, 2018)
Management Method	Input Controls: Gear statutory fishing rights, number of jigging machines
Industry Representation	Commonwealth Fishing Association
Fishing Season	1 January to 31 December Actual fishing January and June (highest catch generally March and April)

Encounter Rate in Dorrigo MSS	<5 vessels (Patterson et al, 2018). Seasonal distribution of squid jig fishing is provided below (AFMA, 2004). *Dorrigo MSS activities fall outside of the squid jig fishery operational period.* 					
Licences/ Active Vessels	Statutory Fishing Rights have been issued for the fishery. The effort, number of permits and number of active vessels in the SSJF (1996-2017) is shown below. 					
Active Vessels (2017)	8 Active Vessels					
Catch Effort in Dorrigo MSS	The total catch of Gould's squid in Tasmanian-managed waters in 2016-17 was 176 t. This was a large decrease from 325 t in 2015-16. Most of the catch in 2016-17 was taken from the south-eastern coast of Tasmania and around King Island (Patterson et al, 2018). Due to the short lifespan of the squid (12 months), a weak relationship between recruitment and stock abundance and high inter-annual variability in squid abundance or availability means that a biomass target to trigger review is not considered appropriate. Instead, the SSJF does not have a biomass target. Instead the fisheries harvest strategy has a 3000t catch trigger to initiate a formal stock review (Patterson et al, 2018).					
Fishery Statistics	**TAE (Total Allowable Effort)**		**Catch (tonnes) (excludes CTS and GABTS)**		**Value ($M) (excludes CTS and GABTS)**	
	2016	**2017**	**2016**	**2017**	**2016**	**2017**
Gould's squid	550 jigging machines	550 jigging machines	[redacted]	[redacted]	[redacted]	NA
TOTAL	-	-	[redacted]	[redacted]	[redacted]	**NA**
Fishery History (Year)	**TAE**		**Total Catch (tonnes)**		**Fishing Intensity in Dorrigo MSS**	
2016	550 jigging machines		[redacted]		NO	

2015	550 jigging machines	[redacted]	NO
2014	550 jigging machines	[redacted]	NO
2013	550 jigging machines	[redacted]	NO
References: Patterson et al, 2017; Patterson et al, 2016; Patterson et al, 2015;			

Table 5-27: SSJF Target Species – Spawning Details

Species	Spawning/Breeding Details
Gould's squid (*Nototodarus gouldi*)	Species (including larvae) is distributed through southern Australian waters for 27oS and inhabit from estuaries to ocean depths of 500 m for most of their distribution. They are most abundant on the continental shelf between depths of 50-200 m (Kailola et al, 1993). Squid spawn multiple times through their Australian distribution and in south-eastern Australia spawn in all months. Gould's squid is relatively short-lived probably reaching a maximum age of only 12 months (Kailola et al, 1993).

5.7.5.4 Victorian Rock Lobster Fishery

The Victorian Rock Lobster Fishery extends from the Victorian coastline to latitude 40ºS (between 140º 57.9'S and 143º 40' E) and 39º 12'S (between 143º 40'E and 150º 20'E) (refer **Figure 5-43**). A portion of the Dorrigo MSS area lies in the 'western zone' of this fishery defined as the area between Apollo Bay and the SA/Victorian border. The fishery primarily targets the southern rock lobster (*J. edwardsii*) using baited lobster pots (SETFIA/Fishwell Consulting, 2018). Lobsters are fished from coastal reefs in waters up to approximately 150 m water depth with most of the catch coming from inshore waters less than 100 m deep (VFA, 2018b). Pots are generally set and retrieved each day marked with a surface buoy. Adult SRLs are carnivorous and feed mostly at night on a variety of bottom-dwelling invertebrates such as molluscs, crustaceans and echinoderms (VFA, 2018b). The major predators of rock lobster include octopus, various large fish and sharks (VFA, 2017). Fishery catch statistics for this sector are provided in **Table 5-28**. Spawning details for the southern rock lobster are detailed in **Table 5-29**.

Figure 5-43: Victorian Rock Lobster fishing management area (VFA, 2018)

Table 5-28: Main Features and statistics for the Victorian Rock Lobster Fishery

Aspect	**Description** **Note: Information provided in Table is from VFA (2017) except where otherwise referenced.**
Primary Landing Port	Portland, Port Fairy, Warrnambool, Port Campbell, Apollo Bay
Management Method	Input Controls: Limited Entry (Rock Lobster Fishery Access Licence), gear restrictions, closed seasons Output controls: TACs and ITQs, Minimum length,
Industry Representation	The Victorian Rock Lobster Association and Seafood Industry Victoria represent the Victorian Rock Lobster Fishery (SETFIA/Fishwell Consulting, 2018).
Fishing Season	1 July to 30 June Fishing closure from 15 September to 15 November for male rock lobsters and from 1 June to 15 November for female rock lobsters.
Encounter Rate in Dorrigo MSS	<5 vessel (confidential data) Effort during 2016/17 in the Western Zone was highest in December/January ([redacted] and [redacted] pot-lifts) and apart from the closed season, effort was lowest during May and June [redacted] and [redacted] respectively) (SETFIA/Fishwell Consulting, 2018) (refer to diagram below). Over the past 11 years, SRL fishermen have been present for [redacted] of these years in the Dorrigo MSS. No SRL licensees entered the MSS area during 2016/17. [redacted]
Licences	Number issued (71); Number active 2016-17 (43)
Active Vessels (2016-17)	[redacted]
Catch Effort in Dorrigo MSS	Historical fishing effort by the Victorian Rock Lobster Fishery shows some effort in the Dorrigo MSS area. Detailed catch and effort data were not provided by the Victorian Fisheries Authority to maintain confidentiality within this area. In the data reporting grids, the last 'non-confidential' reporting period recorded a total of 2,358 kg of Southern Rock Lobster was caught during 2007/08 from 4,483 pot-lifts over 69 fishing days. Over the period 2007/08 – 2016/17, a total of 44,883 kg of Southern Rock Lobster and Giant Crab was caught from 30,618 pot lifts over 460 fishing days by 13 different fishers. Based upon this catch data over a period of 10 years, an average of 4.4 tonnes lobster and giant crab catch (0.2t [giant crab] & 4.2 t [rock lobster] on a pro-rata basis according to relative quota tonnages) has been taken from the VFA data area requested which overlapped the Dorrigo operational area (total area provided was 3172km^2) (SETFIA/Fishwell Consulting, 2018). The Dorrigo MSS 'acquisition area' within Victorian waters is 919 km^2 (or ~1277 km^2 including run-in/run-out) which is 29% (or 40%) spatially of this data area collected from VFA. On this basis (40%), the level of Victorian SRL catch within the Dorrigo acquisition area is 1.7 tonnes (SRL) per annum. Catches were highest in December and January (SETFIA/Fishwell Consulting, 2018).

Fishery Statistics (West Zone)	**TAC (tonnes)**		**Catch (tonnes)**		**Value ($M) (SETFIA, 2018)**	
	2015-16	**2016-17**	**2015-16**	**2016-17**	**2015-16**	**2016-17**

Southern Rock Lobster	230	230	[redacted]	[redacted]	[redacted]	[redacted]
TOTAL	**230**	**230**	[redacted]	[redacted]	[redacted]	[redacted]
Fishery History (Year)	**TAC (tonnes)**		**Total Catch (tonnes)**		**Fishing Intensity in Dorrigo MSS**	
2014-15	230		[redacted]		< 5 licence holders	
2013-14	260		[redacted]		< 5 licence holders	
2012-13	260		[redacted]		< 5 licence holders	
2011-12	240		[redacted]		< 5 licence holders	

Note 1: Catch was limited due to retirement of quota associated with Origin buy-out of catch.

Table 5-29: Spawning Details for the southern rock lobster

Species	Spawning/Breeding Details
Southern Rock Lobster	The SRL lifecycle is complex – after mating in autumn, fertilized eggs are carried under the tail of the female for approximately three months before hatching typically between September and November (VFA, 2017; Kailola et al., 1993). The eggs hatch into larvae (or *phyllosoma*) a planktonic stage, which undergo eleven developmental stages over a period of 12-18 months in pelagic environments while being dispersed and distributed by oceanic currents to distances at least 1100 km from land (Kailola et al., 1993). Given the long-lived nature of the SRL larval phase, there can be up to two cohorts of larvae present in shelf waters at any one time. Larval distribution is initially in shelf waters with currents quickly dispersing larvae along shore and into offshore waters. Mixing of larvae and loss of larvae regional integrity is prevalent in southeast SA, Tasmania and eastern Victoria. Additionally, *phyllosoma* are found over a variety of water depths and are assumed to have no affective horizontal swimming capacity in the marine environment (Bruce et al., 2007). During metamorphosis juvenile rock lobsters shift from the planktonic (*phyllosoma*) phase to a benthic existence (termed *puerulus*) (DPI, 2009) settling into coastal and shelf habitats. Species recruitment and growth can vary from year to year depending on environmental changes including water temperature and movement of oceanic currents. The species presence within New Zealand and Australian waters has been demonstrated to comprise of a single stock (Ward et al., 2002). Transport of larvae in southern Australia is dominated by an easterly displacement from western natal spawning sites by currents running parallel to the coast from south-west WA to the east coast of Tasmania (Bruce et al., 2007). Rock lobsters grow by moulting or shedding their exoskeleton. The frequency of the moulting cycles declines with age from five per year for newly settled juveniles to once per year for mature adults (VFA, 2017). Fishing for male rock lobsters is prohibited between September 15 to November 15 to protect males during the moulting period when soft shells increase their vulnerability (VFA, 2017).

5.7.5.5 Victorian Giant Crab Fishery

The Victorian Giant Crab Fishery has the same fishing boundaries as the Victorian Rock Lobster Fishery (refer **Figure 5-43**). Giant crab inhabits the continental slope, the band of seabed that slopes steeply down from the edge of the continental shelf (the shelf break or shoulder) at approximately 200 metres depth to the deep ocean floor. Giant crabs are most abundant along a narrow zone of the seabed that is dominated by fragile bryozoan communities on the soft muddy banks along the shelf break (DPI, 2018). The fishery targets giant crab (*Pseudocarcinus gigas*) using baited lobster pots in depths of 150-300m (SETFIA/Fishwell Consulting, 2018). Giant crabs are slow moving carnivores that feed primarily on sedentary benthic species such as starfish, carrion, gastropods, asteroids and decapods (DPI, 2018).

Since the introduction of quota management in the giant crab fishery in 2001, there have been <5 dedicated fishers active in the fishery and up to 20 fishers annually reporting giant crab catch as by-product from rock lobster fishing (VFA, 2018). Fishery catch statistics for the giant crab fishery are provided in **Table 5-30**. Spawning details for the giant crab are detailed in **Table 5-31**.

Table 5-30: Main Features and statistics for the Victorian Giant Crab Fishery

<table>
<tr><th>Aspect</th><th colspan="6">Description

Note: Information provided in Table is from DPI (2010) except where otherwise referenced.</th></tr>
<tr><td>Primary Landing Port</td><td colspan="6">Portland, Port Fairy, Warrnambool, Port Campbell, Apollo Bay</td></tr>
<tr><td>Management Method</td><td colspan="6">Input Controls: Limited Entry (Giant Crab Access Licence), gear restrictions, closed seasons

Output controls: TACs and ITQs, Minimum length</td></tr>
<tr><td>Industry Representation</td><td colspan="6">Seafood Industry Victoria represent the Giant Crab Fishery (SETFIA/Fishwell Consulting, 2018).</td></tr>
<tr><td>Fishing Season</td><td colspan="6">Quota Period: 1 July – 30 June

Fishing closure from 15 September to 15 November for male giant crabs and from 1 June to 15 November for female giant crabs.</td></tr>
<tr><td>Encounter Rate in Dorrigo MSS</td><td colspan="6">Aggregation of Giant Crab and Rock Lobster fishery effort within the survey area, due to confidentiality provisions, identified there were less than five fishers operating in the area in 9 or the past 10 years (2007/8 to 2016/17) (SETFIA/Fishwell Consulting, 2018). A total of 13 different operators in the Victorian Rock Lobster and Giant Crab fishery have fished in the proposed MSS area during 2007/08 and 2016/17 (SETFIA/Fishwell Consulting, 2018).

Giant crab fishermen have entered the Victorian sector of the Dorrigo MSS in 10 of the past 11 years (SETFIA/Fishwell Consulting, 2018).</td></tr>
<tr><td>Licences</td><td colspan="6">Maximum number of licences (30); Number active (14)</td></tr>
<tr><td>Active Vessels</td><td colspan="6"><5 vessels</td></tr>
<tr><td>Catch in Dorrigo MSS</td><td colspan="6">Historical fishing effort by the Victorian Giant Crab Fishery shows some effort in the Dorrigo MSS area. Detailed catch and effort data was not provided by the Victorian Fisheries Authority to maintain confidentiality. As per the Victorian SRL assessment, over the period 2007/08 – 2016/17, a total of [redacted] kg of Southern Rock Lobster and Giant Crab was caught from [redacted] pot lifts over [redacted] fishing days by [redacted] different fishers (SETFIA/Fishwell Consulting, 2018).

Based upon this catch data over a period of 10 years, an average of 4.4 tonnes lobster and giant crab catch (0.2t [giant crab] & 4.2 t [rock lobster] based upon a pro-rata according to relative quota tonnages) has been taken from the VFA data area requested which overlapped the Dorrigo operational area (a total requested area of 3172km^2) (SETFIA/Fishwell Consulting, 2018). The Dorrigo MSS 'acquisition area' within Victorian waters is 919 km^2 (or ~1277 km^2 including run-in/run-out) which is 29% (or 40%) spatially of this data area collected from VFA.

On this basis (40%), the level of Victorian giant crab catch within the Dorrigo acquisition area is 0.08 tonnes per annum.

The TACC for the fishery has decreased from [redacted] t in 2009/10 to [redacted] t in 2013/14 and increased slightly to [redacted] t in 2016/7 (SETFIA/Fishwell Consulting, 2018). Most giant crab fishing is a by-product of rock lobster fishing (DPI, 2010). Of the total landed giant crab by all fishers in 2015/16 (i.e. 10 t), 9 t was targeted (DEDJTR, 2017). In 2014/15 of the 10.5 t caught, 10.2 t was targeted (DEDJTR, 2016).</td></tr>
<tr><th rowspan="2">Fishery Statistics (West Zone) (VFA-2018)</th><th colspan="2">TAC (tonnes)</th><th colspan="2">Catch (tonnes)</th><th colspan="2">Value ($M) (SETFIA/ Fishwell Consulting, 2018)</th></tr>
<tr><th>2014-15</th><th>2015-16</th><th>2014-15</th><th>2015-16</th><th>2015-16</th><th>2016-17</th></tr>
<tr><td>Giant Crab</td><td>10.5</td><td>10.5</td><td>[redacted]</td><td>[redacted]</td><td>[redacted]</td><td>[redacted]</td></tr>
<tr><td>TOTAL</td><td>10.5</td><td>10.5</td><td>[redacted]</td><td>[redacted]</td><td>[redacted]</td><td>[redacted]</td></tr>
</table>

Fishery History (Year) (DEDJTR-2017)	TAC (tonnes)	Total Catch (tonnes)	Fishing Intensity in Dorrigo MSS (SETFIA/ Fishwell Consulting, 2018)
2013-14	9	[redacted]	< 5 licence holders
2012-13	12	[redacted]	< 5 licence holders
2011-12	18	[redacted]	< 5 licence holders
2010-11	31	[redacted]	< 5 licence holders

Table 5-31: Spawning Details for the giant crab

Species	Spawning/Breeding Details
Giant Crab	Giant crab is considered a single biological fish stock across their range in southern Australia (Western Australia to Tasmania). Females bear eggs in non-moulting years with clutch size ranging from approximately 0.5 to 2.0 million eggs per year. Mating occurs in June-July and females carry eggs for approximately four months. As hatching approaches (October to November), females are thought to migrate to the shelf-break. The larval duration is around 50 days with dispersal larval release occurring at the edge of the continental shelf (FRDC, 2017). There is a strong capacity for larval dispersal over large spatial scales prior to settlement (PIRSA, 2002).

5.7.5.5 Tasmanian Rock Lobster Fishery

The Tasmanian Rock Lobster Fishery operates in state and Commonwealth waters surrounding Tasmania. Since 1986 the Tasmanian Government has had jurisdiction of the fishery in waters south of 39° 12’, and out to 200 nautical miles from the coastline by way of an Offshore Constitutional Settlement with the Commonwealth Government. The fishery is divided into 11 regions as detailed in **Figure 5-44**. The fishery primarily targets the southern rock lobster (*J. edwardsii*) using baited lobster pots (SETFIA/Fishwell Consulting, 2018). Most of the catch comes from 0-40 m water depths on coastal reefs however some catch is taken as deep as 200 m (SETFIA/Fishwell Consulting, 2018). Pots are generally set and retrieved each day marked with a surface buoy. Rock lobster foraging and habitat characteristics are described under the Victorian Rock Lobster Fishery. Fishery catch statistics for this sector are provided in **Table 5-32**. Spawning details for the SRL are detailed in **Table 5-29**.

Figure 5-44: Tasmanian Rock Lobster fishing management area (TRLFA, 2018)

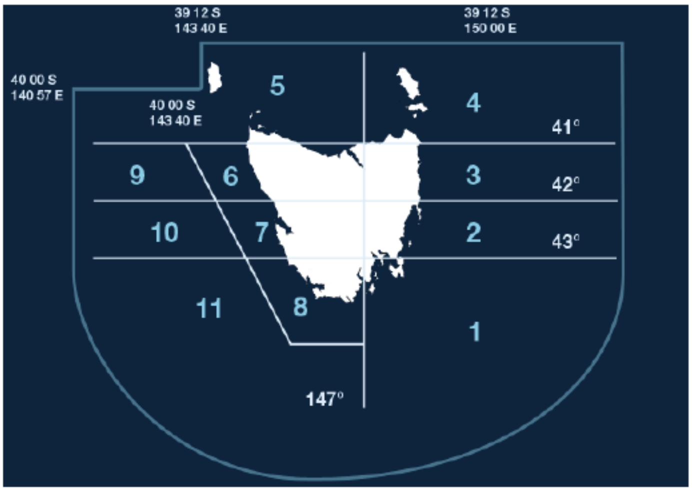


Table 5-32: Main Features and statistics for the Tasmanian Roc Lobster Fishery

Aspect	Description **Note: Information provided in Table is from SETFIA/Fishwell Consulting (2018) except where otherwise referenced.**
Primary Landing Port	North-west Tasmania: Currie Harbour, Grassie Harbour, Smithton, Stanley, Strahan, Wynyard (Fishery (Rock Lobster) Rules 2011)
Management Method	Input Controls: Limited Entry Licences, gear restrictions, closed seasons Output controls: ITQs, TACCs and Minimum length,
Industry Representation	The Tasmanian Rock Lobster Fisherman's Association and Tasmanian Seafood Industry Council (TSIC) represent the Rock Lobster Fishery (SETFIA/Fishwell Consulting, 2018).
Fishing Season	Seasonal closures are present in this fishery. 2018 opening dates are in place (2019 season to be advised): • Females: 1 May 2018 – mid November (all State Waters); • Males: 1 September (all waters south of St Helen's Pt around to Sandy Cape 41°29'S); • Males: 1 October (all other state waters). Closure is usually from mid-September to mid-November (KIRDO, 2018). http://www kingisland net.au/information/king-island-produce).
Encounter Rate in Dorrigo MSS	No information available.
Licences	Number issued (312); Number active (235) (SETFIA/Fishwell Consulting, 2018)
Active Vessels (2016-17)	No information available.
Catch in Dorrigo MSS	Historical fishing effort by the Tasmanian Rock Lobster Fishery shows some effort in the Dorrigo MSS area. Detailed catch figures for the IMAS area requested (2331 km^2) identifies that since 2008 the annual catch is less than [redacted] t with the most recent years (2014 & 2015) returning catch of [redacted] t and [redacted] t respectively (SETFIA/Fishwell Consulting, 2018). Based upon the catch data since 2008, the average catch is [redacted] t (SETFIA/Fishwell Consulting, 2018). The Dorrigo MSS acquisition area in Tasmanian waters is 664 km^2 (or ~926 km^2 including run-in/run-out) which is 28% (or 40%) spatially of this data area collected from IMAS. On this basis, the average annual catch in the Dorrigo MSS area for SRL is estimated at 7.7 tonnes per annum (40%). Based upon 10 year (total catch figures) the highest catch months were December, January, March and April (SETFIA/Fishwell Consulting, 2018). Total <u>10-year</u> catches of SRL increased from late winter to January. Catches were lowest during May to July. Catch data from October was omitted to protect confidentiality (SETFIA/Fishwell Consulting, 2018) (refer to diagram below). [redacted]

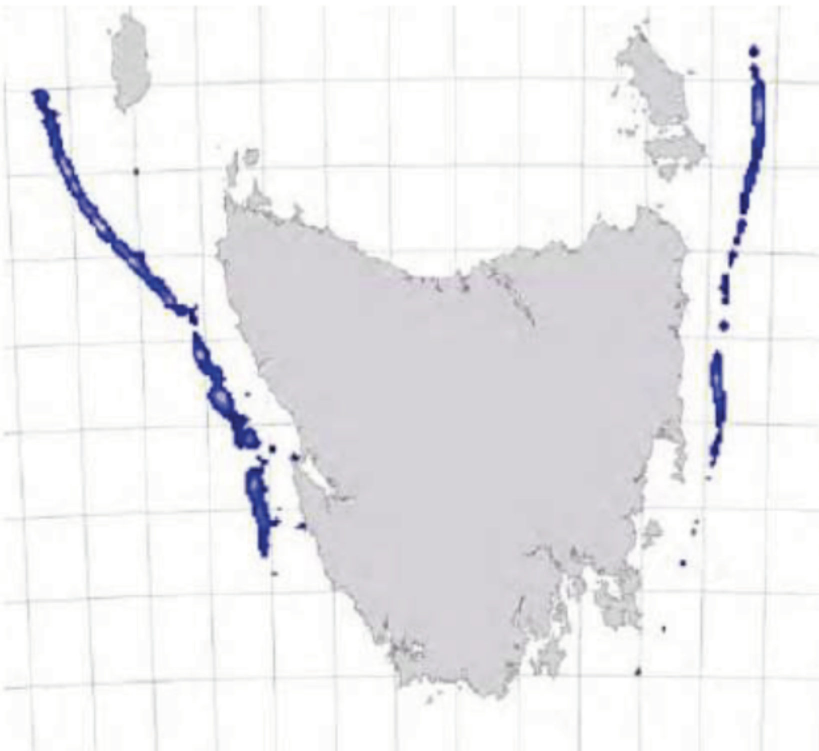
Fishery Statistics (DPIPWE, 2018)	TACC (tonnes)		Catch (tonnes)		Value ($M) (SETFIA/ Fishwell Consulting, 2018)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18

Southern Rock Lobster	1050.7	1050.7	[redacted]	[redacted]	[redacted]	[redacted]
TOTAL	**1050.7**	**1050.7**	[redacted]	[redacted]	[redacted]	[redacted]
Fishery History (Year) (DPIPWE, 2018)	**TAC (tonnes)**		**Total Catch (tonnes)**		**Fishing Intensity in Dorrigo MSS**	
2015-16	1050.7		[redacted]		NA	
2014-15	1050.7		[redacted]		NA	
2013-14	1103.19		[redacted]		NA	
2012-13	1103.24		[redacted]		NA	
2011-12	1103.24		[redacted]		NA	

5.7.5.6 Tasmanian Giant Crab Fishery

The Tasmanian Giant Crab Fishery has the same fishing management boundaries as the Tasmanian Rock Lobster Fishery (refer **Figure 5-44**. Most fishing takes place on the edge of the continental slope using baited steel traps (SETFIA/Fishwell Consulting, 2018) (refer **Figure 5-45**).

Figure 5-45: Tasmanian Giant Crab Active Fishing Areas (DoE, 2014)



Within the Tasmanian giant crab fishery most crabs (*Pseudocarcinus gigas*) are harvested between 140 m and 270 m (DoE, 2014) most abundant along a narrow zone of the seabed that is dominated by fragile bryozoan communities on the soft muddy banks along the shelf break (DPI, 2018). Fishery catch statistics for the Tasmanian giant crab fishery are provided in **Table 5-33**. Spawning details for the giant crab are detailed in **Table 5-31**.

Table 5-33: Main Features and statistics for the Tasmanian Giant Crab Fishery

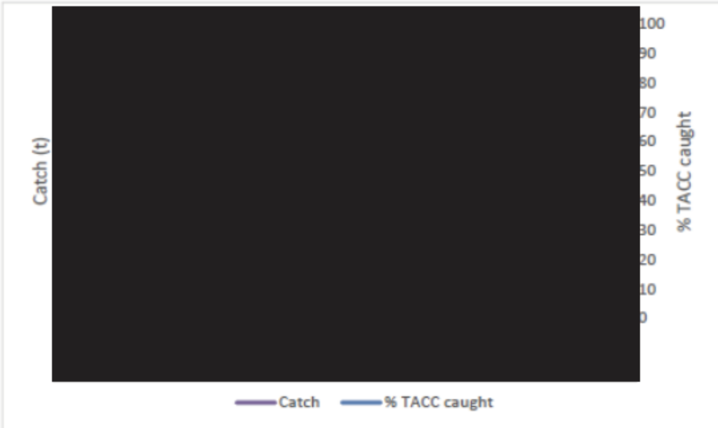
Aspect	**Description** **Note: Information provided in Table is from DPIPWE (2018) except where otherwise referenced.**
Primary Landing Port	North-west Tasmania: Currie Harbour, Grassie Harbour, Smithton, Stanley, Strahan, Wynyard (Fishery (Giant Crab) Rules 2013)
Management Method	Input Controls: Limited Entry (Giant Crab Access Licence), pot restrictions, closed seasons Output controls: TACs, Minimum length
Industry Representation	The Tasmanian Giant Crab Fishery is represented by the TSIC (SETFIA/Fishwell Consulting, 2018).
Fishing Season	Quota Period: 1 March – 28 February Males – Open all Year Females - Fishing closure from 1 June to 14 November.
Encounter Rate in Dorrigo MSS	Seasonal effort within the Giant Crab Fishery along the West Coast is lowest August to October and highest from November to February (refer Figure below) (SETFIA/Fishwell Consulting, 2018). [redacted]
Licences	Maximum number of licences (84); Number active (17) (2013/4)
Active Vessels	Not Available

Catch in Dorrigo MSS

Historical fishing effort by the Tasmanian Giant Crab Fishery shows some effort in the Dorrigo MSS area. Detailed catch figures for the IMAS area (2331 km^2) requested identifies that since 2008 the annual catch is less than 15.8 t with the most recent years (2014 & 2015) returning catch of 4.8 t (SETFIA/Fishwell Consulting, 2018).

The Dorrigo MSS acquisition area in Tasmanian waters is 664 km^2 (or ~926 km^2 including run-in/run-out) which is 28% (or 40%) spatially of this data area collected from IMAS. On this basis, the average annual catch in the Dorrigo MSS area for SRL is estimated at 1.9 tonnes per annum.

Annual catch within the Giant Crab Fishery against TACC is provided below.



Based upon 10 year (total catch figures) the highest catch months were December, January, March and April (SETFIA/Fishwell Consulting, 2018).

Fishery Statistics (West Zone) (DPIPWE, 2018)	**TAC (tonnes)**		**Catch (tonnes)**		**Value ($M) (DPIPWE, 2018)**	
	2016-17	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
Giant Crab	38.3	20.7	[redacted]	[redacted]	[redacted]	[redacted]
TOTAL	**38.3**	**20.7**	[redacted]	[redacted]	[redacted]	[redacted]

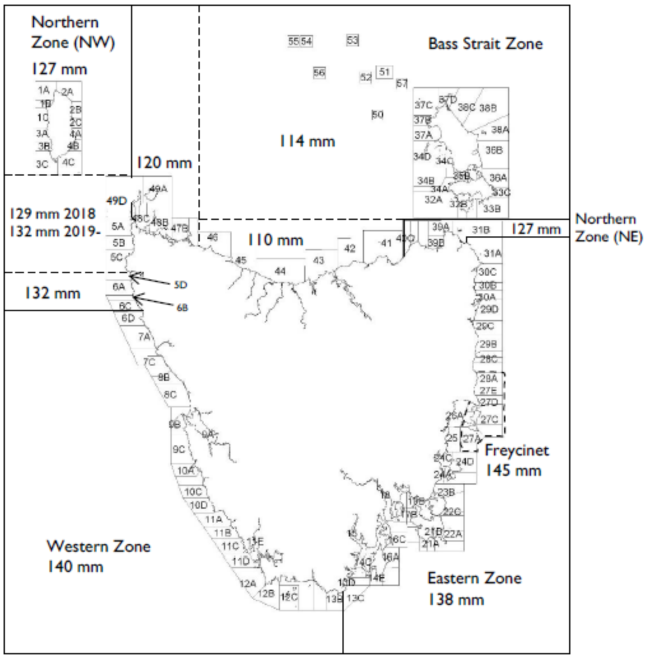
Fishery History (Year) (DPIPWE, 2018)	**TAC (tonnes)**	**Total Catch (tonnes)**	**Fishing Intensity in Dorrigo MSS (SETFIA/ Fishwell Consulting, 2018)**
2015-16	38.3	[redacted]	NA
2014-15	38.3	[redacted]	NA
2013-14	46.6	[redacted]	NA
2012-13	46.6	[redacted]	NA
2011-12	51.75	[redacted]	NA
2010-11	51.75	[redacted]	NA

5.7.5.8 Tasmanian Abalone Fishery

The Tasmanian abalone fishery operates in Tasmanian coastal waters as defined in **Figure 5-46**. Abalone harvesting around King Island is classified as the 'northern zone'.

The Tasmanian abalone fishery focuses predominantly on blacklip abalone (*Haliotis rubra*), with greenlip abalone (*H. laevigata*) typically accounting for around 5% of the total wild harvest in Tasmania (Mundy & Jones, 2017). The total abalone landing for 2016 was 1693.5t comprising of 1559.6t of blacklip and 133.9t of greenlip abalone (Mundy and Jones, 2017). The fishery is a major contributor to the Tasmanian economy and is the largest wild abalone fishery in the world contributing around 25% of the annual harvest (DPIPWE, 2018). The total value of the Tasmanian abalone fishery in 2015-16 was $79.7M (ABARES, 2018)[20]. There are no more than 121 fishing licences (abalone dive) operating in the fishery at any time (Tasmanian Government, 2018)[21].

Figure 5-46: Tasmanian Abalone Fishery Management Area (statistical blocks) (DPIPWE, 2018)



Located on the northwest coast of King Island is the Waterwitch Reef Abalone Research area. Within this area, bounded by a line from 143°47'50"E/39°53'00"S to 143°48'50"E/39°53'00"S to 143°48'50"E/39°54'00"S to 143°47'50"E/39°54'00"S, there is no taking of any fish by diving or swimming underwater and entering those waters for the purpose of diving or swimming underwater is prohibited (DPIPWE, 2018)[22]. The Waterwitch Reef Research Area provides a comparison of changes in biological parameters between fished and unfished sites (Tarbath and Officer, 2003). This research area is located 15 km from the nearest Dorrigo MSS operational boundary and 26 km from the nearest survey acquisition line.

Abalone is a univalve marine gastropod inhabiting near-shore reefs preferring cold water masses ranging between 9-14°C. Blacklip abalone is typically found on sheltered reefs, hidden in caves, fissures and narrow crevices, in water depths ranging from 5 to 20 metres (PIRSA, 2012). Greenlip abalone is found throughout southern Australia from Corner Inlet (Vic) to Cape Naturaliste (WA), with the bulk of the population found in SA (Stobart et al, 2012). For most of their distribution, they occur in two types of habitats. One habitat type is low reef areas at water depths from 5 to 40 metres where abundance is usually highest on the leeward side of reefs, headlands, and islands and protected from the full force of wave action. Drift algae tends to gather in these locations and provides a good supply of food. The second habitat occurs in rough water at the base of steeply sloping granite cliffs, and usually along the sides of gutters or clefts from depths of 10 to 25 metres. In areas of calm water, Greenlip abalone may occur in shallower water on rocky habitat near

[20] http://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-data#australian-fisheries-and-aquaculture-statistics-2016).

[21] Fishery (Abalone) Rules 2017

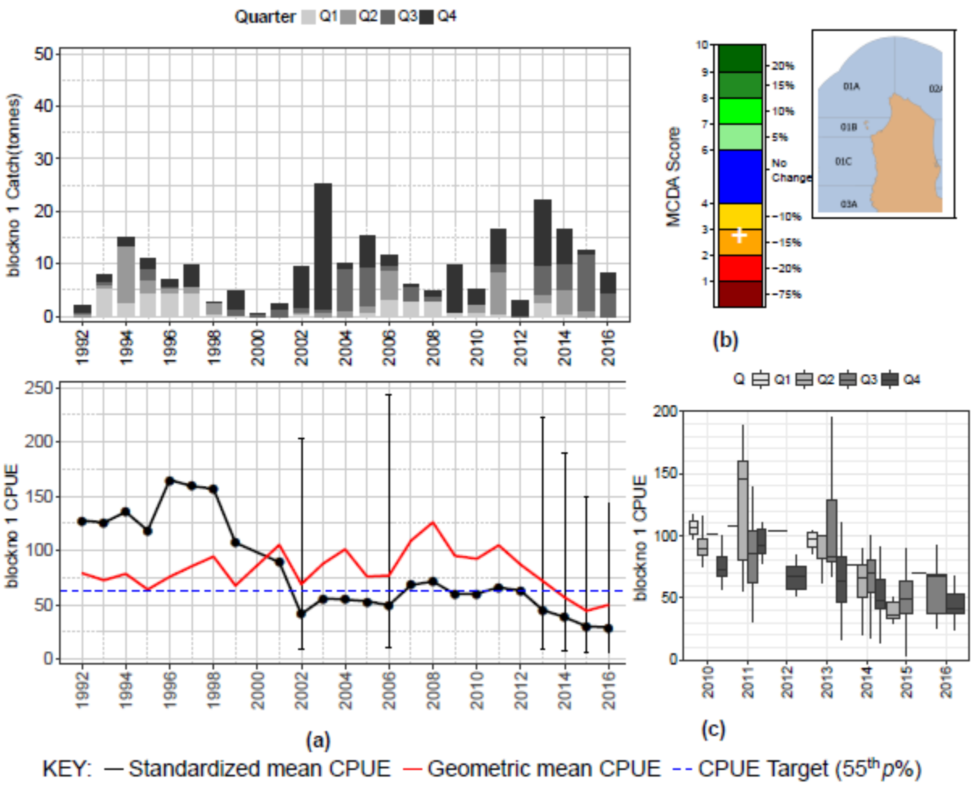
[22] http://dpipwe.tas.gov.au/sea-fishing-aquaculture/recreational-fishing/area-restrictions/fisheries-research-areas

seagrass beds (Stobart et al, 2012). Movement of adult blacklip and greenlip abalone is limited, with most resident within small sections of reef (tens of metres) for months or years. Movements of individuals do occur over small spatial and temporal scales, but do not result in emigration from sites (Mundy and Jones 2017).

Abalone are hand-harvested by divers operating on low pressure surface air supplies (hookah). Abalone vessels are generally small operating close to the coast (Mundy and Jones 2017).

Figure 5-47 and **Figure 5-48** provide fishing catch and effort data for blacklip abalone along the west coast of King island. **Figure 5-49** and **Figure 5-50** provide fishing catch and effort data for greenlip abalone. Abalone harvest on the west coast of King Island in 2016 (Block 1 and 3) was 52 t of blacklip abalone (27.5% TACC) and 3 t of greenlip abalone (2% TACC) (Mundy & Jones, 2017) or approximately $2.6M in revenue. The abalone fishery is open all year round, however the predominant harvest period of blacklip abalone is between July and December and for greenlip abalone, January to June. On King Island abalone is targeted by two divers (KIRDO, 2018)[23].

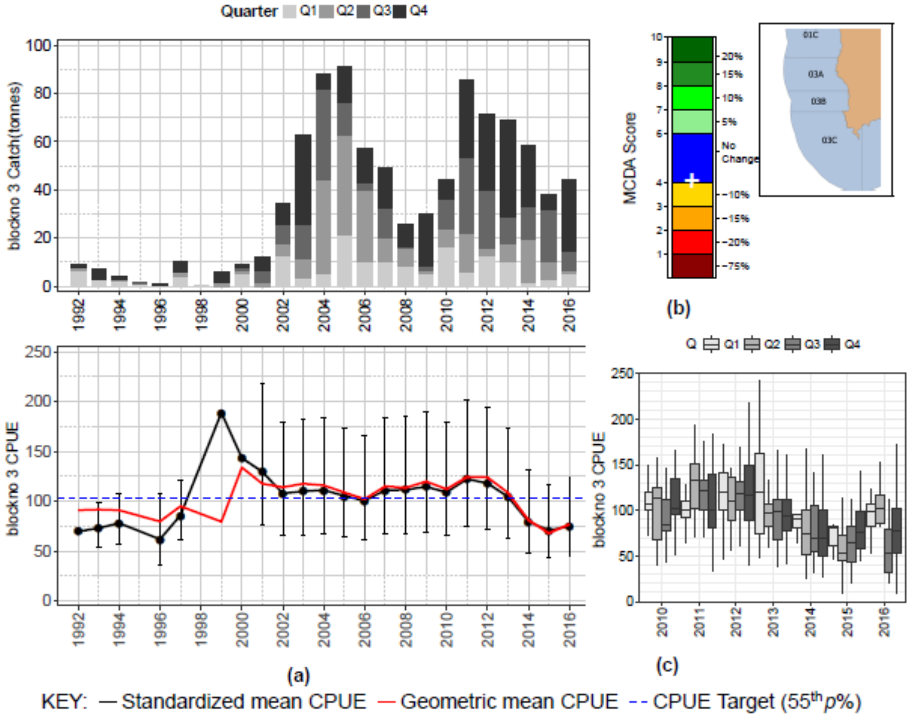
Figure 5-47: Blacklip Abalone Catch and Effort Cape Wickham to King Island Airport (Block 1) (Mundy & Jones, 2017)



Note: a) Catch quarter (bars) with standardised CPUE; b) HCR outcome; c) CPUE boxplot by quarter.

[23] King Island Regional Development Organisation (2018) http://www kingisland net.au/information/king-island-produce

Figure 5-48: Blacklip Abalone Catch and Effort King Island Airport to Middle Point (Block 3) (Mundy & Jones, 2017)



Note: a) Catch quarter (bars) with standardised CPUE; b) HCR outcome; c) CPUE boxplot by quarter.

Figure 5-49: Greenlip Abalone Catch and Effort Cape Whickham to King Island Airport (Block 1) (Mundy & Jones, 2017)

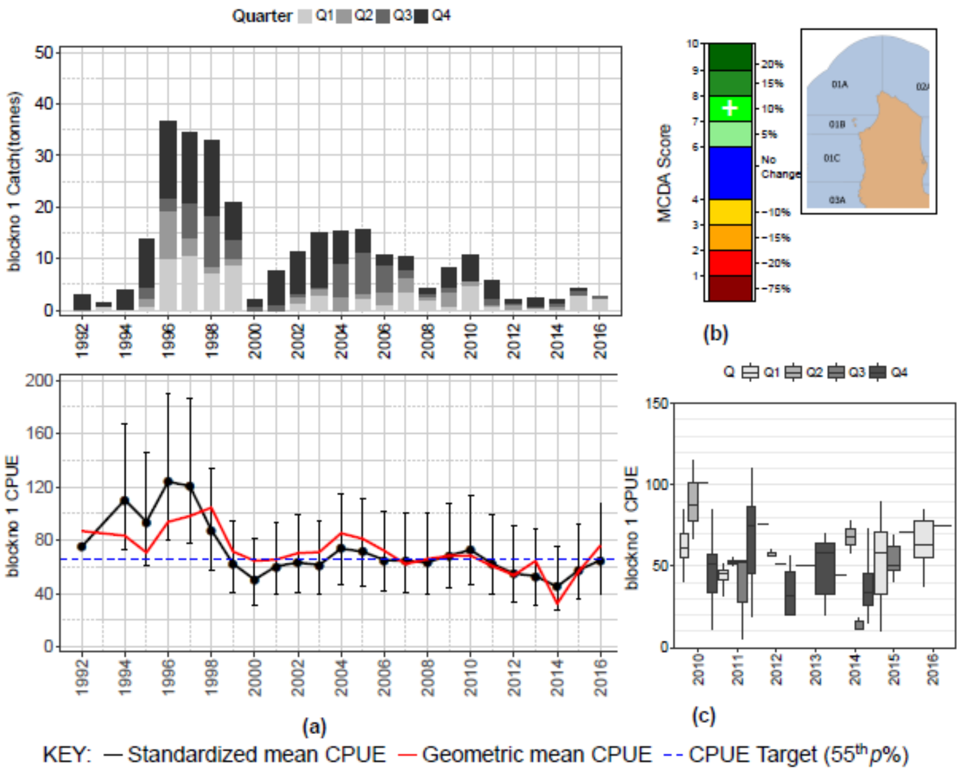
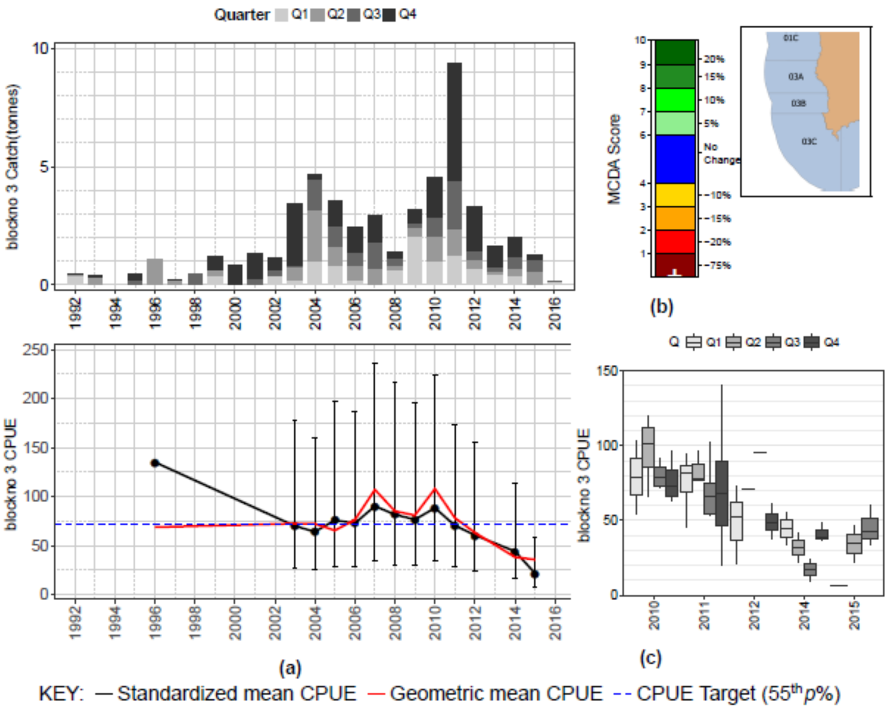


Figure 5-50: Greenlip Abalone Catch and Effort King Island Airport to Middle Point (Block 3) (Mundy & Jones, 2017)



Spawning:
Abalone species in Tasmania are dioecious broadcast spawners with complex reproductive patterns. Gravid animals can be found year-round, with little strong evidence of a peak reproductive season (Mundy and Jones, 2017). Larvae are lecithotrophic and while considered to be pelagic, the embryos are negatively buoyant for the first 24 hours. The larval phase is relatively short (5 to 15 days), and dependent on water temperature (McShane, 1992; cited in Mundy and Jones, 2017). Field studies for blacklip abalone suggest that local recruitment is highly dependent on local abundance (i.e. larval dispersal) (Mundy and Jones, 2017). Studies of greenlip abalone recruitment suggests that connectivity among adjacent populations is also limited, but population structure is two orders of magnitude larger than blacklip abalone (Mundy and Jones, 2017).

The duration of the larval phase typically lasts 4 to 7 days and is predominantly influenced by water temperature. During this period, the free-swimming larvae (veliger) do not feed and are transported by water currents. Larval dispersal studies have shown that larvae can drift many kilometres from their natal site however concluded that larvae were often retained in the same bay or reef system and often limited in spatial scales of less than one kilometre (Miller et al, 2008 in PIRSA, 2012). In their review, Morgan and Shepard (2006) concluded that larvae of shallow-water species such as blacklip and greenlip abalone tended to be philopatric (i.e. they settle near their parental reefs), whereas larvae of deeper water species were dispersed far more widely (PIRSA, 2012). Veligers sink to the sea bed attaching themselves to lithothamnion, a red sea weed covering rock, and begin to grow at a rapid rate. Growth rates depend on the food supply available, but it can be as much as 40 millimetres per year (Tasmanian Abalone Council, 2018).

5.7.5.7 Tasmanian Scale-fish Fishery

The Tasmanian Scalefish Fishery is a multi-gear, multi-species fishery which operates in waters as defined in **Figure 5-51**. Fishing equipment used in the fishery includes seine/purse seine, graball/small mesh net, drop-line, hand-line, fish trap, squid-jig, spear and dip-net. In 2015 there was a total of 281 licenced in the fishery, 195 of which were inactive (SETFIA, 2018). Catch and effort in the fishery are largely controlled through input controls such as limited entry (capped licence numbers), closed seasons and gear restrictions. Output controls include minimum and maximum size limits, trip limits and a quota management system for the banded morwong catch along the east coast (DPIPWE, 2018e).

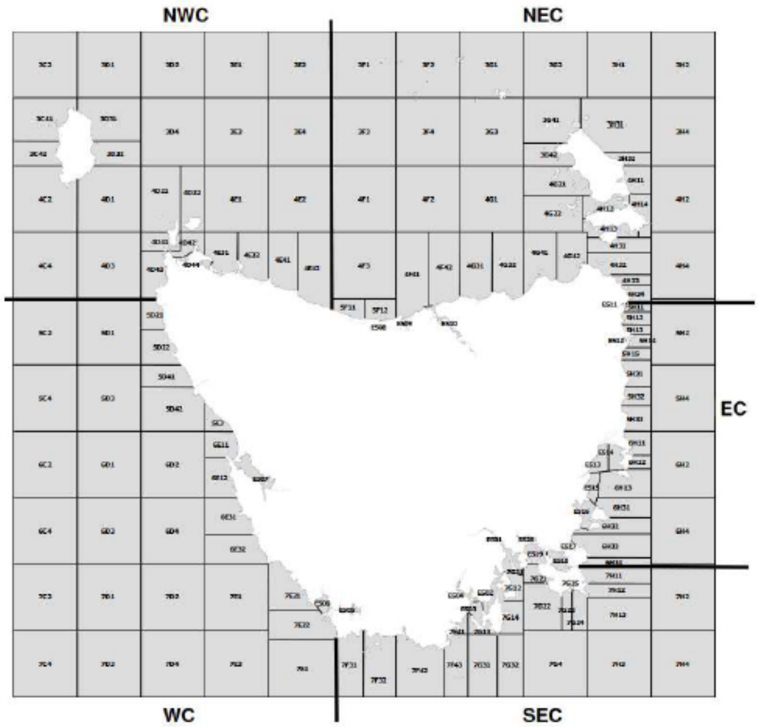
Target species include banded morwong, southern calamari, octopus, tiger flathead, school whiting, southern garfish, wrasse, Gould's squid, bastard trumpeter, blue warehou, silver warehou, flounder, silver trevally and striped trumpeter (DPIPWE, 2018e). IMAS fishing data for the Tasmanian fishing blocks which overlap the Dorrigo MSS include catch of the following species: Australian salmon, striped trumpeter, bluethroat wrasse, purple wrasse and Gould's squid (SETFIA, 2018).

While the Dorrigo MSS lies spatially within the fishery management area for this multi-species fishery (refer **Figure 5-51**), fishing catch was recorded in the area between 2010/11 to 2014/15 and for 2015/16, however no active fishing or catch has occurred within the Dorrigo MSS since 2015/16 (SETFIA, 2018). Based upon 2015/16 catch data, 0.1-4 t of Australian salmon, from a total catch of 85.2 t was caught within the fishing blocks which overlap the Dorrigo survey, however as these fish have habitat in nearshore waters to 20 m water depth any fishing activity will be present along the adjacent King Island coastline and not within the MSS area. No catch was recorded for the other species (striped trumpeter, bluethroat wrasse, purple wrasse and Gould's squid) in 2015/16 (SETFIA, 2018). Recorded effort on the adjacent King Island coastline was between 3-7 days per annum (Moore et al, 2018).

Note that a fishing closure for calamari lies in state waters between 144^{o} 30' and 145^{o} 43' 30" E (Woolnorth Point and Table Cape) was present for the period 6-22 October 2017 to protect a spawning hotspot around Stanley for the species (DPIPWE, 2018e). This area is not within the Dorrigo MSS or oil spill EMBA.

No fishing activity by the Tasmanian Scale-fish Fishery is expected within the Dorrigo MSS area.

Figure 5-51: Tasmanian Scale-fish Management Area (Emery et al, 2017)



5.7.5.9 Seaweed Fishery

The main components of the King Island seaweed fishery are the collection of cast bull kelp; harvesting introduced seaweed (Undaria) (along Tasmanian east coast); and minor, single operations harvesting red and brown seaweeds and collecting cast seaweed from specific beaches around Tasmania (bagged for garden mulch) (DPIPWE, 2018d). Cast bull kelp collection occurs in two general areas – King island and the northern sections of the Tasmanian west coast (DPIPWE,2018d). On King Island the fishery is permitted to harvest cast bull kelp from the west coast of King Island between Cape Wickham and approximately 5km due south of Ettrick Beach, the south coast of King Island from Surprise Bay to the east of Stokes point and the south-east coast of King Island from three areas around red Hut Point, Grassy harbour and City of Melbourne Bay (SEWPC, 2011b).

Harvest occurs year-round but is dependent on prevailing weather conditions. Harvesting and transporting of kelp is prohibited from September to March (inclusive) on sandy beach areas except the north end of British Admiral Beach and other sandy beach which would not be detrimental to nesting hooded plovers (SEWPC, 2011b). The collection of bull kelp is by hand and assisted by winches and mechanical grabs (SEWPC, 2011b).

The annual average harvest on King Island is above 1200 tonnes (dried weight) and supplies approximately 5% of the world production of alginates (DPIPWE, 2018d). Between the years 2007 to 2010 the total dry harvest of bull kelp ranged from 2223 t (2007) to 1605.5 t (2009) (SEWPC, 2011b). Alginates are used in a wide variety of products including sauces, syrups, creams, lotions and ice-cream (DPIPWE, 2018d). Kelp harvesting on King Island generates about $2.5M annually by one company – Kelp Industries Pty Ltd (exclusive licence). The company is supported by up to

80 individuals who have a fishing licence (marine plant) to collect cast bull kelp on the island (DPIPWE, 2017).

5.7.7 Petroleum Exploration and Production

5.7.7.1 Production

The Otway Gas Field Development, operated by Lattice Energy, is located 70 km south of Port Campbell and ~20 km northwest of the nearest Dorrigo MSS operational boundary. This $1.1B development consists of a remotely operated platform (at Thylacine), offshore and onshore pipelines and a gas processing plant located 6.4 km northeast of Port Campbell. The Geographe and Thylacine fields together produce an average of 60 PJ of natural gas per year, along with 100,000 tonnes of LPG and 800,000 Bbl of condensate (Origin, 2016). Over its operating life, the development is expected to supply 950 billion cubic feet (bcf) of raw gas, 885 PJ of sales gas, 12.2 million barrels of condensate and 1.7 million tonnes of LPG to the market. The fields are estimated to contain sufficient natural gas to provide more than 10% of current annual demand in south-eastern Australia over a period of 10 years. First gas sales commenced September 2007.

In 2016, Origin also completed its Halladale and Blackwatch gas field development. The Halladale production well is located 13 km north of the Netherby production well. It was directionally drilled from an adjacent onshore location, with a pipeline laid between the onshore drill site and the Iona Gas Plant (DEDJTR, 2016b).

The Minerva Gas Development is operated by BHP Billiton and commenced production in April 2005. This was a $250 million development that involved the drilling and installation of two subsea wells in shallow waters (60 m deep and 10 km from the coast), which were tied back to an onshore gas plant (4.5 km inland) via a single pipeline. The gas plant has the capacity to produce 150 TJ gas and 600 barrels of condensate per day.

The Casino-Henry-Netherby Field Development, operated by Cooper Energy, is located 17-25 km offshore from Port Campbell in water depth ranging from 65-71 m. The offshore development consists of 4 subsea wells which transport gas via a 250mm gas pipeline to the Iona Gas Plant. Casion commenced production in 2006 and the Henry/Netherby fields in 2010. The daily gross field production from the field is 33.2 TJ/day (Cooper Energy, 2018).

In 2014, production from the Otway Basin operations was 703,733 Bbl condensate, 726,081 Bbl of liquefied petroleum gas (LPG) and 110,806 MMSCF of sales gas (DEDJTR, 2016b).

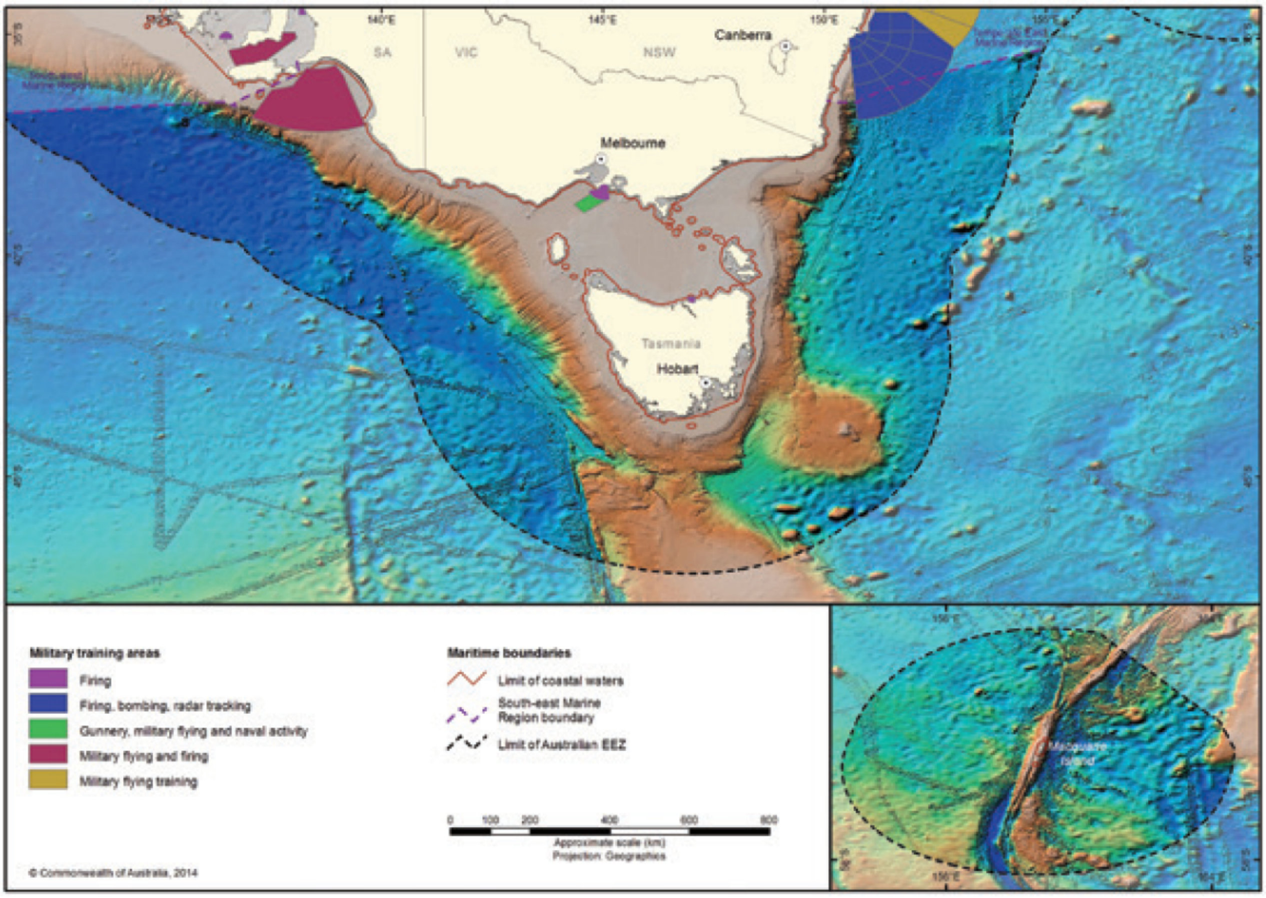
5.7.7.2 Exploration

Numerous exploration wells have been drilled and seismic surveys have been undertaken in the permits of the Otway Basin, most recently by Origin (Enterprise 3D, Astrolabe 3D and Crows Foot 3D MSSs), WHL Energy (La Bella 3D seismic survey) in 2013 and 3D Oil survey (Flanagan MSS) in 2014.

5.7.8 Defence

The south-east marine region is important for a range of defence activities particularly training exercises (refer **Figure 5-52**). Australian Defence Force activities in the region include transit of naval vessels, training execises, shipbuilding and repair, hydrographic survey, surveillance and enforcement and search and rescue (DoE, 2015).

Figure 5-52: Defence training areas within and adjacent to the Region (DoE, 2015)



Five training areas are located more than 100 km from the nearest Dorrigo MSS operational boundary, in and around Port Phillip Bay and Western Port Bay.

Mine fields were laid in Australian waters during World War II. Post-war minefields were swept to remove mines to make marine waters safe for maritime activities. There are three areas identified as dangerous due to unexploded ordnance (UXO), though these are located south and east of Wilson's Promontory (~240 km east of the Dorrigo MSS area).

6.0 ENVIRONMENT IMPACT AND RISK ASSESSMENT METHODOLOGY

This section describes the environmental impact and risk assessment methodology employed for the Dorrigo MSS petroleum activity, adopting 3D Oil's risk assessment framework and toolkit. This framework is consistent with the approach outlined in ISO 14001 (Environmental Management Systems), ISO 31000:2009 (Risk Management) and HB203:2012 (Environmental Risk Management – Principles and Process). **Figure 6-1** provides the process adopted for managing impacts and risks associated with the petroleum activity.

Figure 6-1: AS/NZS ISO 31000 – Risk Management Methodology

6.1 Hazard Assessment Methodology

For this activity, the environmental hazards, impacts and risks have been identified and risk assessed undertaking the following steps:

- Defining the activity and associated environmental hazards (routine and incident);
- Identifying the environmental and social values at risk within, and adjacent to, the petroleum activity area;
- Establishing the credible environmental impact of the hazard to receptors and determining the maximum credible impact for each hazard associated with the proposed activity (the impact of the hazard given no control measures, i.e., inherent impact). Impacts are assessed across a number of dimensions (environment, safety, reputation, financial);
- For environmental hazards with the potential to impact the environment, identifying the likelihood of occurrence of the impact;
- Identifying control measures to eliminate or reduce the level of impact and/or the likelihood of the impact occurring; and
- Assigning a level of residual impact or risk (after control measures are implemented) utilizing 3D Oil's qualitative risk matrix. In accordance with 3D Oil's acceptance criteria, the impacts and risks will continue to be reassessed until it is demonstrated the impact or risk is reduced to a level which is as low as reasonably practicable (ALARP) and is acceptable according to 3D Oil's acceptance criteria.

For the Dorrigo MSS activity, environmental hazard identification and assessment has considered the following:

- Activities that will occur during the Dorrigo MSS and the equipment and vessels to be utilised in those activities;
- The environmental sensitivity of the receiving environment with respect to species distribution, subsea habitat types and location of environmentally sensitive areas (i.e. breeding, resting, feeding) undertaken as part of literature reviews; and
- Feedback from marine stakeholders to understand socio-economic activities that may conflict with Dorrigo MSS activities via communication and consultation activities.

Within this context, a listing of credible activity-related environmental hazards and possible impacts were identified for the MSS activity.

6.2 Impact and Risk Evaluation

6.2.1 Definitions

The OPGGS(E)R Regulations 14(5) & (6) requires the EP to 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., routine) or potential emergency or incident conditions (i.e., incident events).

For this activity, 3D Oil has determined that impacts and risks are defined as follows:

- **Impacts** result from activities that by their very nature *will* result in a change to the environment or a component of the environment, whether adverse or beneficial. Impacts are an inherent part of the activity. For example, there will be underwater sound emissions with associated impacts from vessel activity.
- **Risks** result from activities where a change to the environment or component of the environment *may* occur from the activity (i.e., there *may* be consequences *if* the incident event occurs). Risk is a combination of the *consequences* of an event and the associated *likelihood* of its occurrence. For example, a hydrocarbon spill may occur if a vessel's fuel tank is punctured by a collision incident during the survey. The risk of this event is determined by assessing the consequence of the impact (using factors such as the type and volume of fuel and the nature of the receiving environment) and the likelihood of this event happening (which may be determined qualitatively or quantitatively).

6.2.2 Impact and Risk Evaluation Process

The purpose of impact and risk evaluation is to assist in making decisions, based on the outcomes of analysis, about the controls required to reduce an impact or risk to ALARP. All impacts and risk subject to this step in the same manner.

1. Calculated the inherent impact or risk for a hazard.

a. Select the consequence (impact) level: Determine the worst-case credible outcome associated with the hazard assuming all existing preventative controls have failed. Where more than one impact applies (e.g., environmental and social/cultural), the consequence for each impact is recorded (refer **Table 6-1**);
b. For hazards that may affect the environment: Select the likelihood level from the description that best fits the chance of the identified consequence occurring (refer **Table 6-2**); and
c. For hazards which may affect the environment: Calculate the inherent risk ranking. This is determined by a comparison of the selected consequence and likelihood levels using the qualitative risk matrix in **Table 6-3**.

2. Identifying Control Measures (i.e. Impact/Risk Treatment)

a. For each identified impact and risk, control measures are identified to reduce the impact or risk. The hierarchy of controls philosophy is a useful framework to identify and assess controls that are effective (refer **Figure 6-2**) and is used in this assessment process to determine suitable controls.
b. Multiple controls selected from this hierarchy provide a depth (number) and breadth (control type) to prevent an impact or risk from occurring. Control types listed in the upper section of the hierarchy are recognised as being more effective in terms of functionality, availability, reliability, survivability, independence and compatibility given their inherent design characteristics.

Figure 6-2: Environmental Hierarchy of Controls

Control Type	Effectiveness	Example
Eliminate: Complete removal of hazard		Eliminate activity within sensitive timeframes.
Prevent: Prevent hazardous events occurring		Adopt spatial controls to isolate activity from sensitivity
Reduce: Reduce the consequence should the event occur		Adopt shutdown procedures if cetacean is within power-down zone.
Mitigate: Practices to mitigate the consequences once realised.		Implement Shipboard Oil Pollution Emergency Plan (SOPEP) to mitigate spill impacts

3. Calculate the residual impact or risk

With control measures implemented, all inherent impacts and risks are then reassessed for their residual consequence and risk according to the 3D Oil qualitative risk matrix (refer **Table 6-3**). If the residual impact or risk does not meet the tolerability criteria provided in **Table 6-4** and **Table 6-5**, iterations on the assessment process continue until the impact or risk is considered broadly acceptable or additional controls have been identified and/or rejected or accepted via an ALARP demonstration.

Table 6-1: Consequence Definitions

Consequence	Description
5. Critical	**S:** Extensive Injuries (Multiple Fatalities). **E:** • *Protected Species*: Large population-level impacts. Significant impacts on critical habitats or activities; • *Marine Primary Production*: Large-scale, long-term effects. Recovery > 10 years or effects permanent; • *Penalty*: Potential revocation of Licence or Permit. **F:** Extensive Damage (>$25M). **R:** Extreme adverse public, political or media outcry resulting in international media coverage; critical impact on business reputation.
4. Major	**S:** Major Injury (Single Fatality). **E:** • *Protected Species*: Major disruption to a significant portion of the population. Minor effects on critical habitats/activities. No threats to population viability. • *Marine Primary Production*: Localised but long-term effects; Recovery > 10 years or effects permanent. • *Penalty:* Material breach of licence, permit or act. **F:** Major Damage ($10M-$25M). **R:** Significant impact on business reputation and/or national media exposure; local community complaint.
3. Significant	**S:** Significant Injury (Lost Time Injury (LTI) or Restricted Work Day Case (RWDC)). **E:** • *Protected Species*: Minor disruption to small portion of population. Minor temporary effects on protected species critical habitat or activity. No threats to population viability. • *Marine Primary Production*: Localised medium-term effects; Recovery 5-10 years. • *Compliance*: Possible administrative fine level. **F:** Significant damage ($5M-$10M). **R:** Serious local adverse public media attention or complaints; local user concern; moderate to small impact on business reputation.
2. Minor	**S:** Minor Injury (Medical Treatment Injury) **E:** • *Protected Species*: Minor and temporary disruption to small portion of protected species population. Negligible effects on critical habitats or activities. • *Marine Primary Production:* Localised short-term effects. Recovery in the timescale of months to < 5 years • *Compliance:* Regulatory notification required. **F:** Minor Damage ($1M-$5M). **R:** Public awareness but no public concern beyond local users; Minor impact on business reputation.
1. Negligible	**S:** Slight Injury (First Aid Treatment). **E:** • *Protected Species*: Incidental effects locally within the environmental setting. • *Marine Primary Production*: Recovery in the timescale of days to weeks; • *Compliance*: No statutory reporting. **F:** Slight Damage (0-$1M). **R:** Negligible Impact on Reputation; no public or regulator interest.

Legend: S: Safety, E: Environment, F: Financial, R: Business Reputation

Table 6-2: Definition of Likelihood

Likelihood	Description
5. Very likely	Expected to occur in most circumstances
4. Likely	Probably occur in most circumstances
3. Possible	Might occur at some time
2. Unlikely	Could occur at some time
1. Very Unlikely	Only occurs in exceptional circumstances

Table 6-3: 3D Oil Qualitative Risk Matrix

		Likelihood				
		1: Very Unlikely	2: Unlikely	3: Possible	4: Likely	5: Very likely
Consequence	5. Critical					
	4. Major					
	3. Significant					
	2. Minor					
	1. Negligible					

Table 6-4: Definition of Risk and Management Response

Risk Category/Consequence	Description & Response
High Risk High Impact: Critical, Major	**High Impact/Risk:** Considered intolerable. Work cannot proceed as currently planned. Urgent remedy and resources required for immediate risk reduction. If impact/risk is to be accepted temporarily then approval from the CEO must be obtained and the Board consulted.
Medium Risk Medium Impact: Significant, Minor	**Medium Impact/Risk:** Risk reduction measures need to be implemented in keeping with other priorities. Generally acceptable level of risk where further impact/risk reduction is shown not to be practicable.
Low Risk Low Impact: Negligible	**Low Impact/Risk:** Impacts/Risks are sufficiently low to be acceptable (i.e. at ALARP). Manage for continuous improvement by management.

6.2.3 Demonstration of ALARP

This section provides the methodology for determining whether impacts and risks are ALARP and reflects the principles outlined the NOPSEMA Decision-making – Criterion 10(a)(b) ALARP Guideline (GL1721) (Rev 3, May 2017).

In considering impact and risk-related decision making, 3D Oil utilises the risk-related decision-making framework developed by the UK offshore oil and gas ("Oil & Gas UK", formerly UKOOA, 2014) to assist with the basis for their decisions. A summary of the framework is shown in **Figure 6-3**. The framework takes the form of three different decision context (A, B & C). Initially the decision context needs to be determined with guidance provided on factors affecting that context (i.e. activity type, risk & uncertainty and stakeholder influence). The assessment techniques used depend on the selected decision context. **Figure 6-3** provides the assessment techniques utilised to make an ALARP decision. This approach shows that good practice predominates in Type A decisions; engineering risk assessments and good practice have a major input to Type B decisions (infrequent nonstandard activities, deviation from standard practice, some risk uncertainty, etc); and Type C decisions identify the need for a precautionary approach in the decision making based on significant uncertainty in risk, unproven or novel design, conflict of values, etc. **Table 6-5** details the decision methodologies to establish ALARP for uncertainty based on the framework outlined in **Figure 6-3**.

Figure 6-3: Impact and risk decision making framework

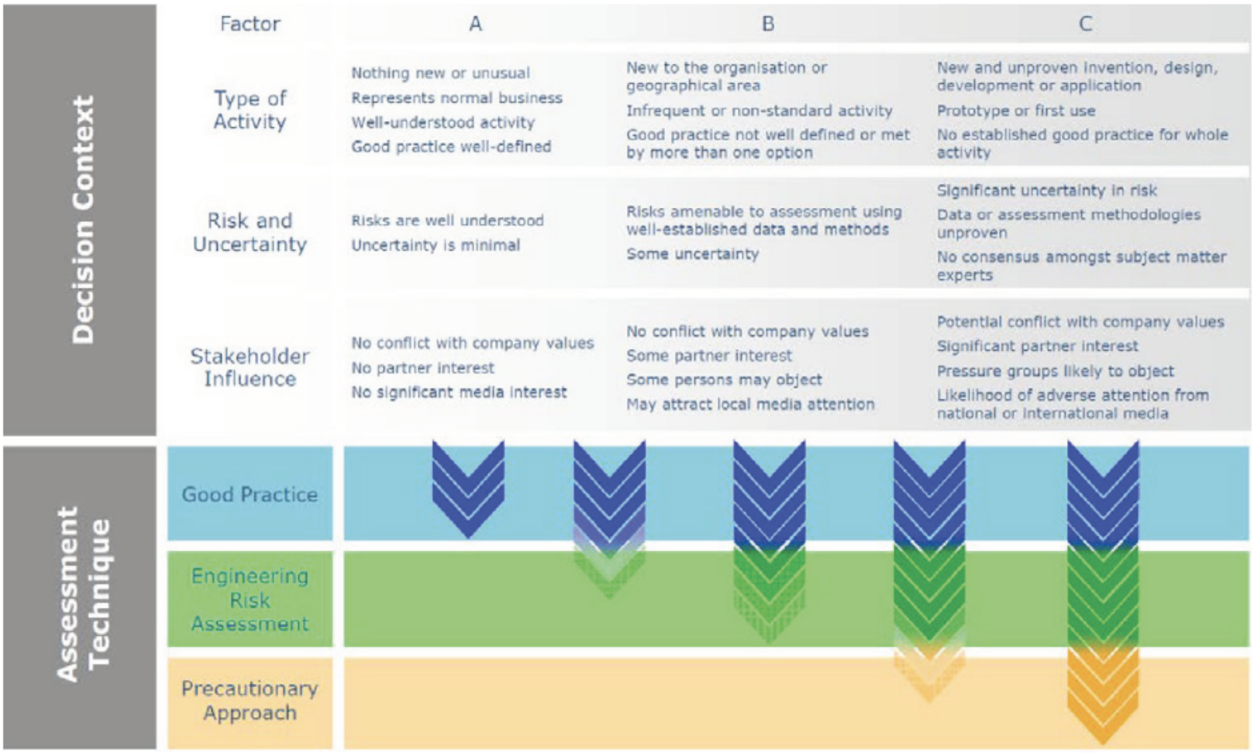


Table 6-5: ALARP Decision-making Methodologies (based upon uncertainty)

Decision Context	Description	Decision Methodologies
A	Risks classified as a Decision Type A are well-understood and established practice and uncertainty is minimal.	**Legislation, codes and standards (LCS):** Identifies the requirements of legislation, codes and standards that are to be complied with for the activity. **Good Industry Practice (GIP)**: Identifies further engineering control standards and guidelines that may be applied over and above that required to meet the legislation, codes and standards. **Professional Judgement (PJ)**: Uses relevant personnel with the knowledge and experience to identify alternative controls. When formulating control measures for each environmental impact or risk, the 'Hierarchy of Controls' philosophy, which is a system used in the industry to identify effective controls to minimise or eliminate exposure to impacts or risks, is applied.
B	Risks classified as a Decision Type B are typically in areas of increased environmental sensitivity with some stakeholder concerns. These risks may deviate from established practice or have some life-cycle implications and therefore require further analysis using the following tools in addition to those described for a Decision Type A. Some uncertainty exists in the impact/risk.	**Risk-based tools such as cost based analysis or modelling:** Assesses the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost benefit analysis to support the selection of control measures identified during the risk assessment process. **Company values:** Identifies values identified in 3D Oil's HSE Policy.

Decision Context	Description	Decision Methodologies
C	Risks classified as a Decision Type C will typically have significant risks related to environmental performance. The risks may uncertain or result in significant environmental impact; significant project risk/ exposure; or may elicit strong stakeholder awareness and negative perception. For these risks, in addition to Decision Type A and B tools, company and societal values need to be considered by undertaking broader internal and external stakeholder consultation as part of the risk assessment process	**Societal Values:** Identifies the views, concerns and perceptions of relevant stakeholders and addresses relevant stakeholder concerns as gathered through consultation.

In addition to this decision-making framework, for higher level impact and risks, ALARP assessments shall assess:

i. Alternative (replacement) controls that may be potentially effective (e.g., lie higher on the hierarchy of controls);
ii. Additional controls that add to the suite of control measures to reduce the environmental impact; and
iii. Improvements to already adopted controls that increase their effectiveness.

All controls considered are documented and the justification for accepting or not adopting the controls documented as part of the assessment. Assessment of the control includes a comparison of the environmental benefit of adopting the control against the cost of implementation. For higher level impacts and risks, this also includes an assessment of the activity design on a temporal and spatial basis to reduce impacts. For both higher-level impacts/risks and where there is a high degree of uncertainty in environmental impact, these costs and benefits are fully explored and reflected in the risk assessment.

Note the titleholder is required to reduce the impacts and risks based to as low as reasonably practicable. That is, implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure.

6.2.4 Demonstration of Acceptability

3D Oil considers a range of factors when evaluating the acceptability of environmental impacts or risks associated with its activities. This evaluation works at several levels, as outlined in **Table 6-6** and is based on NOPSEMA's Guidance Notes for EP Content Requirements (N04750-GN1344, Rev 3, April 2016) and recent guidance issued in Decision-making – Criterion 10A(c) Acceptable Level (GL1721, Rev 3, May 2017). Specific criterion detailed in **Table 6-6** allows for the identification of specific acceptance criteria for environmental sensitivities affected by the petroleum activity. Within the impact/risk assessment sections of this EP (refer **Section 7**) acceptance levels are defined and an evaluation is completed to assess how the predicted extent, severity, duration and uncertainty of environmental impacts and risks compare with these pre-defined acceptance levels.

Where predictions are not within the pre-defined acceptable levels further management of impacts or risks will be undertaken until predefined acceptance levels are achieved. Note that for many lower order impacts and risks (i.e. impacts and risks where the environment or receptor affected is not formally managed, less vulnerable, widely distributed, is not protected and/or threatened, there is confidence in the effectiveness of adopted control measures and the effects on the environment or receptor is localised and recoverable) much of the criteria listed within **Table 6-6** will not be applicable.

Table 6-6: 3D Oil Acceptability Criteria

Context	Factor	Criteria	Demonstration
Internal	3D Oil Policy	Is the proposed management of impact or risk aligned with 3D Oil's HSEC Policy?	The impact or risk must be compliant with the objectives of this policy.
	Company Standards/ Systems	Is the proposed management of the impact or risk aligned with the 3D oil Management System?	Where specific procedures and work instructions are in place for the management of the impact and risk in question, acceptability is demonstrated.
External	Natural Environment	Are the values and sensitivities of the environment, including matters protected under Part 3 of the EPBC Act (World Heritage, national Heritage, Wetlands of International Importance, listed threatened species and communities, listed migratory species, Commonwealth marine environment) protected so that no significant impacts result to the environment?	Impacts are risk are demonstrated not to have a significant impact upon protected matters in accordance with EPBC Policy Statement 1.1 – Significance Guidelines.
	Relevant Persons Expectations	Have relevant persons raised any objections or claims about adverse impacts associated with the activity, and if so, have merits of the objection been assessed? For those objections and claims with merit, have measures been put in place to manage those concerns?	Stakeholder concerns have been assessed, responded to and controls adopted for objections and claims which hold merit.
Legislative & Other	Legislation & Conventions	Is the impact or risk managed in accordance with existing Australian, State and/or international laws/obligations? Have applicable objectives and actions within marine reserve management plans, species conservation or recovery plans, threat abatement plans, conservation advices, bioregional plans? Have National water quality management strategy requirements been met? Have management requirements with respect to managing pollution from ships and biosecurity been met?	Compliance with specific laws and management plans/advices is demonstrated.
Industry Standards	Industry Standards and Best Practices	Do standards adopted reflect best practice guidance (i.e. IAGC Guidelines, IPIECA Guidelines, APPEA Guidelines, OGP Guidelines)?	Compliance with best practice guidance is demonstrated.

Context	Factor	Criteria	Demonstration
Ecologically Sustainable Development (ESD) (refer below)	ESD Application	Does the proposed risk/impact comply with the APPEA Principles of Conduct (APPEA, 2008), requiring integration of ESD principles into company decision-making, and Government policy frameworks that integrate ESD principles into implementation strategies?	The overall operations are consistent with the APPEA Principles of Conduct and Commonwealth environmental strategy documents

Ecologically Sustainable Development:
Section 3A of the EPBC Act 1999 defines ESD, which is based on Australia's National Strategy for Ecological Sustainable Development (1992) that 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.

ESD Principles are outlined below:
1. 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. This principal is not considered separately for each acceptability evaluation*).
2. If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. *If there is, the project shall assess whether there is significant uncertainty in the evaluation, and if so, whether the precautionary approach should be applied.*
3. The principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. (*The EP assessment methodology ensures that potential impacts and risks are ALARP, and where the potential impacts and risk are determined to be serious or irreversible the precautionary principle is implemented to ensure the environment is maintained for the benefit of future generations. Consequently, this principal is not considered separately for each acceptability evaluation*).
4. The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making (*Project to consider if there is the potential to affect biological diversity and ecological integrity*).
5. Improved valuation, pricing and incentive mechanisms should be promoted (*Not relevant to this EP*).

6.3 Monitoring 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, standards and measurement criteria that are described for each environmental hazard in **Section 7** of this EP.

Additional aspects of monitoring and review are described in the Implementation Strategy in **Section 8** of the EP include:

- Analysing and lessons learnt from events (including near-misses), changes, trends, successes and failures;
- Detecting changes in the external and internal context, including changes to risk criteria and the risk itself which can require revision of risk treatments and priorities; and
- Identifying emerging risks.

7.0 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

This section presents the evaluation of the environmental impact assessment (EIA) and environmental risk assessment (ERA) completed for the Dorrigo 3D MSS using the methodology described in Section 6 as required by OPGGS(E)R Regulations 13(5) and 13(6).

This section also presents the environmental performance outcomes, performance standards and measurement criteria for each of the identified environmental hazards. Where measurement criteria associated with *performance outcomes or performance standards* are not met, a recordable incident will be documented and reported to NOPSEMA (refer **Section 8.11**). The following legislative and guideline definitions are used in this section:

- Environmental performance outcome (EPO) – a measurable level of performance required for the management of the environmental aspects of the activity to ensure the environmental impacts or risks will be of an acceptable level;
- Environmental performance standard (EPS) – a statement of performance required of an adopted 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 residual rankings for all impacts and risks identified and assessed in this Section are summarised in **Table 7-1**.

Table 7-1: Dorrigo MSS environmental impact and risk ranking summary

#	Environmental Hazard	Section	Residual Impact or Risk Ranking
Impacts			**Impact**
1	Lighting impacts	7.1	NEGLIGIBLE
2	Acoustic sound disturbance (seismic source)	7.2	MINOR
3	Treated bilge water discharges (vessels)	7.3	NEGLIGIBLE
4	Treated sewage/grey water discharges (vessels)	7.4	NEGLIGIBLE
5	Food-scrap discharges (vessels)	7.5	NEGLIGIBLE
6	Air emissions	7.6	NEGLIGIBLE
Risks			**Risk**
1	Introduction of invasive marine species	7.7	LOW
2	Disruption to commercial vessels	7.8	LOW
3	Waste overboard incident (solid/non-biodegradable)	7.9	LOW
4	Equipment (streamer) loss	7.10	LOW
5	Marine fauna collision by vessel	7.11	LOW
6	Vessel spill (collision/refuelling)	7.12	LOW
7	Deck spill (chemical/oil)	7.13	LOW
8	Oil Spill Response	7.14	LOW

Routine planned or known activities (e.g., routine discharges or emissions) with a known impact are assigned an environmental impact rating from ‘negligible’ through to ‘critical’. Accordingly, the impact assessment tables presented in **Sections 7.1** to **7.6** provide impact consequence rankings (rather than a risk ranking).

Incidents *may* or *may not* occur. Accordingly, assessment is based upon a risk analysis which focuses on the impact if the event occurs and its likelihood of occurrence (for example, a diesel spill from a vessel). The assigning of a likelihood and consequence ranking is based on the knowledge and experience of those involved in the survey as well as, where possible, data on event probabilities (e.g., vessel collision frequencies, etc.).

Acceptability Criteria:
Review of the environmental receptors potentially present within the EMBA during the survey period, their sensitivity to MSS activities and conservation and management plans requirements which need to be observed has led to acceptability criteria for the Dorrigo MSS as presented in **Table 7-2**.

Table 7-2: Dorrigo MSS environmental impact and risk acceptability criteria

Receptor	Relevant Context	Acceptable Level of Impact
Environmental Receptors		
Zeehan CMP (Multiple use zone – IUCN VI)	South-east Commonwealth Marine Reserves Network – Management Plan 2013-23 (Part 3): Management Approach for Multiple Use Zones: • *Provides for general sustainable use by allowing for activities that do not significantly impact upon benthic habitats.* • *Activities are allowed provided they are consistent with the IUCN management principles and will not have an unacceptable impact on the values of the area.* Australian IUCN Reserve Management Principles (IUCN VI): *Provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species.*	• *No disruption to ecological processes supporting key fauna (values) present in the CMP.* • *No significant impact*[24] *to benthic habitats within the CMP;* • *Conservation values within CMP are retained for:* o *Migrating blue and humpback whales; and* o *Foraging by black-browed, wandering and shy albatrosses, and great-winged and cape petrels.*
Plankton	• Seismic research on effects of seismic on plankton • EPBC Act 1999 (EPBC Policy Statement 1.1 – Commonwealth Marine Environment)	*No significant impact to plankton biomass during Dorrigo MSS.* *No significant impact to plankton biomass which affects foraging behaviour of whales in foraging BIAs.*
Pygmy blue, sei and fin whales (in foraging BIA)	• EPBC Act 1999 (EPBC Policy Statement 1.1/2.1) • EPBC Act 1999 (S229 – Killing or injuring a cetacean) • Conservation Management Plan for Blue Whale (DoE, 2015). • Conservation Advice for fin whale (DoE, 2015) • Conservation advice for sei whale (DoE, 2015)	*No injury or damage to cetaceans.* *No interference with foraging behaviours within blue whale foraging BIA which would cause displacement from the foraging area.*

24 As defined by the EPBC Policy Statement 1.1 (SEWPC, 2013)

Receptor	Relevant Context	Acceptable Level of Impact
Southern right whale (migration corridors and calving BIA)	• EPBC Act 1999 (EPBC Policy Statement 1.1/2.1) • EPBC Act 1999 (S229 – Killing or injuring a cetacean) • Conservation Management Plan for the southern right whale (SEWPC, 2012) • EPBC Act 1999 (EPBC Policy Statement 1.1/2.1)	*No injury to southern right whales.* *No behavioural disturbance to coastal aggregation or calving activities in coastal BIAs.*
Humpback whale (during migration)	• Conservation Advice for the Humpback whale (2015) • EPBC Act 1999 (S229 – Killing or injuring a cetacean) • EPBC Act 1999 (EPBC Policy Statement 1.1/2.1)	*No injury to humpback whales.* *No behavioural disturbance to humpback whale activities in calving, resting, foraging or migration BIAs.*
Other whales (migrating)	• EPBC Act 1999 (EPBC Policy Statement 1.1/2.1) • EPBC Act 1999 (S229 – Killing or injuring a cetacean)	*No injury to whales.*
Marine turtles	• EPBC Act 1999 (EPBC Policy Statement 1.1) • Recovery Plan for Marine Turtles in Australia (2017-2027) (DoEE, 2017) • EPBC Act 1999 (Part 3 – Protected Matters (Offences))	*No injury to marine turtles.* *No lighting impacts to habitats critical to the survival of turtles (e.g. nesting beaches).*
Albatross, petrel and shearwater foraging BIAs	• EPBC Act 1999 (EPBC Policy Statement 1.1) • EPBC Act 1999 (Part 3 – Protected Matters (Offences)) • Short-tailed shearwater, Pacific gull, Caspian tern, Australian Fairy tern (foraging) BIA (DoEE, 2018b)	*No significant impact to bird foraging activities within the Dorrigo MSS area.*
Shoreline Birds: Fairy tern, Curlew Sandpiper, Eastern Curlew, Red Knot, Hooded Plover, Lesser sand plover, bar-tailed godwit	Conservation advice for the: • Australian fairy tern (TSSC, 2011) • Curlew sandpiper (TSSC, 2015d) • Eastern Curlew (TSSC, 2015f) • Red Knot (TSSC, 2016a) • Hooded Plover (TSSC, 2014) • Lesser sand plover (TSSC, 2016b) • Bar-tailed Godwit (TSSC, 2016c; 2016d)	*No anthropogenic disturbance to shoreline habitats*
White Shark	• EPBC Act 1999 (Part 3 – Protected Matters (Offences); EPBC Policy Statement 1.1) • Recovery Plan for the white shark (SEWPC, 2013)	*No injury to the white shark.*
Cephalopods	• Sound research on effects of seismic on cephalopods • EPBC Act 1999 (EPBC Policy Statement 1.1 – Commonwealth Marine Environment)	*No adverse effect on cephalopod population (e.g. breeding, feeding, migration behaviour, life expectancy) and spatial distribution.*
Pinnipeds	• EPBC Act 1999 (EPBC Policy Statement 1.1 – Commonwealth Marine Environment) • EPBC Act 1999 (S254 – Killing or injuring a member of a listed species)	*No injury to pinnipeds*
Crustaceans	○ Sound research on effects of seismic on crustaceans ○ Fishery Status Reports ○ Stakeholder Feedback.	*No impact to crustacean biomass within the MSS area which affects the sustainability of crustacean resources.* *(i.e. Crustacean population affected by seismic acquisition does not cause commercial/recreational fishing TACCs or fishery management KPIs to review harvest arrangements)*

Receptor	Relevant Context	Acceptable Level of Impact
Fish (pelagic & demersal)	○ Research on effects of seismic sound on fish ○ Commonwealth Fisheries Status Reports ○ Stakeholder feedback	*No impacts to fish biomass within the MSS area which affects the sustainability of fish resources.* *(i.e. Fish population affected by seismic acquisition does not cause commercial/ recreational fishing TACCs or fishery management KPIs to review harvest arrangements)*
Benthic invertebrates (sponges, sea-squirts)	• EPBC Act 1999 (EPBC Policy Statement 1.1)	*No damage to benthic filter-feeders within the MSS area.*
Socio-economic Receptors		
Commercial/ recreational fishery within the Dorrigo MSS area during survey period (exclusion impacts)	• OPGGSA S280 (Interference with other's rights) • Commonwealth Fisheries Status Reports • State Fishery Status Reports • Stakeholder Consultation	*Survey activities will not interfere with fishing to a greater extent than is necessary for the reasonable exercise of acquiring seismic.* *No spatial conflict preventing access to fishing areas between commercial/ recreational fishing and Dorrigo MSS activities during the survey period.*
Commercial/ recreational fishery within the Dorrigo OA during survey period (Catchability/abundance impacts)	• OPGGSA S280 (Interference with other's rights) • Commonwealth Fisheries Status Report • State Fisheries Status Reports • Stakeholder Consultation	*Survey activities will not interfere with fishing to a greater extent than is necessary for the reasonable exercise of acquiring seismic.* *Catchability/abundance impacts from survey operations are localised, temporary and recoverable within the Dorrigo MSS area.*
Commercial Abalone Divers (King Island)	• OPGGSA S280 (Interference with other's rights)	*Divers do not suffer health impacts as a result of survey operations.*

7.1 IMPACT: Light Emissions

7.1.1 Hazard

Light emissions will be emitted from all survey vessels on a 24 hour per day basis during survey activities from the following:

- For marine safety, vessel navigation lighting in accordance with the *Navigation Act 2012*, Marine Order Part 30 (Prevention of Collisions) will be maintained to provide clear identification to other marine users;
- Deck lighting will be provided to allow for the safe movement of personnel around the deck during hours of darkness; and
- For intermittent periods during night hours, spot lighting may be required for in-sea equipment inspection, deployment, and retrieval (this will mainly involve the use of spot-lights focusing aft of the vessel towards the source and deflectors). It should be noted that prevailing sea state conditions in the region may preclude in-water night-hour inspections on a personal safety basis.

7.1.2 Known and Potential Impacts

The known and potential environmental impacts of artificial lighting offshore are:

- Localised light glow that may act as an attractant to light-sensitive species (e.g., seabirds, squid, turtle hatchlings, zooplankton), in turn affecting predator-prey dynamics; and
- Attraction of light-sensitive species during breeding periods (e.g., turtle hatchlings, shearwaters).

Area affected by impact: The area affected by light emissions from vessel presence is localised around moving vessels based upon the limited low-intensity light sources on-board the vessels. This impact may occur anywhere within the Commonwealth waters of Dorrigo MSS area (including the multiuse zone of the Zeehan CMP).

Possible environment/receptors affected by impact: Receptors which may occur within this localised area, either as residents or migrants, are:

- Marine Mammals;
- Plankton;
- Pelagic fish;
- Cephalopods; and
- Seabirds.

7.1.3 Evaluation of Environmental Impacts

Localised light glow that may act as an attractant to light-sensitive species.

Seabirds: Seabirds may be attracted to vessels at night due to the light glow. Bright lighting can disorientate birds, thereby increasing the likelihood of seabird injury or mortality through collision with infrastructure, or mortality from starvation due to disrupted foraging at sea (Wiese *et al*., 2001). 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.

Bird strikes have been recorded on fishing vessels in the Southern Ocean where powerful ice lights are used in back-deck activities, however bird mortality arising from these events are generally low (Black, 2004). Seismic vessels do not utilise such lighting on back-deck activities with the lighting emitted diffuse similar to passing commercial shipping. Given the temporary and constantly moving nature of the light source measurable impacts to marine bird species are not expected. Threats listed within the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-16 (SEWPC, 2011) do not identify lighting as a significant threat to the species.

Marine Mammals: There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of marine mammals. 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.

Fish/Cephalopods/Zooplankton: 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.

Other marine life may be attracted to vessels due to increased attraction by prey items (e.g., fish, squid and plankton) aggregating directly under downward facing lights - a technique used by squid jig fishermen to attract and capture squid species. Fur seals have been reported as being a minor irritation for squid fishermen, as they chase prey species attracted to light sources (Gales et al. 2003).

MSS vessels are in constant motion for this limited duration MSS activity. Any alterations to marine species foraging patterns or behavioural impacts arising from light emissions onto marine waters will be localised and temporary with rapid impact recovery at any location as the light source passes.

Attraction of light sensitive species during breeding periods.
Light pollution along, or adjacent to, turtle nesting beaches is an issue as it alters critical nocturnal behaviours, particularly the selection of nesting sites and the passage of adult females and emerging hatchlings from the beach to the sea (Limpus, 2009 in SEWPC, 2011). There are no turtle rookeries along the King Island coast, so lighting will not impact turtle hatchlings.

Artificial light can cause significant impacts on burrow-nesting petrels and shearwaters. Fledglings often become disoriented and grounded as a result of artificial light adjacent to rookeries as they attempt to make their first flights to sea, a phenomenon known as 'fallout' (Birdlife International, 2012). Rodrigez at al. (2014) investigated the effects of artificial lighting from road lighting on short-tailed shearwater fledglings. The study identified removal of this light source close to nesting areas resulted in a decrease in grounded fledglings and reduction in bird fatalities. Dorrigo MSS activities operate at significant distance from coastal bird colonies (> 18 km). Measurable impacts on fledglings from vessel lighting are not expected.

Impacts to Matters of National Environmental Significance:
Vessel lighting emissions are not expected to have a 'significant' impact to any of the matters of NES applicable to this MSS, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓

Temporary and localised lighting emissions will not result in any significant effects to populations or habitats of threatened fauna.	TECs are not present withinthe area affected.	Migration, feeding, resting or breeding activities or habitats will not be impacted by a localised and temporary lighting emissions. The MSS area does not represent a destination point for migratory species.	Localised and temporary lighting emissions will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. Wiil not impact on biodiversity of ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo MSS area affected by lighting emissions are outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	Internationally or Nationally Important Wetlands	Commonwealth Marine Reserves (CMR)	Coastal protected areas
X / X	X	✓	X
KEFs are located on the seabed at least 100m below vessel activity. KEFSs are unaffected.	There are no international or nationally important wetlands within the area affected by lighting emissions.	Temporary and localised reduction in lightfall on sea-surface is possible within the upper water column within the Zeehan CMR. Emission does not result in impacts to conservation values.	Coastal protected areas are outside the Dorrigo MSS area.

7.1.4 Environmental Impact Assessment

Table 7.3 provides the environmental impact assessment for vessel lighting emissions.

Table 7-3: Light emissions EIA

Aspect	Light emissions from survey vessels.
Impact Summary	Light spill attracting light-sensitive species (seabirds, fish, zooplankton) which may affect predator-prey dynamics.
Extent of Impact	Localised small radius glow immediately around constantly moving vessel.
Duration of Impact	Temporary (duration of survey) and rapidly recoverable (very short-term)
Level of Certainty of Impact	**HIGH.** Impacts from lighting in the marine environment have been studied and documented and are well understood.
Species possibly affected within survey environment:	• **Marine seabirds** (some protected, BIAs present for widely distributed seabirds, small portion of population potentially affected at any one time). • **Fish** (not protected, widely distributed, small portion potentially affected at any one time). • **Cephalopods** (not protected, widely distributed, small portion potentially affected at any one time). • **Zooplankton** (not protected, widely but patchily distributed, small proportion of population affected at any one time).

Impact Decision Framework Context	**Decision Context: A** The use of vessel lighting at night is normal operations with impacts of light to sensitive receptors well understood. Though light sensitive fauna are identified as having the potential to be present in the area, there is a high level of centainty that in the unlikely event of localised attraction, any impact would be in close proximity to the vessel, temporary and recoverable due to the size of the vessels and the lighting on-board, the constant movement of the vessel and the short duration of the survey. There is little uncertainty associated wit this aspect. No objectins have been raied by stakehilders with respect to light emissions from vessels. *On this basis – Decision Context A is applied to this hazard.*		
Impact with controls failure (Inherent)			
MINOR: Localised short-term effects. Temporary disruption to a small proportion of a protected species population (seabirds). Localised, temporary effects.			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Reduce vessel external lighting to levels required for navigation, vessel safety and safety of deck operations.	Reduce (engineering control)	YES	Good Practice well defined and established in Marine Orders (Part 30 & Part 59) for vessel operating at sea. Lighting is required to provide navigational safety and meet legislative requirements. **Control adopted**.
Environmental induction for crew including MFOs, marine, deck and bridge crew	Reduce (administrative control)	YES	Good Practice – established and adopted by the offshore petroleum sector. Environmental benefit outweighs the cost. **Control adopted**.
Periodically inspect lighting on-board to confirm it complies with lighting standards.	Reduce (administrative control)	YES	Good Practice – established and adopted by the offshore petroleum sector. Environmental benefit outweighs the cost. **Control adopted**.
Alternative Control: Reduce lighting below levels required for navigation and back-deck activities	Eliminate	NO	No additional cost but introduces unacceptable safety risk to personnel and vessel. Very little benefit given the low numbers of light sensitive fauna in surrounding survey waters. **Control not adopted**
Alternative Control: Use of lighting wavelengths that are less intrusive to marine fauna	Prevent (engineering control)	NO	Not regarded as practical given the range of marine fauna that may be present, and the different wavelengths that may affect behaviours of different species. Would result in little benefit given low level of impacts expected at significant cost. **Control not adopted.**
Modified Control: Introduction of low spill lighting shields.	Reduce (engineering control)	NO	Not considered warranted (cost outweighs environmental benefit). Back-deck activities are normally semi-enclosed which limits the level of light spill entering the environment. **Control not adopted.**
Impact consequence with controls (residual)			
NEGLIGIBLE: Localised, temporary effects. Negligible Impacts. Almost immediate recovery.			
ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS			
EPO	EPS		MEASUREMENT CRITERIA

<table>
<tr>
<td rowspan="2">Vessel lighting is reduced to that required for navigational safety and safe night operations to limit the localised attraction of marine fauna.</td>
<td>Vessel Lighting Requirements
External lights will be directed on deck, except where required for navigational purposes or safe operations.
To prevent light spill to marine waters while ensuring the vessel is visible to other marine vessels lighting according to the following standards will apply:
• Marine Order Part 30 (Prevention of Collisions);
• Marine Order Part 59 (Offshore Support Vessel Operation); and
• ILO Code of Practice – Accident Prevention on Board Ship at Sea and in Port.</td>
<td>Inspection records confirm that lighting is restricted to levels required for safe operations.
<u>Responsible Person</u>: Vessel Master</td>
</tr>
<tr>
<td>Crew Environmental Induction
Environmental induction for survey crew including MFOs, marine, deck and bridge crew informs requirements on lighting impacts and controls.</td>
<td>Induction records verify attendance.
<u>Responsible Person</u>: Vessel Master</td>
</tr>
<tr>
<th colspan="3">Demonstration of ALARP</th>
</tr>
<tr>
<td>Hazard Consequence Criteria</td>
<td colspan="2">A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.</td>
</tr>
<tr>
<td>ALARP Statement</td>
<td colspan="2">No additional, alternative and improved control measures would provide further environmental benefit.</td>
</tr>
<tr>
<th colspan="3">Demonstration of Acceptability</th>
</tr>
<tr>
<td>Internal Context: 3D Oil Policy compliance</td>
<td colspan="2">The impact management strategy for artificial lighting impacts reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.</td>
</tr>
<tr>
<td>Internal Context: 3D Oil Management System</td>
<td colspan="2">Section 8 details the relevant management system processes adopted to implement and manage hazards to ALARP:
• Contractor and Supplier Management (Section 8.7); and
• Environmental Performance Monitoring and Reporting (Section 8.12).</td>
</tr>
<tr>
<td>External Context: Natural Environment</td>
<td colspan="2"><u>Environmental Significance:</u> As assessed above, lighting emissions are localised around vessels, temporary (due to vessel movement) and recoverable. No significance criteria is triggered for marine mammals, threatened/migratory seabirds, fish, cephalopods and zooplankton.
<u>Key Ecological Features</u>: KEFs (West Tasmanian Canyons & Shelf Rocky Reef and Hard Substrate) present are located on the seabed and not expected to be affected by vessel lighting.
<u>Species Recovery Plans</u>: The Dorrigo MSS is not located in areas which contain turtle nesting habitats; and are distant (> 18 km) from any shoreline features containing seabird nesting colonies. The Dorrigo MSS only has a small temporal overlap with the short-tailed shearwater breeding season (October to May).</td>
</tr>
<tr>
<td>External Context: Stakeholder Expectations</td>
<td colspan="2">Stakeholder consultation has been undertaken (refer Section 4). No stakeholder concerns have been raised to date associated with vessel lighting. As such, 3D oil considers that there is broad acceptability of the impacts associated with these emissions.</td>
</tr>
</table>

Legislation and Conventions	Dorrigo MSS complies with the requirements of the following legislative provisions with respect to lighting emissions. Acts/Statutes: • Commonwealth *Navigation Act 2012* and Marine Order Part 59 (Offshore Support Vessel Operations) & Marine Order Part 30 (Prevention of Collisions). • EPBC Act 1999 (Action will not significantly impact matters of NES. International Conventions: International Regulations for Prevention Collisions at Sea (COLREGS) 1972 SE Marine Reserves Network Management Plan (2013-2023): • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1); • Management Plan does not specifically reference lighting impacts from vessels as a threat to the reserves network. South-east Marine Region Profile: No specific references in plan regarding light issues from vessels. Recovery/Conservation Plans & Advices: Review and assessment of threatened species recovery plans and conservation advice (refer **Section 5.4**) did not identify threats associated with vessel artificial lighting impacts. No actions from recovery plans are applicable to this impact. Threat Abatement Plans: Not triggered by this discharge
Good Industry Practice	**APPEA CoEP:** Objectives met for MSS with respect to reducing the impacts other marine life to a level which is ALARP and acceptable including: • Adoption of management measures in accordance with legislative requirements/ guidelines; and • Utilising research /knowledge and latest data on local environment to assess potential impacts. **IAGC** Environment Manual (Worldwide Geophysical Operations): No guidance provided regarding vessel lighting. Compliant with these guidelines.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with lighting impacts from vessels during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, impacts from lighting emissions are localised, temporary and rapidly recoverable. On this basis there is no significant disruption to ecological processes supporting conservation values within the Zeehan CMP and Commonwealth marine environment.
Environmental Monitoring	
Nil	
Record Keeping	
Vessel Inspection Records. Environmental Induction records	

7.2 IMPACT: Acoustic Sound

7.2.1 Hazard

MSS activity involves the use of seismic source arrays that produce high intensity, low frequency impulsive sounds will be generated by the seismic array during survey activities. Sound will be produced at regular intervals with the energy directed primarily towards the seafloor, however sound will also radiate at angles close to horizontal potentially propagating sound over long distances. Attenuation of sound with distance is governed by the bathymetry, seabed and oceanographic properties (Urick, 1983).

Acoustic Modelling

3D Oil will utilise a source array of size 3260 in^3 (max) during the Dorrigo MSS. JASCO Applied Sciences ('JASCO') have conducted acoustic modelling for the Dorrigo MSS region to establish the area affected by sound. The study used four sound propagation models to predict the acoustic field around the airgun array for frequencies from 5 Hz to 25 kHz. The full modelling report is provided in **Appendix 6**.

The modelling accounts for the acoustic emission characteristics of the 3260 in^3 array towed at a depth of 8 m and considered source directivity and range dependent environmental properties of the Dorrigo MSS area. The results are presented as sound pressure levels (SPLs), zero-to-peak pressure levels (PK), peak-to-peak pressure levels (PK-PK) and either per pulse or accumulated sound exposure levels (SEL) as appropriate to the ecological threshold comparison. The underwater 3260in^3 (max) array proposed for the Dorrigo MSS is 8 m x 14 m consisting of 2 strings towed at 8m depth. The firing pressure is 2000 psi. The model is based on a 12.5 m shot point interval (based on triple source mode) and ~ 600 m line space interval. Sound speed profiles for the modelled sites were assessed for the period October to May and comparison of the profiles identified October as having the greatest propagation, which was applied within the modelling. This ensured that the study did not underestimate distances to received sound level thresholds over the entire survey period. The underwater acoustic signature of the array was predicted by JASCO's Airgun Array Source Volume (AASV) model accounts for array layout and volumes. Predicted source sound levels for the 3260in^3 seismic source array are shown in **Table 7-4**. Most energy is produced at frequencies below 600 Hz.

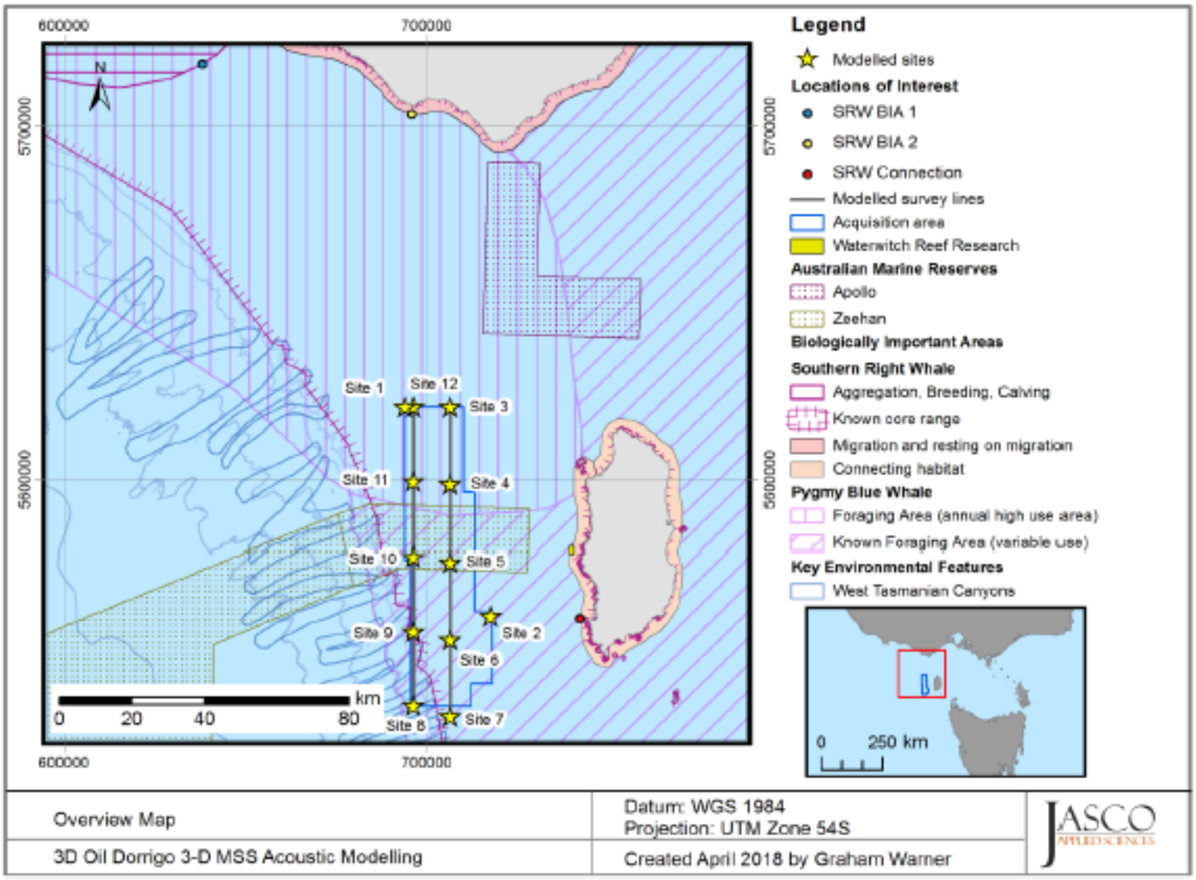
Table 7-4: Source Level Specifications in the horizontal plane for the 3260 in^3 array at an 8 m tow depth (Warner et al, 2018).

Direction	Peak Source Pressure Level ($L_{s,pk}$) (dB re 1µPa^2m^2)	Per-pulse source SEL ($L_{S,E}$) (dB re 1µPa^2m^2s)		
		10-2000Hz	2000-25000Hz	10-25000Hz
Broadside	249.3	224.7	186.6	224.7
End-fire	246.1	223.3	186.7	223.3
Vertical	255.5	228.5	194.3	228.5
Vertical (surface ghost)	255.5	230.9	197.7	230.9

For the Dorrigo MSS, acoustic modelling was performed at twelve sites representative of the differing water depths and bathymetry within the survey area and for the proposed acquisition plan (refer Figure 7-1). Per pulse sound fields were modelled at two standalone sites (Sites 1 and 2) and at ten sites along two possible seismic survey acquisition lines over approximately 24 hours of operation. Zero-to-peak pressure levels (PK) and peak-to-peak (PK-PK) pressure levels were also computed for these sites. Water depths vary from 105 m (Site 2) to 751 m (Site 8) and covered the continental shelf, shelf break and continental slope of the Dorrigo MSS area.

Seafloor sound levels were assessed at Site 2, the shallowest of the sites and per-pulse sound field were assessed at a total of three receiver locations of interest (the Southern Right Whale (SRW) BIA located at Logan's Beach and the SRW connecting habitat located in both Victorian and Tasmanian state waters).

Figure 7-1: Location of Sound Modelling Sites for Dorrigo MSS (Warner et al, 2018)



For impact assessment on the marine environment, 3D Oil has used guidelines developed from best scientific evidence available. Within each receptor section is a discussion relating to available science and the most suitable sound parameter adopted to assess acoustic impacts.

Per-pulse modelling results:
Full results from the modelling study are provided in the JASCO Applied Sciences Report (**Appendix 5**). As shown in **Table 7-4**, although there was little difference in the broadband source levels between the end-fire and broad side directions, below a few hundred hertz some directivity caused slightly higher emissions in the broadside direction at those frequencies.

SPL per-pulse results for the Dorrigo 3D MSS reflect the bathymetry of the survey area. The range to SPL isopleths with levels between 160-180 dB re 1μPa^2.s were similar for all sites but at lower level sound thresholds showed stronger propagation at shelf-break locations. The bathymetry of the acquisition area on the continental shelf is relatively flat. Sound footprint shapes in this area are dominated by the airgun array directivity pattern which has strong lobes in the end-fire and broad-side direction (refer **Figure 7-2** and **Figure 7-3**). Sound levels vary little with depth on the continental shelf, but as sound propagates off the shelf and into deep water, the water sound speed profile constrains sound energy around the deep channel axis at approximately 1-1.5 km depth (refer **Figure 7-4** and **Figure 7-5**).

Figure 7-2: Site 2 (105m water depth) – Predicted SPL for the 3260 in^3 array as vertical slices. Levels are shown broadside (top) and end-fire (bottom) directions (Warner et al, 2018).

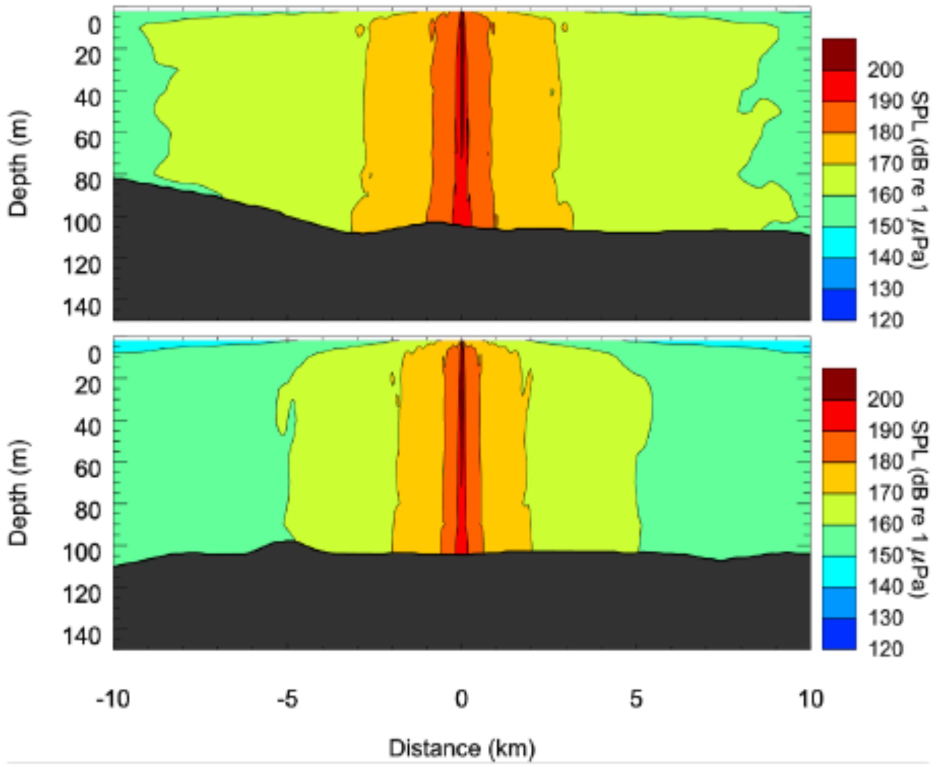


Figure 7-3: Site 9 (133 m water depth) – Predicted SPL for the 3260 in^3 array as vertical slices. Levels are shown broadside (top) and end-fire (bottom) directions (Warner et al, 2018).

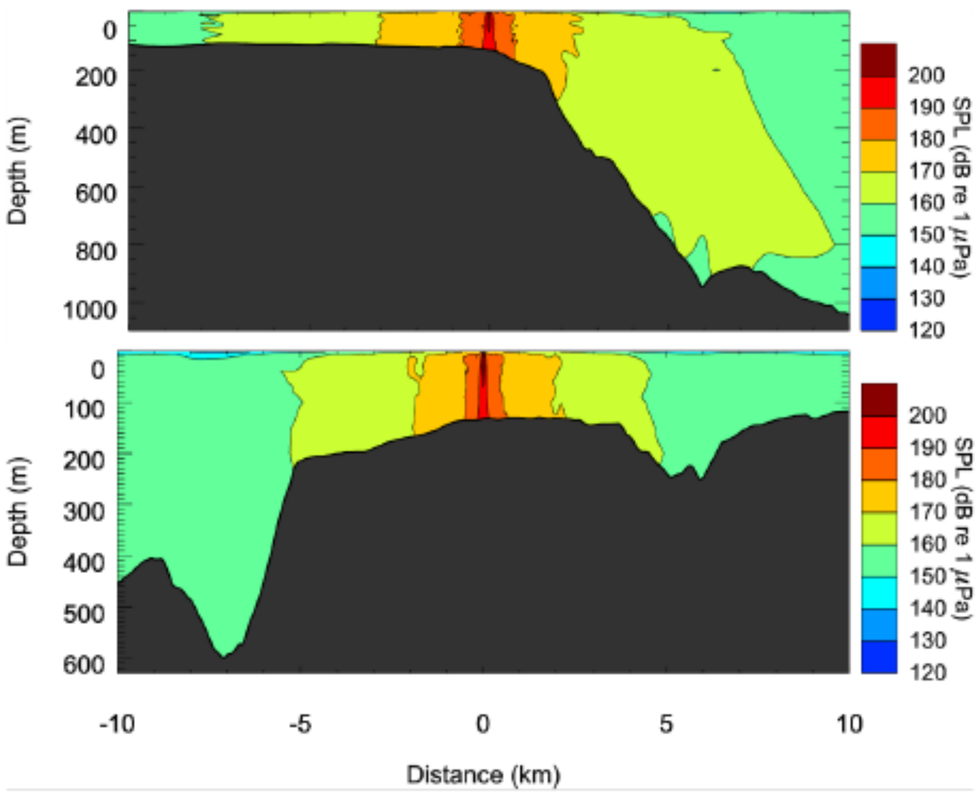


Figure 7-4: Site 2 (105 m water depth) – Predicted SPL for the 3260 in^3 array as vertical slices. Levels are shown along a single transect from broadside offshore along a heading of 270° (Warner et al, 2018).

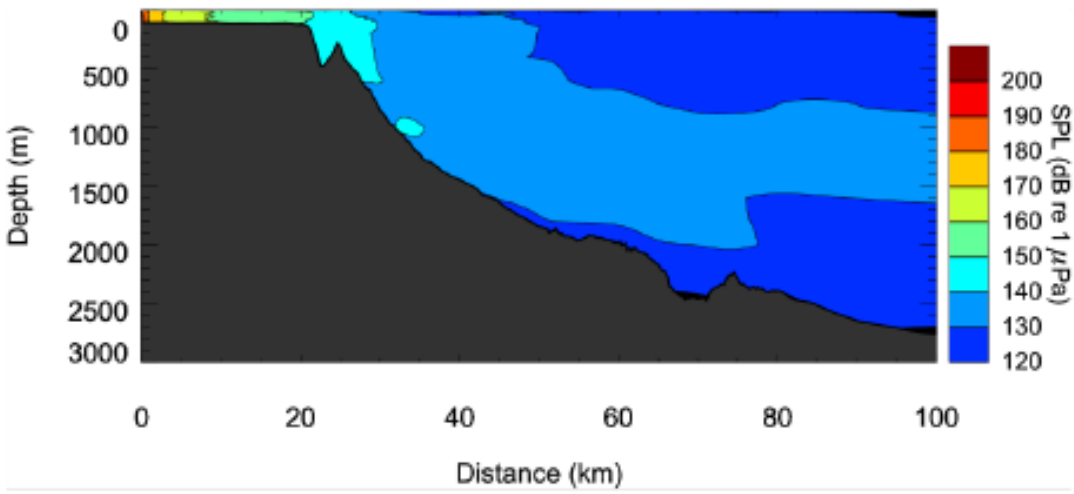
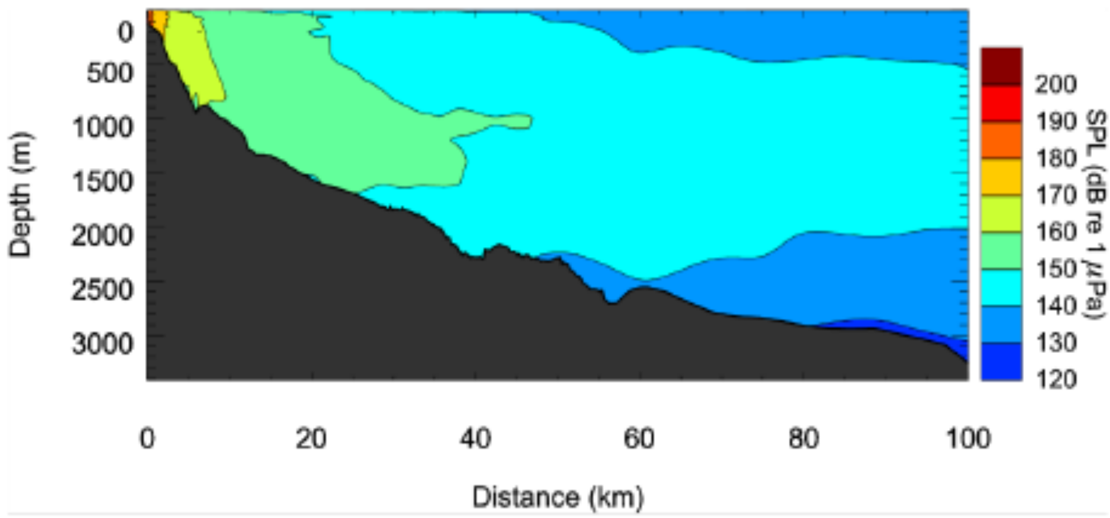


Figure 7-5: Site 9 (133 m water depth) – Predicted SPL for the 3260 in^3 array as vertical slices. Levels are shown along a single transect from broadside offshore along a heading of 270° (Warner et al, 2018).



The PK metrics (relevant to marine mammals, turtles and fish) were similar among all modelled sites. Because acoustic energy spreads as it propagates away from the airgun array, the distance to seafloor PK and PK-PK isopleths is expected to decrease as water depth increases for other sites within the operational area (Warner et al, 2018).

Multiple-pulse sound fields:

During a seismic survey, new sound energy is introduced into the environment with each pulse from the airgun array. Accurately assessing the cumulative acoustic field depends not only on the parameters of each pulse but also the number of pulses delivered over a period and the relative position of the impulses. At receiver locations close to the survey lines, the modelled sound level is dominated by those shots nearest to them.

The accumulated SEL scenario considers 24 hours of seismic operation along two specified acquisition lines. The modelled scenario assumes a pulse spacing of 12.5 m, consecutive lines are 10 km apart and a survey speed of 4.5 knots which consists of 13679 single impulses. As modelling of these impulses takes considerable time, the accumulated exposure was estimated based upon 10 per-pulse model sites from source locations along the survey lines which formed a library of representative impulse footprints. These acquisition lines were segmented into zones by classifying impulse points into one of ten representative sites based upon proximity. To produce the accumulated received sound levels and calculate the distances to specified maximum-over-depth sound level thresholds, the gridded sound levels of the ten representative footprints were transposed graphically to each impulse location along the survey lines. The sound grid fields form all impulses were summed to produce a cumulative sound field grid.

The cumulative SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, definition of a time period is required. The Popper et al (2014) sound exposure guidelines for TTS effects in fish are based upon data from Popper et al (2005) for exposure to several riverine species to a seismic airgun. This study showed that exposure to a SEL_{cum} of 186 dB re 1µPa^2.s accumulated over five seismic pulses within about five minutes resulted in about 20 dB of TTS in the lake chub and northern pike. In all cases, fish that showed TTS recovered to normal hearing levels within 18-24 hours (Popper at al, 2005). This is the only study in published literature that includes information on TTS recovery periods in fish exposed to seismic airgun noise and is the basis for the fish TTS exposure thresholds in Popper et al (2014).

The Popper et al (2005) study was done using a static source (airgun array) and static receptors (fish in cages at 13-17 m from the array) and therefore is not representative of a MSS with a moving source. On this basis, the Popper et al (2005) study represents the worst-case scenario as the source is fixed and not moving (i.e. fish received five pulses of identical intensity over five minutes which is not representative of a moving source). Since a seismic survey vessel is constantly moving, a stationary receptor is exposed to the maximum sound level once in a sequence of exposures. Given the only data available for TTS recovery in fish exposed to airgun noise indicates a recovery period from a substantial TTS of 20 dB of less than 24 hours, a 24-hour period is seen as appropriate for modelling cumulative SEL.

Cumulative SELs are used to assess possible PTS and TTS in marine mammals, fish and turtles.

Sound Source Verification (SSV):

Prior to the commencement of the Dorrigo MSS, the seismic contractor will be required to demonstrate that the proposed airgun array has equivalent source levels that match the specifications used in modelling (refer **Table 7-4**). The SSV process will be a requirement of the seismic contract tender assessment (refer **Section 8.7**).

The in-field measurement process, which can be conducted at any suitable location worldwide using any survey vessel in the contractor's fleet will have the following general requirements:

- Reputable service provider with demonstrated track record (grey or peer-reviewed literature) in the field of measurement of airgun arrays;

- Water depth can be determined by the operator;
- Measurement line:
  - Minimum of a single pass directly over the hydrophone; and
  - Must commence firing of array and be measures 3 km before passing over the hydrophone. Firing of the array can stop 3 km beyond the hydrophone position.
- Array-hydrophone separation: 50-500m.
- Hydrophone must be directly on the vessel track line to allow characterisation of the vertical direct path.
- In water depths <100m the seabed should be relatively flat.
- Hydrophone specifications:
  - Operator to determine sensitivity as required to accurately record the impulses without clipping;
  - Must have an appropriate frequency response in the sensitivity range required to accurately measure the airgun array from 10 to at least 15,000 Hz;
  - The frequency response should be flat between 10-10,000Hz; and
  - Systems with a sharp roll of over 1000 Hz are not appropriate.
- Recorder Specifications: 24-bit, 64 ksps minimum sample rate.
- SSV report must quantify:
  - Airgun layout and depth (x,y,z location for each individual airgun);
  - Location of array(s) behind vessel;
  - Vessel speed shot interval and other pertinent details;
  - Approximate geology down to 500m below seabed;
  - Sound speed profile through water column measurement;
  - Measurement system specifications;
  - Measurement system sensitivity, including frequency response curve for hydrophones;
  - Bathymetry of measurement location;
  - Measurement methodology;
  - Estimate of far-field source levels from the measured values;
  - Level vs slant plot for PK, PK-PK, SEL and 125ms SPL metrics; and
  - Data points in plots (level and range values) to be provided digitally.

Variation in recorded sound levels up to 3 dB are considered within the margin of error for the methodologies and technology used for the in-field SSV and ground-truthing, including autonomous loggers deployed on the seabed directly beneath a measurement line.

To allow for the fact that there could be some outlier shots, due to highly reflective sections of seabed, or misfires of the airguns, the acceptability criteria will be set at 90% (i.e. >90% of the shots must be within 3 dB of the source specifications provided in **Table 7-4**). If greater than 10% of the measured values exceed the modelling predictions by more than 3dB, the seismic contractor will be required to retrieve the airgun array from the water, reconfigure, deploy and then repeat the measurement line. This process will have to be repeated until the airgun array meets the required sound source specifications.

The SSV report and associated digital data will be provided by the seismic contractor to 3D Oil and to a suitable independent peer reviewer, for checking and verification.

7.2.2 Known and Potential Impacts

The potential biological, ecological and economic impacts from sound pulses are:

- Physical injury such as mortality, damage to auditory tissues or other air-filled organs resulting in hearing loss [temporary threshold shifts (TTS) or permanent threshold shifts (PTS)];
- Physiological, such as changes to metabolic rate or biochemical stress indicators;
- Behavioural effects, such as disturbance or displacement of local species with disruption to natural processes (migration, foraging, masking);
- Localised changes in abundance and catch levels of commercially targeted invertebrate or fish species from physical, physiological or behavioural changes.

Area affected by Impact: Areas and effects vary by species and location. This information is discussed in each of the relevant receptor sections.

Possible environment/receptors affected by impact:
Receptors which may occur within this localised area, either as residents or migrants, are:

- Plankton (including fish egg/larvae);
- Marine invertebrates (lobsters, crabs, sponges, gastropods);
- Fish (including commercial species, shark, pelagic and demersal);
- Cetaceans (whales and dolphins);
- Pinnipeds;
- Marine turtles;
- Abalone divers;
- Marine seabirds;
- Marine Parks (Zeehan and Apollo CMP); and
- Key ecological features (West Tasmanian canyons, shelf rocky reefs and hard substrates).

7.2.3 Evaluation of Environmental Impacts

7.2.3.1 Plankton

Receptor Sensitivity:
Plankton, as described in **Section 5.4.2**, includes fish eggs and larvae, is widely dispersed throughout the ocean and transported by prevailing currents. Plankton cannot take evasive action to avoid seismic sources. Most plankton are microscopic with approximately 75% of zooplankton comprising of copepods, small crustaceans that are the most abundant multicellular animals on earth. Zooplankton can be categorised as those species which spend most of their life as plankton (the *holoplankton)* and those that only spend part of their lifecycle in the planktonic phase such as eggs and larvae of fish, crabs, lobsters (the *meroplankton*) (Richardson et al, 2017).

Larval fish species studied appear to have hearing frequency ranges similar to those of adults and similar acoustic thresholds (Popper et al, 2014). Swim bladders may develop during the larval phase which renders the larvae susceptible to pressure-related injuries (e.g. barotrauma) and the effects of sound upon eggs, and larvae containing air is focussed around barotrauma rather than hearing (Popper et al, 2014). A scientific literature performed by Popper et al (2014) identified anthropogenic sound impacts to eggs and larvae range from no impact to mortality/tissue damage close to an operating array in most studies.

Larval stages are often considered more sensitive to stressors than adult stages (Byrne and Przeslawkski, 2013) but field studies have identified that exposure to seismic sound reveals no differences in development, mortality or abundance of Dungeness crab larvae exposed to single discharges from a seven-airgun array (222-231 dB re 1µPa PK-PK) even within 1 m of the source (Pearson et al, 1994). Similarly, no effects were measured on the mortality, abnormality, competency, or energy content of lobster larvae *(J. edwardsii*) after exposure of berried females and early embryonic stages to cumulative SELs of 190-197 dB re 1µPa^2.s (209-212 dB re 1µP PK-PK) within close proximity of an operational array (~6-8m) (Day et al, 2016).

Impacts to eggs/larvae have been observed in laboratory studies where test subjects have been exposed to intense and lengthy periods of low-frequency sound. Christian et al (2003) found developmental differences between control and treatment groups of snow crab eggs exposed to peak sound levels of 216 dB re 1µPa every 10 s for 33 minutes in close proximity to the test subjects (~2m). The author identified that the study conditions did not represent conditions of an actual survey and limited sample size could only provide preliminary findings. DFO (2004) building on the work of Christian et al. (2003) undertook further work on the reproductive biology of snow crabs showing that there was no difference in larvae hatched from gravid females between control and exposed groups.

Other studies assessing seismic sound impacts to eggs, larvae and fry identified damage was possible up to 10 m from an operating array (Kostyuchencko, 1973; Matishov, 1992; Booman et al, 1996; and Cox et al, 2011) while other studies did not identify any sign of damage (Dale & Knudsen, 1987; Pearson et al, 1994; DFO, 2004, Payne et al, 2009; Bolle et al, 2012 and Day et al, 2016) (refer **Table 7-5**). Gausland (2000) noted several studies which confirmed that signal levels exceeding 230-240 dB re 1µPa (PK-PK) are necessary for harm to occur and massive physical damage can only occur within a few meters from the airguns and as a consequence seismic-created mortality is so low that it can be considered to have inconsequential impact on recruitment to the population.

Saetre & Ona (1996) investigated the consequences of seismic-induced mortality of fish larvae at a population level, although the study was limited in scope. The work was based upon observed mortality distances for larvae and fry in Booman et al (1996) for five species of fish (cod, saithe, herring, turbot and plaice). On a worst-case basis, it was estimated that the number of larvae killed during a seismic survey (> 10 days) was 0.45% of the total larvae population (Saetre & Ona, 1996). When compared with the natural mortality rates for species (i.e. cod and herring eggs/larvae have a natural mortality rate of 5-15% per day), the potential mortality associated with the seismic survey is negligible.

Table 7-5: Observed sound effects on plankton, fish and invertebrate eggs and larvae.

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Anchovy, Red Mullet, blue runner and crucian Carp (fish eggs)	Single airgun	250 (estimated)	0.5, 5 and 10	210-236 (Estimated)	Survival (combined species) one day post exposure: 75.4% at 0.5m; 87.7% at 5m; 90.2% at 10m compared with 92.3% in control group. The study found that at distances of 0.5m, 7.8% of anchovy eggs were damaged however detected no damage with the red mullet eggs at this distance. At 5 m from the source, 3.6% of anchovy eggs were damaged but at 10 m, four species of egg did not show any damage. Pathological effects (embryo curling, membrane perturbation and yolk displacement) were observed in small percentage in anchovy and blue runner eggs at 5 m and crucian carp at 0.5m. No effects in mullet eggs. **No effects beyond 10 m from the airgun.**	Kostyuchenko (1973)
Atlantic Cod (eggs, larvae and fry)	Single Airgun (640 cm^3) (eggs, larvae & fry) Single Airgun (8610 cm^3) (fry only - 110 age)	222 (640 cm^3) 231 (8610 cm^3)	1-10 150-300	200-210 (Estimated)	Smaller airgun: No significant difference of survival between test group and control group was observed for any distance (1-10 m from the source) for the egg stages (2, 3 and 10 days post fertilisation); the larval and post-larval stages (1, 5, 37, 38, 40 and 41 days after hatching); and hatching for fry (56, 69 and 110 days). The feeding success of the exposed larvae and fry was not significant compared with the control group indicating no sub-lethal effects from the small airgun. Fry (age of 110 days) experienced balance problems after exposure but recovered in a few minutes. Larger airgun: None of the specimens were killed however balance problems were observed after exposure. Fry recovered within a few minutes. **Captive eggs, larvae and post-larvae showed no signs of damage when placed 1 m from the source.**	Dalen & Knutsen (1987) Field Study
Cod (larvae 5 days)	Single airgun	250 PK-PK	1	250 PK-PK	Matishov (1992) observed delamination of the retina in cod larvae within 1 m of a seismic source. **Injuries to larvae reported for the closest (1m) exposure range.**	Matishov (1992)
Dungeness Crab (egg and larvae)	Seismic Array (842 in^3)	244	1, 3 & 10 m	222- 231 PK-PK	In blind, controlled field experiments, early Stage II zoaea of Dungeness crab (Cancer magister DANA) were exposed to sounds from single discharges of seven air guns. Their survival and development were followed during subsequent laboratory culture. The study was designed so that exposures were at the high end realistically expected during a typical survey operation. No statistically significant differences were found in immediate survival rates, long-term survival rates or time to moult between the exposed and control larvae, even within 1 m of the source. Post-hoc power calculations to confirm the adequacy of the study sample and 'effect' size identified here was adequate replication to detect Type II errors or 'false negative' effects. '*Failure to detect effects in the experiment indicates that any effects on survival and time to moult were small (e.g. < 10% for survival, < 1 day for time to moult to Stage II)*'. **Survival and growth of Dungeness crab larvae not impacted by airguns discharging within 10m.**	Pearson et al., (1994) Field/Laboratory Study
Cod, Pollock, Herring, Turbot, Plaice, (eggs, larvae & fry)	Airgun array consisting of 3 x Bolt 1500 C (585 in^3), 1 x Bolt 1500 C (290 in^3) and 1 x Bolt 1500 C (155 in^3)	NS	0.75 6.0	242 220	Field experiment using a stationary source array suspended 6 m below the surface with bags of specimens placed at distances from 1 to 5 m from the source. Two different set-ups were used. Highest mortality rates and most frequent injuries were observed out to 1.4 m distance, while low and no mortality rate and more infrequent injuries were observed out to 5 m distance. **Increased mortality and injury within 5 m of the array.**	Booman et al., (1996) Field Study

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Plankton (including bivalve larvae and fish eggs)	Airgun array (3542 in^3)	232 255 PK-PK	~200	NS	Undertaken in Bass Strait, this study used vertical plankton tows (0-20m water depth) along transects running parallel and adjacent to seismic survey lines to establish the significance in abundance and dead/alive plankton (including bivalve larvae and fish eggs). Methodology included sampling behind a seismic survey vessel, before the vessel or 2 km distant from the vessel. Sampling consisted of five control transects (5 net tows ~ 500 m apart on each transect) and one impact transect (10 net tows). No statistically significant changes associated with seismic testing were detected for planktonic taxa. However, high levels of variability in plankton communities meant that only large changes would have been detected by this sampling regime. Power analysis revealed for most taxa the number of transects sampled (5 control and 1 impact), in combination with the patchiness of the distribution of the taxa themselves, meant that for most taxa changes would only be detected if they cause an 80-90% decrease in the mean abundance of the taxa. Copepods were the least patchy taxa and a decrease of 20-40% was likely to have been detected. **No significant difference in abundance of zooplankton before/after a seismic vessel or 2 km distant from the vessel.**	Parry et al. (2002) Field Study
Snow Crab (fertilised eggs)	Single airgun ($40in^3$)	224-227	2	221-227 PK	Study into impacts on reproductive biology of female snow crabs including observation of developmental differences in fertilized eggs between control and test groups. One batch of eggs (about 4,000) showing a similar level of development were divided into two groups for exposure to a seismic airgun and as a control group. Twelve weeks after this exposure, the fertilized eggs showed a 1.6% higher mortality compared with the control group, and 25.7% fewer eggs had developed to the next developmental stage in the exposed group. However, the limited sample size (2000 eggs) in this instance (equivalent to 2% of a gravid female *C. opilio* brood) meant that findings were preliminary and further testing warranted. The authors note that females carry eggs at depth where received sound levels are much lower than the 2m test distance (i.e. not realistically translated to field conditions). **High sound levels may retard the development of eggs exposed to sound in excess of 221 PK at 2 m, although the eggs were taken from one individual.**	Christian et al., 2003 Laboratory Study
Snow Crab (fertilised eggs)	Single airgun (1310 in^3)	Unknown	Unknown	Unknown	Survival of embryos being carried by female crabs and locomotion of the resulting larvae after hatch were unaffected by the seismic survey. **No increase in egg mortality or larvae survival.**	DFO, 2004
Monkfish (larvae) Capelin (fertilised eggs)	Single airgun ($20in^3$)	NS	~1.5m ~2.5m	205 PK-PK 199 PK-PK	<u>Monkfish:</u> Seven separate trials (6 trials with 10 airgun discharges and 1 trial with 30) No significant differences were observed between control and exposed larvae examined 48–72 hours post exposure. <u>Capelin:</u> No significant differences in mortality were observed between control exposed eggs to seismic energy and examined 3 days post exposure to 20 airgun discharges. **No difference in mortality in eggs and larvae exposed to acoustic sound.**	Payne et al., 2009 Laboratory Study

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Salmon (eggs and embryo)	Single airgun (40 in^3)	NS	0.1 m 2.7 m	207-232 PK	Study established airgun impacts to two salmon species (lake trout, rainbow trout and kokanee) both pest species. Embryos were exposure to acoustic sound at distances of 0.1 m and 2.7 m at two depth ranges (5 m and 15 m) to establish mortality impacts over ~ 20 days (i.e., eye-up to hatch). Mortality in lake trout embryos treated at 0.1 m from the air gun appeared higher than control groups at 74 (~5 days) and 156 daily temperature units in degrees Celsius (TU C) at both depths. Exposure to the air gun at 0.1 m resulted in acute mortality up to 60% greater than controls among the four lake trout developmental stages. Mortality was at least 20% greater than corresponding controls, except the 5 m depth treatments at 207 and 267 TU C. Treatments at 0.1 m from the air gun at 15 m depth had large effect sizes in the latter developmental stages (207 and 267 TU C) relative to shallow treatments. The effect of the air gun discharge at 2.7 m was negligible across developmental stages and depths. **No significant difference in development at distances of 2.7 m from the operating array. Mortality evident in embryos at 0.1 m from the operating array.**	Cox et al., (2011) Field Study
Sole Larvae (Solea solea)	Projector playing pile driving sounds	210 dB re $1\mu Pa^2.s$ (SEL)	100	≤ 206 dB SEL_{cum}	No clear differences between exposure groups and the control group were observed for any of the larval stages. **No increased mortality or injuries compared to control group.**	Bolle et al., 2012 Laboratory Study
Southern Rock Lobster (egg, larvae)	Single airgun ($45in^3$)	223-227 PK-PK 200-205 SEL	5.2	209-212 PK-PK 186-190 SEL	Study observed acoustic impacts on the larval stages of lobster development where egg-bearing female spiny lobsters (*Jasus edwardsii*) were exposed to a $45in^3$ airgun operating at 2,000 psi (SEL ~200 dB re $1\mu Pa^2.s$). The study concluded the following: • There was no difference in fecundity between control and exposed lobsters; • A small but significant difference in the length of the larvae was observed in the exposed lobsters. No difference was found in width or dry mass of the larvae and no hatches were found to suffer from high mortality rates or deformities; • No energy difference was identified between larvae from control and exposed lobsters; and • Larval activity/survival between control and exposed lobster groups was not significant. Overall there were no differences in the quantity or quality of hatched larvae, indicating that the condition and development of spiny lobster embryos were not adversely affected by air gun exposure. **No impact of airgun on quality or quantity of hatched larvae at any distance.**	Day et al., 2016 Field Study

Species/ Organism	Source	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Zooplankton	Single airgun (150m³)	Not Stated	0, 250 & 800 m	183 PK-PK (or SEL 156) 178 PK-PK (or SEL 153)	Study measured the impact of a seismic array to zooplankton abundance and mortality (before/after airgun operation). Study was undertaken over a two-day period with the following findings: • The abundance of zooplankton was observed to open a "hole" within the zooplankton as measured by sonar. Abundances established through net tows had a median decrease of 64% within 1 hour. • The air gun exposure caused a two-threefold increase in dead adult and larval zooplankton observed out to the maximum 1.2 km range sampled. This was observed on both Day 1 and Day 2 however the zooplankton dead/total ratios were significantly reduced compared with controls at the maximum sampling range of ~1.2km. Exposure abundances of no-impact and 50% of control abundance for copepods/cladocerans (86% of the taxonomic composition *after exclusion of tows with zero values*) occurred at ranges of 509-658m and 973-1119m respectively. Movement of water was present between days and McCauley identifies that "without detailed information on mixing, advection and current set above tidal flow (not known), it is not possible to draw any conclusions on the different zooplankton abundance… between Day 1 and Day 2". McCauley (pers. com) advises that due to the increase in abundance counts on Day 2 at the 800m sample location, this has been used as the determinant for stating that the impact range was 1.2 km. • The paper observes that all krill larvae within the exposed samples were dead at all range groups. Raw plankton abundance counts for *Nyctiphanes australis* (krill) identifies that no krill larvae (*Nauplius*) were present in the control/exposed tows for Day 1 (800 m) or Day 2 (250m & 800 m). It is also noted that the abundance counts for tows which did measure *Nauplius* kill were very low: Day 1 (0m) – 8 animals/m³; Day 1 (250 m) – 10 animals/m³ and Day 2 (0m) – 1 animal/m³. It is also noted that for the krill *calyptopis* phases larvae were measured within all range groups on both days and there was an increase in abundance on Day 2 (800 m) for almost all plankton groups. McCauley (pers.com).	McCauley et al (2017) Field Study

McCauley et al (2017) released field study research from the temperate waters of southeast Tasmania, which quantified zooplankton impacts (abundance and dead-to-total zooplankton counts) before and after exposure to a single 150 in^3 airgun at an operating pressure of 2000 psi. Deployed acoustic loggers measured sound from the air gun signals. Zooplankton samples were taken at three distances from the airgun - 0, 250m and 800 m which due to water movement through the study area were effectively at 200m, 500m and 1200 m from the operating airgun. Bioacoustic techniques were employed to identify changes in zooplankton distribution and net samples were used to measure changes in zooplankton abundance and the proportion dead of zooplankton after airgun exposure. In this study, copepods dominated the mesozooplankton (0.2-20 mm) and impacts were not assessed on microzooplankton (0.02-0.2 mm) or macrozooplankton (> 20 mm) (Richardson et al., 2017). The movement and lack of detail on water body mixing, advection and current set above tidal flows through the study area made interpretation of results difficult (Richardson et al, 2017).

McCauley et al. (2017) reported three findings from the field study, to show that zooplankton were affected by the airgun:

- The proportion of the mesoplankton community that was dead increased two –to-threefold;
- The abundance of zooplankton estimated by net samples declined by 64%; and
- The opening of a 'hole' in the zooplankton backscatter observed via acoustics.

The results of this study found that zooplankton exposure to airguns increased the mortality rates from a natural level of 19% per day to 45 % per day on the day of exposure (i.e. a mortality rate of 32%) (Richardson et al., 2017). The impacts to plankton were limited to 1.2 km from the operating array as determined by raw plankton abundance counts. This distance is more than two orders of magnitude greater than the 10 m previously measured (McCauley et al, 2017).

The study attributes the impact to external sensory hairs that zooplankton possess may be extremely sensitive and in response to seismic sound, may shake to the point where damage may accrue to 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 be large in comparison with the ecosystem concerned.

CSIRO's Oceans and Atmosphere Business Unit were engaged by APPEA to undertake a desktop study that:

a) critically reviewed the methodologies and findings of the McCauley et al (2017) study; and
b) simulated the large-scale impact of a seismic survey on zooplankton in the Northwest Shelf region based upon the mortality rate associated with airgun noise exposure reported by McCauley et al (2017).

CSIRO's review of the McCauley et al (2017) study found that there were three primary questions raised by the results of the experiment, all of which warranted further investigation (Richardson et al, 2017):

i. *There was not attenuation of the impact with distance*:
The study did not observe a consistent decline in the proportion of dead zooplankton as distance or as the received sound level decreased.

ii. There was an immediate decline in abundance.
The immediate decline in zooplankton abundance as measured in the towed nets/acoustic data is unclear. If zooplankton were killed, they would not immediately sink from surface layers or be rapidly eaten. A time delay to reduced abundance would be expected. A lower abundance might be attributed to active avoidance of the area by zooplankton leaving a

higher proportion of dead zooplankton. Richardson et al. (2017) concluded the immediate decline in abundance is difficult to explain.

iii. *Was here sufficient replication to be confident in the study findings*.
Conclusions drawn by McCauley are based upon a relatively small number of zooplankton samples. A total of 24 samples were collected: 2 tows each sampling time x 3 distances from the airgun (0m, 200m and 800m) x 2 levels (exposed, control) x 2 replicate experiments (Day 1, Day 2). This equates to a total of 24 samples – 12 samples collected under conditions associated with the airgun, six on each day of the two field tests. The main potential confounding explanation in the study would be that a different water mass entered the area on each day of the experiment and had lower abundance and higher proportions of dead zooplankton. Richardson et al. (2017) conclude that "*although this is relatively unlikely it cannot be discounted because of the relatively few samples collected and only two replicate experiments conducted*".

Independently, the International Association of Geophysical Contractors (IAGC) initiated an independent expert review of the McCauley et al (2017) paper by leading plankton ecologists in well-respected scientific institutions given the results were inconsistent with previous studies. In short, the reviewers expressed the opinion that although the result of the study should be considered further, the data was not sufficient to support the conclusions of McCauley et al (2017). Independent reviewers identified the following issues with the study:

i. The sample size was inadequate;
ii. Water column movement data was insufficient to support the contention that there was a hole in the plankton field;
iii. Towed net and acoustic survey data disagree regarding zooplankton class size;
iv. The acoustic "hole' indicating dead zooplankton may result from zooplankton which had swum to the bottom (10 m away based upon an observed dense acoustic scattering layer);
v. Bottom sampling should have been conducted to address the issue of whether large zooplankton was present (i.e. killed or actively swum to the bottom);
vi. The wrong size nets were used and not towed correctly;
vii. There is statistical error in the tow data.

This independent IAGC review has been shared with the authors of the McCauley et al. (2017) paper, and those authors have concurred with many of the shortcomings in study design and evaluation identified by the independent reviewers (IAGC, 2017). The IAGC (2017) concluded that the results of McCauley et al. (2017) showing patterns and trends, do not actually exist in the data. Further, the results presented by McCauley et al. (2017) are of questionable scientific merit and, accordingly, must be subjected to more rigorous scientific study before being accepted as the "best available science" regarding the potential effects of seismic sound on zooplankton. Existing published studies demonstrating that any seismic effects on zooplankton occur only to tens of meters remain the best available science until the preliminary study by McCauley et al. (2017) can be properly replicated.

As identified in **Table 7-5**, Parry et al (2002) studied the effects of seismic array operation on plankton. Vertical plankton tows (0-20 m water depth) were taken along transects running parallel and adjacent to seismic survey lines. Within that study Parry et al. (2002) established no statistical difference in plankton between control and impact samples, however the statistical power of the study was low given the patchiness and variance in plankton samples obtained. For most plankton taxa abundance change would only have been detected if an 80-90% decrease in the mean abundance occurred. Copepods, the least patchy taxa, would have required an abundance decrease of 20-40% for changes to be detected. Post-impact samples were estimated to be sampled within ~ 200m of the centre of the water most impacted by the airgun array.

Richardson et al (2017) undertook a plankton simulation study to estimate the spatial and temporal impact of seismic activity on zooplankton on the NWS from a large-scale seismic survey considering mortality estimates of McCauley et al (2017), accounting for estimated plankton growth rates, natural mortality rates and the ocean circulation in the region. The hypothetical 3D MSS modelled was 2900 km^2 in size with 60 survey lines, water depths 300-800 m deep, an airgun source of 3000-3200 in^3 with an operating pressure 2000 psi at the edge of the NWS during summer. To simulate the movement of zooplankton by currents, a hydrodynamic model seeded with 0.5 million particles utilised currents generated by CSIRO's Ocean Forecast Australian Model and particle trajectories tracked every two hours to quantify impacts to the zooplankton population (i.e. those impacted and not impacted). Zooplankton particles could be hit multiple times by airgun pulses if carried by currents into the future survey path. The greatest limitation of the model was accurate knowledge of the natural growth and mortality rates of zooplankton. To address this the CSIRO researchers tested the sensitivity of the model to different recovery (growth-mortality) rates, and also the sensitivity of the results to ocean circulation by undertaking simulations with and without water motion (Richardson et al, 2017).

The results of the simulations that included ocean circulation showed that the impact of the seismic survey on zooplankton biomass was greatest in the *survey region* (defined as the survey area with a 2.5 km impact zone around it) where 22% of the zooplankton biomass was removed. Zooplankton within the *survey region + 15km*[25] had 14% of the biomass removed, and the *survey area +150 km*[26] had 2% of the biomass removed. The time to recovery (to 95% of original level) for the survey region and survey region +15 km was 39 days after the start of the survey and three days after the completion of the survey (Richardson et al, 2017).

Richardson et al (2017) found there was a substantial impact associated with zooplankton populations at a local scale within or close to the survey area, however on a regional scale the impacts were minimal and were not discernible over the entire NWS bioregion. In addition, the study found that the time for zooplankton biomass to recover to pre-seismic levels inside and within 15 km of the survey area was three days after the completion of the survey. The relatively quick recovery was due to the fast growth rates of zooplankton and the dispersal and mixing of zooplankton from both inside and outside the impacted region (Richardson et al, 2017).

Adopted Sound Impact Criteria (Plankton):

Sound exposure guidelines for eggs/larvae mortality have been established by the Working Group on the Effects of Sound on Fish and Turtles (Popper et al. 2014) approved by the Accredited Standards Committee S3/SC 1 Animal Bioacoustics and accredited with the American National Standards Institute (ANSI). Mortality data for eggs and larvae within those guidelines are based on a study by Bolle et al. (2012) who found no damage to larval fish at received levels of 210 dB re 1µPa^2.s SEL_{24hr} and on this basis, the threshold is considered conservative. Based upon available studies reviewed in **Table 7-5**, the Popper et al. (2014) thresholds nominated in **Table 7-6** are considered relevant and adopted in this EP to assess impacts to plankton for the Dorrigo MSS.

25 Defined as near-field effects

26 Defined as far-field effects

Popper also identifies a moderate risk of impairment (i.e. recoverable injury or TTS) or behavioural impact (e.g. water column displacement) to eggs and larvae at locations near the source array (i.e. tens of metres); and a low risk of impairment at intermediate distances (hundreds of metres from source array). Given these effects are close to the array, plankton impacts are not expected to be significant at a population level.

Table 7-6: Sound exposure guidelines for mortality, impairment and behavioural change in fish eggs and larvae (Popper et al, 2014).

Type of Animal	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Eggs and larvae	> 210 dB SEL_{cum} or > 207 dB PK[27]	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Definitions:					
Mortal and mortal injury	Immediate or delayed death.				
Recoverable injury	Injuries including hair cell damage, minor internal or external haematoma, etc. None of these injuries are likely to result in mortality.				
Temporary Threshold Shifts	Short or long-term change in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6 dB or greater that persists and has been selected as the working group considers that anything less than 6 dB will not have a significant effect from a hearing standpoint.				
Masking	Impairment of hearing sensitivity by greater than 6 dB in the presence of noise.				
Behavioural effects	Substantial change in behaviour for the animals exposed to sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction or alteration in migration patterns. This criterion does not include effects on single animals or where animals have become habituated to the stimulus or small changes in behaviour such as a startle response or small movements.				
Note: Peak and rms pressure levels are dB re 1µPa; SEL dB re 1µPa^2.s. All criteria are presented as sound pressure since no data on particle motion exists. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) (tens of metres), intermediate (I) (hundreds of metres) and far (F) (thousands of metres) (Popper et al. 2014).					

Acoustic modelling undertaken for the Dorrigo survey assessed one location[28] for the 207 PK threshold and predicted the maximum predicted horizontal range for mortality impacts was within 191 m from an operating airgun array. The mortality and potential mortal injury using the SEL_{24hr} metric was not reached horizontally from the array and the PK metric is applied to assess impacts to plankton (Warner et al, 2018) (refer **Appendix 5** for full report).

Using the received level at which McCauley et al (2017) measured an impact, as this is the latest research to show an impact to plankton, 178 PK-PK is reached at a maximum distance (R_{max}) of 9.56 km.

Extent and duration of exposure and identified potential impacts:

Species/Habitats Present:

[27] When assessing for possible egg/larvae mortality impacts, applying the PK thresholds results in a larger distance from the source and is therefore more conservative when compared to the SEL_{cum} value (Warner et al, 2018).

[28] Most conservative from modelling purposes using the shallowest depth of 105 m on the continental shelf. One location was selected given the Dorrigo MSS is positioned primarily on the continental shelf.

Plankton: The Dorrigo MSS area lies predominantly on the southern Australian continental shelf and while the MSS area does not overlay areas of upwelling (Bonney upwelling and West Tasmanian canyons) the Dorrigo MSS due to regional currents receives plankton from upwelled areas, particularly during the highly productive period, November to April. **Section 5.4.2** provides details of the Dorrigo MSS area relative to these upwelling areas. The Dorrigo MSS area is a recognised BIA (foraging) for the pygmy blue whale, a species which is present in areas of high krill availability (refer **Section 5.2.5.2**). The Dorrigo MSS area also overlays a portion of the Zeehan CMP "multi-use zone".

Fish and Invertebrate Egg/Larvae: A review of commercial fish and invertebrate species present in the Dorrigo MSS (refer **Table 5.4**) identifies the following fish/invertebrates may spawn within the Dorrigo MSS area in the survey timeframe (September to October) (Bruce et al, 2002):

- Ocean perch (protracted spawning in late winter to late summer);
- Southern rock lobster (larval release from berried females between September to October; multiple cohorts of larvae widespread in waters year-round);
- Giant crab (fertilised eggs carried by berried female between September and November; widespread larval phase approximately 50 days after hatching);
- Pilchard (synchronous multiple-batch spawners between September and February in inshore areas on the continental shelf).

The Dorrigo MSS area does not overlap key spawning or aggregation areas and any associated egg/larvae presence, based on available literature (NOO, 2002; Kailola et al, 1993; Bruce et al; 2002, 2003; FRDC, 2018; TasFish, 2018), is widespread with dispersal via currents within the area. Impact assessment to eggs/larvae are therefore assessed as plankton (below).

Note from available scientific literature, abalone spawn in nearshore waters on a year-round basis (Mundy and Jones, 2017). Recruitment studies identifies localised distribution and colonisation from these spawning events (Mundy and Jones, 2017). Abalone grounds are located ~26km from the nearest survey line, and there is no spatial overlap of, or proximity to, spawning areas which is predicted to cause impacts to the fishery.

Potential Impacts:

Impacts to BIA (pygmy blue whale foraging – high abundance): The Dorrigo MSS overlaps the seasonal high productivity, high use foraging BIA for pygmy blue whales connected to upwellings. To prevent overlap temporally with this foraging BIAs, the Dorrigo MSS has been positioned between September 1 to October 31, 2019. Blue whale presence is not expected within this timeframe (refer **Section 5.2.5.2**) and no impacts to zooplankton (krill) stocks from upwelling events are predicted which would affect or displace foraging from the BIA.

Plankton: Studies within **Table 7-5** identify damage to plankton is likely to be restricted to a range < 10 m from an operational airgun based upon the weight of scientific evidence. Calculations indicate that approximately 1%[29] of the plankton drifting on currents through the Dorrigo MSS area will be affected by acoustic sound over the 35-day survey period.

[29] Calculation is based on an area of 10m impact radius around airgun at 12.5 m shot-point intervals for the planned MSS. It assumes 4255 km sail line distance (includes lead-in and lead-out distances), uniform distribution of plankton, a 100% mortality rate within the 10m and an average current drift through the survey area of 0.2m/s (i.e. a net average current drift of 17.3 km per day and based upon a survey line length of 115 km (including lead-in and lead-out)). A south current direction through the permit

Utilising the Popper et al. (2014) criteria in **Table 7-6** for plankton mortality (207 dB re 1μPa PK @ 191 m) it is estimated[30] ~2.4% of the plankton present within Dorrigo MSS acquisition area (for entire 35 days) and 0.1% of plankton present in the Otway bioregion would be impacted per day which is less than identified daily natural mortality rates for fish eggs and larvae. Natural mortality rates of plankton can be very high, exceeding 50% per day in some species and commonly exceeding 10% per day. A review of mortality estimates for fish eggs/larvae identified a mean mortality rate of M=0.24 which equates to a mortality rate of 21.3% per day (Houde and Zastrow, 1993; cited in Fuiman & Werner, 2002). For marine species, only 180 individuals are expected to survive the larval stage (> 99.9% mortality) from an initial cohort of one million larvae under average mortality rates and larval stage duration (36 days). Causal factors leading to high levels of mortality include predation, inadequate food resources, physical exposure or poor water quality and diseases/parasites (Fuiman & Werner, 2002). Seismic impact compared with natural mortality is therefore not considered significant to plankton at, fish eggs or larvae at a population level.

As a sensitivity to this assessment, using the received level at which McCauley et al (2017) identified an impact to plankton, the 178 dB re 1μPa PK-PK isopleth is reached at a maximum distance of 9.56 km (Warner et al, 2018) from the operational array. Looking at the theoretical simulation performed by Richardson et al (2017) to understand possible "worst case" implications at a regional level, a comparison of conditions within the Dorrigo and NWS MSSs has been undertaken. For comparative purposes, the equivalent "*survey region*" based upon the Richardson et al (2017) study is the "*survey region with an impact buffer of 9.56 km*".

Though the Richardson et al (2017) study was based on a hypothetical 3D survey in the Northwest shelf IMCRA meso-scale bioregion, which covers tropical waters of the continental shelf and slope north-west Australia and has differing oceanic conditions to the temperate Dorrigo marine environment, the theoretical model has some applicability to the Dorrigo MSS area. Richardson et al (2017) identifies that '*the applicability of the study to specific regions should be done with some reservations, considering the local and regional oceanography. Further, zooplankton growth rates are slower in colder regions and so the recovery of zooplankton populations following exposure to seismic activity is likely to be slower'*. To enable a broad comparison between plankton impacts observed in the NWS study accommodating conditions in the Dorrigo MSS area, a comparison of the conditions within the Dorrigo MSS and NWS 3D MSS simulation are provided in **Table 7-7**.

Table 7-7: Comparison of NWS 3D MSS simulation conditions with Dorrigo MSS Conditions.

Parameter	NWS 3D MSS	Dorrigo MSS
Survey Acquisition Area (km^2)	2900	1580
Survey Sail Line Distance (km)	4831	4255 (includes 5km lead-in and 10km lead-out on all seismic lines)
Survey Line Length (km)	80	100 (longest)/31 (shortest)

area would see a complete changeout of affected water through the acquisition area every 6.6 days. Note that for the period September to October the net prevailing current is east. On an easterly current basis, complete change-out of affected water through the acquisition area (22 km max width) would occur in approximately 30hrs.

30 The basis of the calculation and area of mortality within a 191 m radius of all seismic lines based upon the length and spacing of line identified in Table 7.8 for a vessel travelling 4.5 nm per hour, 12 hrs to complete one seismic line (100 km) with 2 hours to lead in to next seismic line (i.e. 22 hr daily operation) (Area affected is 37.1 km^2). This assumes a uniform distribution of plankton.

Parameter	NWS 3D MSS	Dorrigo MSS
Number of Survey Lines	60	43 (33 long/10 short)
Range of Water Depth (m)	300-800	100-840
Survey Duration (Days)	35 days (continuous)	35 days (continuous)
Airgun Capacity (in^3)	3000-3200	3260
Operating Pressure (psi)	2000	2000
Planned Distance between seismic lines (m)	600	580
Planned Distance between consecutive lines	7000	10000
Shot-point interval	18.75 m	12.5 m
Proportion of bioregion affected	0.0188	0.042
Water Temperature	24-29ºC[31] (January)	13-14ºC
Current Speed/Direction	0.5 (max)[32] (southwest)	September[33]: 0.3m/s (av.) – 0.7m/s (max) (East) October: 0.2m/s (av.) – 0.7m/s (max) (East)
Survey Orientation	Parallel with current	Cross- current
Copepod Lifecycle (Generation rates)	13 days @ 25ºC (Recovery Rate of zooplankton population is 0.10 per day)	26 days @ 15.5º C [34] Recovery Rate of zooplankton population is 0.1 per day)

The two surveys have similar duration, acoustic source and line spacing intervals although the Dorrigo MSS is approximately half of the NWS acquisition area. Differences between locations include ocean mixing rates (currents) and water temperatures. An assessment of the differences on relative zooplankton biomass levels and recovery rates between locations follows:

- *Ocean mixing currents (i.e. total currents 0.5 m/s (NWS) and 0.7 m/s (Dorrigo)):* Increased ocean mixing in the Dorrigo MSS area will increase plankton transport away from the survey area minimising the potential for "multiple impacts" on individual plankton which directly affected the relative plankton biomass depletion in the theoretical depletion model in Richardson et al (2017). Not all plankton in an area where a source is active will be affected and once the source array has passed impacted plankton commence recovery. As identified by Richardson et al (2017), 1-2% of the total number of particles are impacted in any 12-hour period, the time to acquire one seismic line[35]. The model predicted the relative

[31] IMOS Sea Surface Temperature Maps (http://oceancurrent.imos.org.au/sst.php)

[32] IMOS Ocean Currents Moored Instrument Arrays 2018 (http://oceancurrent.imos.org.au/timeseries/ANMN_P23/mapst/01_Aust_vrms_1_2018.html). Mixing has been based upon peak rates as average current rates for the NWS in January are not available. Note the 2018 timeframe has been selected as 2003 data from the area is not publicly available. Richardson et al (2017) note that the current period selected for the simulation was a neutral ENSO period. Selection of maximum current speeds is considered conservation as it reduces the number of times a plankton "particle" might encounter seismic sound through the NWS simulation area (& hence total impact levels).

[33] Current data from Oil Spill Modelling Report (RPS, 2018).

[34] Recovery rate in 13-14ºC water temperatures is expected to take double the time as it does in 25ºC water. This is based upon the works of Huntley & Lopez (1992) who measured the production of marine copepods as a function of temperature. A common copepod (*A. tonsa*) was used to provide the comparison between these temperatures (i.e. generation time of 7 days at 25.5ºC and 14 days @ 15.5ºC).

[35] Note there is a period of approximately 2 hrs of no seismic after one line as the ship turns to start a new line.

zooplankton biomass in the *survey area* reduced to a minimum after 23 days of survey operations and then increased gradually until the end of the survey on Day 36. A continuous decline in relative population biomass to a minimum at Day 36 was not observed reflecting water movement through the survey area, the entry of new zooplankton into the area and recovery of zooplankton as they moved into non-impacted areas (Richardson et al, 2017).

Richardson et al (2017) identifies that at any time, most particles in the survey region are not impacted by seismic noise (i.e. relative biomass is close to 1). However, the frequency distribution of those impacted vs non-impact is skewed with a small number of plankton particle (<2%) down to a relative biomass of 0.4. Within the simulation this occurs if currents carry plankton populations into the future path of the survey and multiple exposures occur before the population has recovered. For the NWS study most of the plankton particles were not impacted and the maximum number of heavily impacted particles were from Days 20 to 40. For the Dorrigo MSS, based upon the McCauley et al (2017) 178 dB re 1µPa PK-PK isopleth, once the acoustic source is > 9.5 km from the operational array, the zooplankton population commences recovery. The Dorrigo survey will be undertaken using a racetrack methodology, allowing enough area for the seismic vessel with streamers to turn. Accordingly, the source gets further away from its original position with each sequential line (refer **Figure 7-6**).

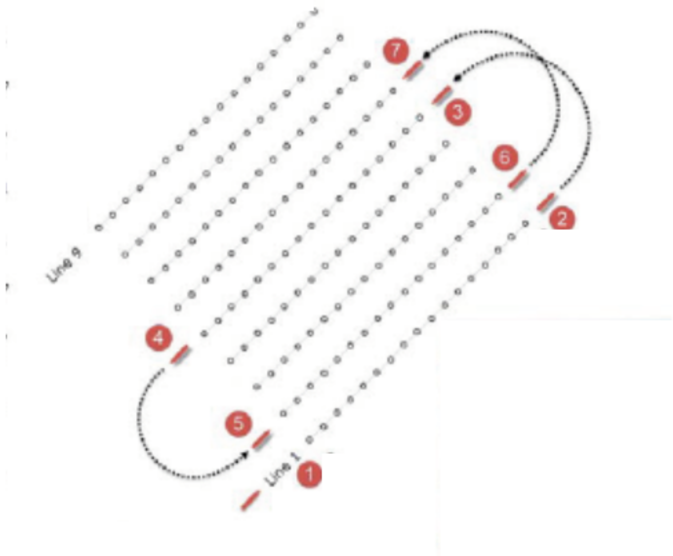
The NWS study was designed with acquisition lines parallel with current direction (~ 100 km long) and based upon *peak* current speeds outlined in **Table 7-7** has less mixing[36] than the ocean conditions in Bass Strait and therefore more opportunity for multiple exposures to individual plankton "particles" and decline in overall relative plankton population numbers. The Dorrigo MSS is designed with has a cross-current orientation and based upon *average* current speeds (0.2-0.3 m/s) will have a complete water volume changeout in the acquisition area each 20-30 hours[37], equivalent to the time for the survey vessel to acquire 1.5-2.1 lines. On this basis it is very unlikely individual plankton "particles" within the Dorrigo MSS area will be affected by the same number of sound exposures, a factor leading to the level of relative population depletion in the NWS simulation (i.e. a relative biomass decline of 22%).

- *Water temperatures (i.e. 24-29°C (NWS) versus 13-14°C (Dorrigo)):* Given the cooler water temperature within the Dorrigo MSS area, population recovery on a relative zooplankton biomass will be slower than the NWS. Review of generation rates for plankton in different marine temperatures (Huntley & Lopez, 1992) identified generation timeframes for plankton in 15°C water temperature was approximately double the time frame as that in 25°C water temperatures. The NWS study utilised a typical copepod lifecycle of 13 days at 25°C with a recovery rate of 10% per day (r=0.10) (Richardson et al, 2017) to calculate relative zooplankton biomass recovery.

Figure 7-6: Typical Seismic Line Sequence Methodology

36 Based upon maximum peak current rates (0.5 m/s) for NWS study complete water changeout across the survey area will occur in 2.3 days, the time to acquire approximately 4 seismic lines with the potential for multiple exposures to a single plankton population as the plankton is moving parallel with the survey line (i.e. potential for > 2 plankton impacts).

37 Note at peak currents of 0.7 m/s transit of a particle through the Dorrigo MSS area would take ~ 7 hrs.



While water temperatures in the Dorrigo MSS area are lower than those used in the NWS study, the study is considered applicable as it looked at a range of recovery rates (0.05, 0.1 and 0.15). Given the lower temperatures, biomass generation rates are expected to be approximately half of that utilised in the NWS simulation. The lower biomass recovery rate (r=0.05) has been used from the simulation to inform the expected relative biomass recovery times in the Dorrigo MSS area to 'normal' levels. From Richardson et al (2017) for a recovery rate of 5% per day (r=0.05), zooplankton biomass declined until survey Day 22 with relative biomass recovery (i.e. return to 95% relative zooplankton population) predicted in both the *survey area* and the *survey area +15km* at Day 42, six days after the completion of the survey.

Richardson et al (2017) explored a number of variables (oceanic movement and plankton population recovery rates) utilising conditions in the NWS to establish theoretically, the potential impact to relative zooplankton biomass utilising McCauley et al (2017) sound thresholds. Using this theoretical model for Dorrigo MSS conditions, the relative zooplankton biomass impact (i.e. 'hits') is expected to be less than the simulated NWS study due to the increased ocean mixing (i.e. < 22% biomass reduction). Using the lower plankton recovery rate from Richardson et al (2017) due to Dorrigo's colder waters and slower population recoveries, the relative plankton biomass would be expected to return to 95% population levels (r=0.05) within the *survey area* and *nearfield* within 6 days of survey completion. On this 'worst-case' sensitivity, this reduction in zooplankton biomass within the Dorrigo MSS area for the entire 35-day survey period, is less predicted to be less than the mean mortality for fish larvae of 21.3% *per day* (Houde and Zastrow, 1993; cited in Fuiman & Werner, 2002). On this basis, zooplankton impacts are not significant at a population level and localised on a bioregional basis.

The Dorrigo MSS area spatially overlaps the following key sensitive environments:

- *Zeehan CMP* which has major conservation values associated with blue and humpback migration (not plankton-related) and foraging area for a variety of seabirds (albatross and petrels). The Dorrigo MSS lies outside key upwelling timeframes and conservation values associated with upwelling-related albatross/petrel foraging are not compromised. Given the localised impacts to zooplankton (Popper et al, 2014) and rapid recovery of zooplankton (Richardson et al, 2017; Huntley & Lopez, 1992), indirect impacts on seabird prey

(cephalopods, fish and crustaceans) are expected to be incidental to their widespread foraging distribution.
- The *West Tasmanian Canyons KEF* (36.7 km^2 spatial overlap or 0.3% KEF area) which influences currents, create upwelling hotspots and has significant sponge diversity at the head of the canyons with associated fish abundance. As per Zeehan CMP, the temporal placement of the Dorrigo MSS is outside timeframes where upwelling conditions prevail. Any impact to zooplankton within this KEF is localised and rapidly recoverable with any zooplankton impact incidental to these canyon habitats.
- The *shelf rocky reefs and hard substrates KEF* (not spatially defined) provides attachment sites for macroalgae and sessile invertebrates enhancing productivity and biodiversity. The Dorrigo MSS area is estimated to have a 0.42% spatial overlap with the area which could contain this KEF[38]. Any impact to zooplankton within this KEF is localised and rapidly recoverable with impact incidental to these habitats.

The Dorrigo MSS area and timeframe avoids most fish/invertebrate spawning periods except for the following species (refer also to **Section 4.4.5.2**):
- *Ocean perch*: Species is commercially caught between Coffs Harbour and Eyre Peninsula, but is present in waters from Ballina (NSW to Shark Bay (WA) (FRDC, 2018). Spawning occurs from winter to early summer Species is not considered over-fished (FRDC, 2018). Spawning biomass is above the reference limit point (Patterson et al, 2018);
- *Pilchard/Sardine*: Species is distributed from Hervey Bay (Qld) to Shark Bay (WA) and spawns spring and summer (Kailola et al, 1993). Species spawning biomass is above the reference limit point (Patterson et al, 2018);
- *Southern rock lobster*: Species is distributed from Coffs Harbour (NSW) to Dongara (WA) with eggs hatching into larvae between September and November (Kailola et al, 1993). Impacts to SRL fecundity due to acoustic exposure is unlikely and increased mortality, delayed development or abnormal development to egg masses carried by berried females is not expected (Day et al, 2016); and
- *Giant crab*: Species is distributed from central NSW to south-west WA (Kailola et al, 1993). The Dorrigo MSS timeframe overlaps with berried female phase of the reproductive cycle (FRDC, 2017). No change to development rate in exposed fertilised crab eggs/embryos is expected compared with unexposed eggs/embryos (Payne et al, 2008; Christian et al, 2003; DFO, 2004; Pearson et al, 1994).

These species are widely distributed along the southern margins of Australia and eggs/larvae distributed across the region by current regimes. Given the small predicted impacts from the Dorrigo MSS compared with natural mortality rates (Houde & Zastrow, 1993; Saetre and Ona, 1996; Richardson et al, 2017) and the resilience of some species eggs/larvae to acoustic noise (southern rock lobster and giant crab), any impacts to eggs/larvae will be incidental to these species populations.

Impacts to zooplankton and the broader environment are expected to be localised, temporary and recoverable given the following:
- Zooplankton, including fish eggs and larvae, present in the water column are abundant in the environment, not spatially restricted and broadly (but not evenly) distributed in the

[38] KEF is estimated based upon the bioregion area of the continental shelf in the SE Marine Bioregion of 501,500 km^2, adopting 75% of this area based upon the continental shelf range (0-200m water depth (DoE, 2015).

environment. Zooplankton is likely to exhibit spatial patchiness with movement with currents (Richardson et al, 2017);

- Survey is temporally positioned during early spring corresponding to a period where there is lower absolute zooplankton loadings (i.e. not upwelling) (Kampf, 2015; Gill et al, 2011; Butler et al, 2002; DoEE, 2018; Hosack & Dambacher, 2012) (refer Section 5.4.2). Zooplankton loadings in the Dorrigo MSS area during that period are representative of the broader Otway bioregion during September/October;
- Predicted zooplankton impacts (~0.2% of plankton within Dorrigo MSS impacted per day) is inconsequential when compared mean natural mortality rates for fish (~21.3% population decline per day) (Houde & Zastrow, 1993; Saetre and Ona, 1996; Richardson et al, 2017);
- Zooplankton has rapid recovery rates (~days) (Huntley and Lopez, 1992; Richardson et al, 2017);
- From a bioregional perspective, the area where zooplankton is impacted (assessed on most conservative areal basis)[39] is localised within or close to the acquisition area and represents 10% of the Otway bioregion.

<u>Summary</u>:

Consequence Level (Plankton/eggs/larvae): Given normal patchy concentrations of plankton (including fish eggs and larvae), impacts are expected to be short-term, and localised predominantly within the Dorrigo MSS area. Recovery times in the timescale of days (negligible consequence).

Controls assessment to limit impacts to plankton abundance: The CSIRO study (Richardson et al, 2017) identifies survey design parameters which should be considered in limiting impacts to zooplankton. These are assessed in **Table 7-8**.

[39] Basis of calculation that total Dorrigo acquisition area + 10 km (based upon McCauley et al, 2017 178 dB re 1µPa (PK-PK) isopleth) which has a total area of 3840 km^2.

Table 7-8: Assessment of Potential Control Measures to reduce impacts to Zooplankton (Richardson et al, 2017).

Control Measure	Practicable	Will it be Implemented?	Justification
Temporal Buffer: The Dorrigo 3D MSS will be sequenced to avoid upwelling periods where high plankton levels may be present (November to April).	YES	YES	3D Oil has sequenced the Dorrigo MSS in a period where there is a low likelihood of wind and currents leading to upwelling conditions. Sea states across the period May to August are not conducive to seismic acquisition on a safety and acquisition basis (greater downtime increasing survey duration). **Control adopted.**
Seismic Line Directions: Reroute survey lines to run across or into prevailing currents to prevent multiple impacts to zooplankton.	YES	YES	The 3D polygon survey line alignment have been designed to maximise acquisition efficiency and reduce the time taken to acquire data. Alternate line alignment would lead to more infill lines and a greater survey duration. The 3D survey, during the September to November period is primarily aligned across the prevailing currents (i.e. prevailing current is to the east and survey direction is north-south). **Control adopted.**
Location of the Survey: Conduct survey in areas off the continental shelf only.	NO	NO	Survey area does not cover targets which lie on the continental slope or abyssal plain. Not relevant to this survey scope. **Not applicable to survey**
Hours of Operation: Conducting surveys during the day rather than night to minimise impacts on zooplankton (due to diurnal movement).	NO	NO	The seismic signal does not sufficiently attenuate in the vertical direction regardless of the day/night timeframe (design parameter not considered relevant to the Dorrigo survey). **Not applicable to survey**
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. **Control adopted.**
Reduce acoustic shots in the environment: Shut source down during line turns.	YES	YES	3D Oil has adopted this as good practice. **Control adopted.**

7.2.3.2 Marine Invertebrates

General:

Marine invertebrates lack a gas-filled bladder and are thus unable to detect the pressure changes associated with sound waves. All cephalopods as well as some bivalves, echinoderms and crustaceans have sac-like structures called statocysts which develop during the larval stage and may allow an organism to detect the particle motion associated with sound waves in water to orient it-self (Carroll et al. 2017). In addition to statocysts, cephalopods have epidermal hair cells which help them to detect particle motion in their immediate vicinity similar to the lateral line in fish (Kaifu et al., 2008). Decapods have sensory setae on their body (Popper et al., 2001) including antennae which may be used to detect low-frequency vibrations (Montgomery et al., 2006).

Some research postulates that shellfish, crustaceans and most other invertebrates only 'hear' seismic sounds at very close range of a sound source (i.e. "near-field") (McCauley, 1994; Parry & Gason, 2006; UNEP, 2012). Aquatic invertebrates with ciliated "hair" cells may be sensitive to water movements caused by currents or "particle motion" which occur close to the sound source. These hair cells may allow for the sensing of near-by prey or predators or help with local navigation.

Particle motion falls off rapidly with distance from an acoustic source (Tasker et al., 2010) so only aquatic invertebrates located close to sound sources may be affected or detect nearby sound.

For invertebrates, auditory invoked potentials have revealed responses in cephalopods at 400 Hz with sensitivity dropping below 10 Hz (Carroll et al., 2017). Similarly, behavioural studies on squid revealed an optimal hearing range of 200-400 Hz with capacity down to 80 Hz (Money et al., 2016: cited in Carroll et al., 2017). Prawns have shown a response at 500 Hz irrespective of body size, while lobsters have shown variation according to life stage with juvenile lobsters detecting sounds between 20-1000 Hz and adults showing acoustic sensitivity at two peaks 20-300 Hz and 1000-5000 Hz (Pye and Watson, 2004; cited in Carroll et al., 2017). No data is available on the frequency-specific hearing/particle motion detection capability of lobsters although some preliminary experiments have shown responses to water vibrations in the frequency range 20–180 Hz (Goodall et al., 1990). For hermit crabs, responses were detected at a frequency of 5 – 400 Hz and particle velocities of 0.03-0.44 ms^{-2}; and for *Panopeus* crabs between 90 and 200 Hz where vibrations of <0.01 ms^{-2} could be sensed (Edmonds et al. 2016).

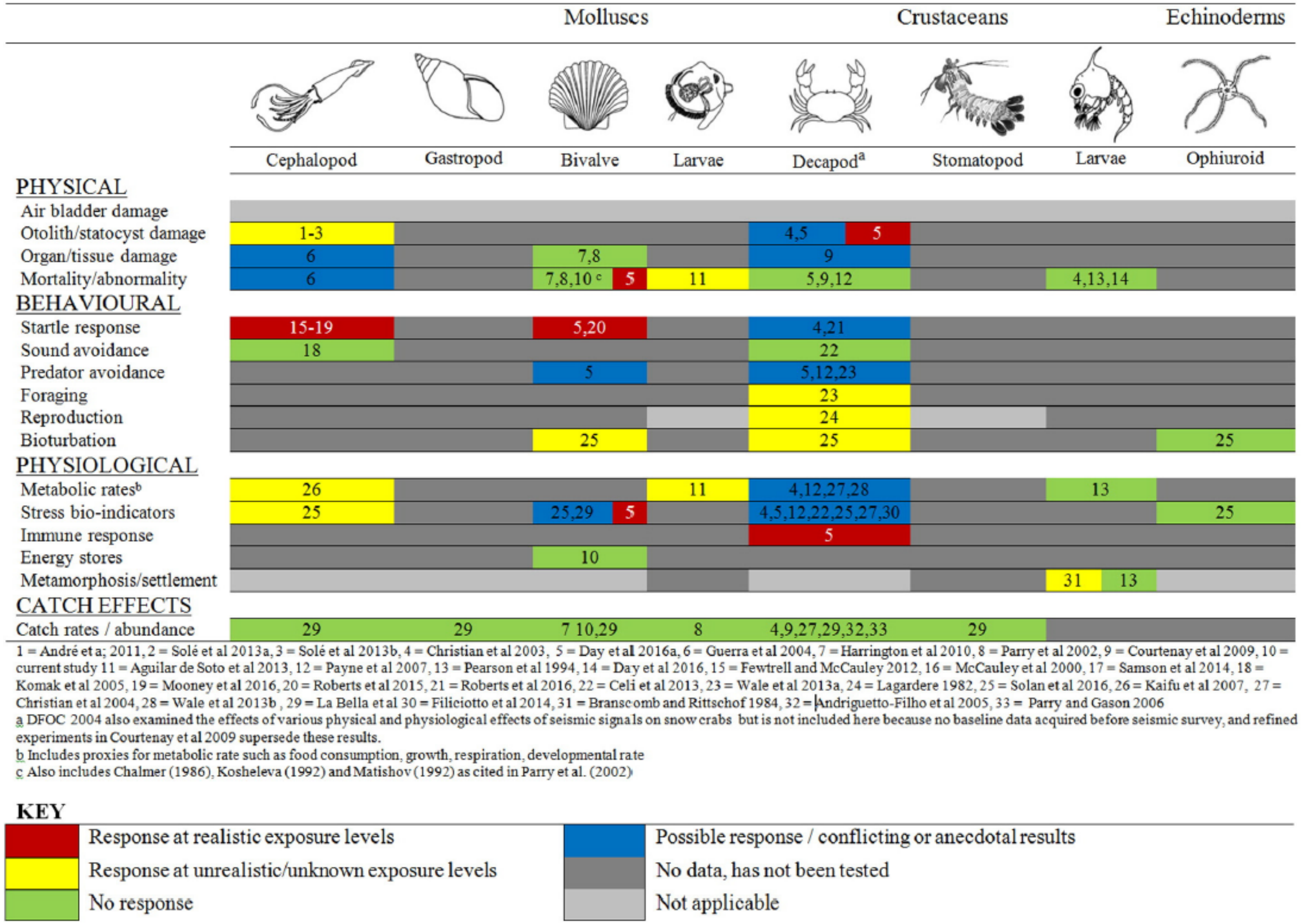
Edmonds et al. (2016) cites evidence that crustaceans have a noise resistant physiology as the snapping shrimp (family *Alpheidae*) may represent the greatest single contribution to biological sound in shallow temperate and tropical waters. Snapping shrimp produce clicks at source levels of ~ 175-220 dB re 1µPa (PK-PK) and span a broad frequency spectrum from 2 Hz to more than 200 kHz.

Many marine invertebrates have far lower mobility than pelagic species and are often localised to specific benthic microhabitats. As such, they have less ability to avoid seismic sound by moving away from an area. Some sound sensitive species, such as cephalopods, have greater mobility and have been shown to respond to sound.

Section 5.4.3 details invertebrate species expected within the Dorrigo MSS area from available literature.

Figure 7-7 provides a summary of potential impacts of low frequency sound on various responses of marine invertebrates (Carroll et al, 2017). **Table 7-10** provides a summary of relevant scientific literature for invertebrate species which may be present within and around the survey area – porifera, ascidians, bryozoans, hydrozoans, crustaceans (including giant crab and lobster); and molluscs (cephalopods, abalone).

Figure 7-7: A summary of potential impacts of low-frequency sound on various responses of marine invertebrates. Impacts are classified according to the sound exposure treatments as realistic for seismic surveys (i.e. few short bursts of low frequency sound at >1-2m) or unknowns/unrealistic (i.e. continuous sound exposure > 100 bursts of nearfield sound exposure in aquaria) (Carroll et al, 2017).



Benthic Filter-Feeding Communities

Receptor Sensitivity:
Filter feeding communities are generally associated with hard substrates and may include ascidians, porifera, hydrozoans and bryozoans. Porifera (sponges) provide habitat for a variety of animals, including shrimp, crabs, barnacles, worms, brittle stars, sea cucumbers, and other sponges (Turner, 2002).

Marine invertebrate species such as porifera, bryozoans and ascidians do not contain air cavities which might function like a fish swim bladder in responding to pressure (i.e. trauma due to rapid pressure changes) or statocysts present in some species (e.g. cephalopods) which assist in maintaining equilibrium and in some cases linear or angular acceleration (Normandeau Associates, Inc. 2012). On this basis, impacts to benthic filter-feeding communities in the survey area are not expected to be significantly impacted from the sound "pressure" (far-field) component of the sound wave, and given the water depth of the survey area, near-field "particle motion" impacts are also expected to be limited.

Little research has been undertaken on sound impacts on ascidians, bryozoans or porifera. One study, assessing seismic sound impacts to (glass) sponge feeding characteristics, observed no increased feeding rates when exposed to a received SEL of 151 dB re 1µPa^2.s at water depths of 160 m (Tunnicliffe et al. 2008). Within the study it was noted that the sponge has a narrow range of behavioural responses – they cannot swim away, change shape, move appendages or alter blood flow however response effects can be measured by water flow through the animal. This water flow through the walls and out a central "mouth" is necessary for respiration and feeding with cessation for sustained periods likely to affect the animal's health. Tunnicliffe et al (2008) concluded that there was little or no evidence that acoustic pressure from the airgun influenced the physiological functions of the sponge.

Soft coral, another sessile filter feeder, was studied during the Maxima 3D survey at Scott Reef. Because of soft coral's flexibility, allowing the animal to minimise stress by reconfiguring in response to fluid forces, soft corals were not expected to be damaged by sound pulses produced by airguns as close as 1 m away (Woodside, 2012). Corals in and around the lagoon were exposed to seismic sound (both experimental seismic lines and during the full seismic survey) using a 2055 in^3 source over a 59-day period. The experimental lines passed directly over the coral communities (source @ 7m water depth, corals at ~ 60 m water depth) and the full seismic survey passed within tens to hundreds of metres (horizontal offset) of the corals. The maximum estimated received sound level at the coral impact sites were 226-232 dB re 1µPa (PK-PK); 214 -220 dB re 1µPa (SPL) and a maximum cumulative SEL of 197-203 dB re 1µPa^2.s (Salgado-Kent et al, 2016; cited in Santos 2018). The corals were monitored for dead or bare coral cover and % red algae. No detectable effects were found from one or multiple passes of the seismic airgun array. Further there was no evidence of coral breakage, no signs of physiological impairment of the corals and no long-term change in coral community structure related to the experimental or full seismic survey activities (Woodside, 2012). Surveys of coral reef areas in offshore Brunei after seismic acquisition did not detect any impact on hard corals, soft corals, sponges or other sessile benthic organisms resulting from pressure pulses from airgun emissions (IEC, 2003: in Woodside 2012).

Extent/duration of exposure and identified potential impacts:

Habitats Present:
There are no BIAs or critical habitats present in the Dorrigo MSS area for filter feeders, however the shelf rocky reef and hard substrate KEF is present within the Dorrigo MSS area and the survey area spatially overlaps a portion of the West Tasmanian Canyon KEF (0.3% of the KEF) where sponges are located at the head of canyons. The shelf rocky reef and hard substrate KEF is non-spatially defined but present in water depths between 50-220 m (refer **Section 5.5.8**) and sessile invertebrates such as porifera, bryozoans and ascidians, support this KEF's functioning. Sessile species are particularly sensitive to activities which physically impact the seabed and create sedimentation (Boertmann and Mosbech, 2011).

Potential Impacts:
Based on the research to date and soft coral studies undertaken at Scott Reef, it is unlikely, based upon the airgun array selected for the Dorrigo MSS, that the sessile invertebrates present in the MSS area will be exposed to sound levels high enough to cause physical or physiological impacts. The maximum estimated received sound level at the coral impact sites in that study was 214-220 dB re 1µPa (SPL) (Salgado-Kent et al, 2016; cited in Santos 2018). Dorrigo MSS modelling predicts a per-pulse SPL of 200 dB re 1µPa^2.s at 40 m from the operational array (no higher SPLs calculated) (Warner et al, 2018). On this basis, no damage to filter feeders are expected based upon a 214-220 dB re 1µPa (SPL) no-damage threshold.

Impacts to filter feeders and the broader environment are not expected to be significant given the following:

- Studies have not identified any impacts to sessile filter feeders below 214-220 dB re 1µPa (SPL) (Salgado-Kent et al, 2016; cited in Santos 2018). Dorrigo MSS modelling does not predict sound levels above 200 dB re 1µPa (SPL) (Warner et al, 2018);
- The Dorrigo MSS area spatially overlaps 0.3% of the West Tasmanian Canyon KEF;
- The Dorrigo MSS area spatially overlaps 0.42% of the SE marine region and 4.2% of the Otway bioregion where the non-spatially defined shelf rocky reef and hard substrate KEF is present; and
- The Dorrigo MSS does not involve physical contact with the seabed which could physically damage sponge communities.

Summary:

Consequence: As predicted noise levels from the Dorrigo MSS acoustic array are below the 'no-damage' per-pulse thresholds for filter-feeding communities, and impacts are expected to be incidental, localised and recoverable (negligible consequence).

Controls assessment to limit impacts to filter-feeding communities: An assessment of controls to limit impacts to filter feeding communities from seismic activities is provided in **Table 7-9**.

Table 7-9: Assessment of Potential Control Measures to limit impacts to filter-feeding communities

Control Measure	Practicable	Will it be Implemented?	Justification
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. **Control adopted.**

Crustaceans (Lobster, Crab)

Receptor Sensitivity:

Physiological Sensitivity (including mortality): Recent critical reviews into the effects of invertebrate sensitivity into loud impulsive, low frequency sound, typical of seismic surveys, has been undertaken (Carroll et al., 2017; Edmonds et al., 2016). No lethal effects from seismic noise have been observed for crab (*C. pagurus*) or lobster species (*H. gammarus, N. norvegius*) (Edmonds et al., 2016; Carroll et al, 2017).

Edmonds et al., (2016), in a critical evaluation of crustacean sensitivity to impulsive, low frequency underwater noise identified physiological sensitivity in the Norwegian lobster (*N. norvegicus*) and closely related crustacean species including juvenile stages. Edmonds et al., (2016) identified that the current evidence for physiological sensitivity relates to the "local, particle motion effects of sound in particular". The review by Salgado-Kent et al (2016) also supported the finding of no evidence of direct mortality crustaceans from seismic exposure.

Physiological impacts have been identified in the following studies:

- *Statocyst Damage:* Day et al. (2016) found that airgun exposure in rock lobsters (*Janus edwardsii*) damaged statocysts up to a year later. These effects were not observed in snow crabs (*C. opilio*) after exposure to 200 shots at 10 second intervals and 17-31 Hz (Christian et al, 2003; Carroll et al, 2017). A theoretical study similarly found that particle displacement produced in crabs from seismic sound would be too small to damage tissue (Lee-Dadswell, 2009: cited in Carroll et al, 2017). The measured received sound levels of test specimens within these studies were 209-212 dB re 1µPa (PK-PK) (Day et al., 2016) and 197-220 dB re 1µPa (PK-PK) (Christian et al., 2003).

  Payne et al. (2007), in a preliminary study into the impacts of seismic to the American lobster (*H. Americanus*), exposed animals to received sound levels of 202 dB re 1µPa (PK-PK) and 227 dB re 1µPa (PK-PK) utilising 'turnover rates' to establish whether there was damage to statocyst organs. The study reported no difference in turnover rates between control and exposed animals 9, 65 and 142 days after airgun exposure. In contrast, Day et al., (2016) found rock lobsters showed delayed time to right themselves after exposure to airguns in three of the four study events undertaken (reflecting statocyst damage). For the study event that did not observe a difference in righting times, lobsters were sourced from an area of high anthropogenic (shipping) noise[40], where the population continues to thrive, making the ecological implications of statocyst damage unclear. Day et al. (2016) also observed the potential for neural impairment (measured as tail extension reflexes) for studies undertaken in summer. In summer studies, exposed lobsters had a reduced ability to maintain tail extension (23% after 14 days). There was no significant difference for tail extension reflexes for study events undertaken during winter.

- *Haemolymph Biochemistry*: Day et al. (2016) established for a period of up to 120 days post exposure, haemolymph biochemistry (pH, electrolytes, mineral ions, organic molecules and enzymes) did not show a response, potentially indicating that lobsters are physiologically resilient to air gun signal exposure. The haemolymph refractive index, a measure of nutritional condition, did show a response in one study event (of four). In this study, at 120- and 365-days post exposure, lobsters had a significant reduction in refractive index. Additionally, the number of circulating haemocytes, an indicator of immune response and health, was significantly reduced in all four study events (23% to 60% across the study events). This reduction, identified up to 120 days post exposure, may indicate possible stress and the potential for negative impacts to nutritional capacity or chronic immunological impairment. Payne et al. (2007) found no effects on the American lobster haemolymph biochemistry, but in some trials found a reduction in calcium which may indicate a potential for disturbance to osmoregulation. Christian et al. (2003) found no chronic or long-term effects on stress bio-indicators in haemolymph in snow crabs.

Behavioural Sensitivities: Behavioural changes have been observed in decapods (i.e. alarm response) when located < 10 cm from the sound source (Goodall et al., 1990), however showed no response to seismic sound at distances ≥1 m (Goodall et al., 1990; Christian et al., 2003). Sound avoidance behaviours have a more lasting impact on populations than startle responses particularly if animals migrate out of an area where a seismic survey is conducted (Carroll et al, 2017). Christian *et al.* (2003) investigated the behavioural effects of sound exposure to eight tagged snow crabs. No tagged animals left the area after exposure, with five captured in the fishery the following year and the remainder captured within 35 km of the release location. A subsequent study on caged snow crabs exposed to airgun sound (~202dB dB re 1µPa (PK)) at a depth of 50 m identified that the species did not exhibit any overt startled response.

Commercial catch/abundance rates: Potential effects of seismic sound on catch rates and abundance have been tested on decapods with no significant differences detected in studies between sites exposed to seismic operations and those not exposed (Carroll et al, 2017). Parry and Gason (2006) detected no change in the Victorian SRL fishery (*J. edwarsii*) before, during and after intensive seismic exploration activities between 1978 and 2004. Study conclusions determined there was no evidence leading to a decline in rock lobster catch rates on either a long-term and short-term basis from seismic operations. However, in the absence of specific sound pressure levels received by crustacean stocks, no reliable conclusions can be drawn. La Bella et al. (1996) also observed no effect on the short-term catch rates of the Norway lobster (*N. norvegicus*) from localised seismic survey operations (received sound level estimated at ≤ 147 dB re 1µPa SPL).
Christian et al (2003) identified that post-seismic snow crab catch was higher than pre-seismic catch, but this was likely due to physical, biological or behavioural factors unrelated to the acoustic source. The authors concluded that there was no significant relationship between catch and distance from

[40] Lobsters were collected from Crayfish Point Reserve in the Derwent Estuary. This population is thought to be at carrying capacity (Kordjazi et al, 2015) and survival rates estimated through capture and release studies is around 95% (Gardner and Green, 2009).

the seismic source (received levels 197-237 dB re 1µPa (PK-PK)). It was noted that researchers commented on limitations with the current stock assessment methodologies as they do not have sufficient resolution to show statistically significant changes in distribution or abundance from seismic survey operations above that of their natural variation (Edmonds et al, 2016; Christian et al, 2003).

Morris et al, (2017), in a more recent study, found MSS activity did not negatively affect snow crab catch rates in the short term (within days) or over longer timeframes (weeks). Significant differences were found in catch across study areas and study years, however these results suggest that if seismic effects on snow crab harvests do exist, their magnitude is smaller than changes related to natural spatial and temporal variation.

It is noted that in relation to catchability, the primary physiological response detected by Day et al (2016) which may translate into reduced mobility or sensory ability (and hence catchability) in the SRL is damage to the statocyst. Impairment to spatial orientation from this damage may affect the lobster's ability to enter baited traps and to locate food. However, Kordjazi et al (2015) observed in lobster populations where statocyst damage is known to exist in nature, very high survival rates have been measured indicating that a lobster's ability to locate food is not impaired.

Adopted Sound Impact Criteria:

It is likely that the mechanism of impact to invertebrates is not from sound pressure, but rather from particle motion. It is unknown what level of particle motion might lead to a behavioural response as described by Day et al (2016). Key factors influencing sound exposure to crustacean species is therefore water depth and size of the operating airgun array. Carroll et al. (2017) concludes that "*particle motion should be considered in noise impact studies on fish and invertebrates, particularly those species lacking a gas-filled bladder (all elasmobranchs and marine invertebrates). Thresholds studies reporting only sound pressure may be of limited use for these species as they do not detect the pressure component of sound*".

In the absence of a suitable particle motion metric to establish impacts, the use of the pressure-related metric gives some measure for the understanding of potential impacts to crustaceans in the Dorrigo MSS area. As Payne et al. (2007) identified no effects on righting time in the lobster at 202 dB re 1µPa PK-PK and Day et al., (2016) found effects at 209 dB re 1µPa PK-PK, the threshold of 202 dB re 1µPa PK-PK (lower threshold) has been adopted as a precautionary threshold to assess possible impacts.

Table 7-10: Observed sound effects on invertebrates present within the Dorrigo MSS area (scientific studies)

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
SPONGES (*Aphrocallistes vastus*)	Sponge Pumping Rates	Bolt Airgun ($164\ cm^3$)	226 PK-PK (Calc)	~160 m	151 SEL 182 PK-PK 177 PK	One study, looking at possible acoustic impacts from seismic sources to (glass) sponge (i.e. porifera) feeding characteristics, identified no increased feeding rates within the species when exposed to an air-gun.	Wilmut et al., 2007
LOBSTER (*H. americanus)*	Mortality Physical trauma Stress bio-indicators Foraging/anti-predator characteristics Behavioural impacts	Airgun (18-31 Hz Peak) $10\ in^3$ (Lab) $40\ in^3$ (Field)	230 PK-PK	~2	Field: 227 PK-PK (E) Lab: 202 PK-PK (M)	A number of endpoints were assessed in animals exposed to a "low level" exposure of ~202 dB re 1 µPa (PK-PK) and a "high level" exposure of ~227 dB re 1 µPa (PK-PK). The endpoints included assessment of (a) lobster survival, (b) food consumption, (c) turnover rate, (d) serum protein, (e) serum enzymes, and (f) serum calcium. A small histopathological study was also carried out on lobsters from 1 of the 5 trials. Observations were often made over a period of a few days to several months. This study had the following results: • No effects on mortality several months after exposure (to 9 months); • No effect of major external deformities such as a loss of leg or other appendages; • No significant effect on food consumption from seismic survey although food consumption was observed to increase in exposed animals (not major); • No effect on haemolymph biochemistry but possible reduction in calcium in some trials which may indicate a potential for disturbance to osmoregulation (uptake of excess water); • No structural differences denoting cell or tissue rupture, necrosis or inflammation, as assessed by light microscopy, were noted in hepatopancreatic tissues of control and exposed animals. • No effects on turnover rate 9, 65 or 142 days after exposure to air gun sound. The author warns of over-interpretation of these results as they are preliminary. Further study is warranted.	Payne et al., 2007 Field/Laboratory Study

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Lobster (*Janus edwardsii*)	Mortality Physical trauma Stress bio-indicators Foraging/anti-predator characteristics Behavioural impacts	Airgun (45 in^3 @ 2000 psi)	223-227 PK-PK 200-205 SEL	5.2 (Water depth 10-12 m)	209-212 PK-PK	The study observed the following results: • No lobster mortality was observed during the study up to a year after the exposure even close to the airgun, however sub-lethal effects were observed; • Tail extension reflexes (potential neural impairment) showed no significant difference between control and exposed lobsters for winter surveys. For summer survey the ability of exposed lobsters to maintain tail extension was significantly reduced (32% immediately, persisting to 14 days after exposure where a decrease of 23% was observed). Stress in lobsters is known to be exacerbated in summer conditions. This disruption suggests that complex reflexes and behaviours such as escaping from a predator may be impacted although the ecological implications were not investigated in this study. • Righting response times significantly longer in three of the four study events. Times increased by 80-157% between exposed and control groups over 120 days in study events. Further investigation established statocyst damage to hair cells, which correlated with impaired righting times. For one experiment, the damage persisted for 365 days post-exposure and after lobsters had moulted indicating damage may be permanent. For the one study event which did not observe a difference in righting, lobsters were sourced from an area which was subject to higher levels of anthropogenic noise (e.g. sound from large cargo ships) and control animals had similar levels of damage. Lobsters in this area are monitored and are thriving, making the ecological implications of statocyst damage unclear. It also raises the possibility that lobsters can adapt to statocyst damage as the (fourth study) lobsters did not display impaired righting reflexes. • Haemolymph (invertebrate blood) assays for pH, electrolyte and mineral irons, organic molecules and enzymes showed no significant difference between the two groups indicating lobsters are physiologically resilient to air gun signal exposure. However, in one survey event, the haemolymph refractive index (measure of nutritional condition) showed a response. At 120- and 365-days post exposure exposed lobsters had a significantly reduced refractive index indicating a reduced nutritional status. This was not found in any of the other three survey events and no other condition indicators indicated the lobsters were negatively affected. • Haemocyte counts (immune response) showed a significant response to exposure in all four experiments had a sustained modification of total haemocyte count resulting in a reduction in cell numbers, suggesting a response to trauma or stress and leaving the lobster vulnerable to infection. In one experiment this reduction was progressive over time reaching a low at 120 days post exposure. In same experiment exposed lobsters maintained until 365 days post exposure had 100% increase in cells potentially indicating an immune response to pathogens. This result raises concerns that exposure may affect the immune system over a chronic (months post exposure) time period leaving then vulnerable to pathogens. Further study is required to evaluate if immune function is altered and if there is an impact to animals in the wild. Hatched larvae from berried female lobsters maintained until eggs hatched were found to be unaffected in terms of egg development, the number of hatch larvae, larval dry mass and energy content and larval competency. These results suggest that exposure during the embryonic stage did not impair the development and hatching of lobster larvae.	Day et al., 2016 Field Study

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Lobster (*Janus edwardsii*) Con't	Southern Rock Lobster (egg, larvae)	Single airgun (45in^3)	223-227 PK-PK 200-205 SEL	5.2	209-212 PK-PK 186-190 SEL	Study observed acoustic impacts on the larval stages of lobster development where egg-bearing female spiny lobsters (*Jasus edwardsii*) were exposed to a 45in^3 airgun operating at 2,000 psi (SEL ~200 dB re 1µPa^2.s). The study concluded the following: • There was no difference in fecundity between control and exposed lobsters; • A small but significant difference in the length of the larvae was observed in the exposed lobsters. No difference was found in width or dry mass of the larvae and no hatches were found to suffer from high mortality rates or deformities; • No energy difference was identified between larvae from control and exposed lobsters; and • Larval activity/survival between control and exposed lobster groups was not significant. Overall there were no differences in the quantity or quality of hatched larvae, indicating that the condition and development of spiny lobster embryos were not adversely affected by air gun exposure. **No impact of airgun on quality or quantity of hatched larvae at any distance.**	Day et al., 2016 Field Study
Spiny lobster (*Palinurus elephas*)	Other behavioural effects	Recorded shipping noise	Various (peak ~105 SPL)	<2	Various	Study observed the following: • Lobsters exposed to boat movements showed significantly higher mobility (higher velocity, distance moved, mobility in comparison with controls.) • After acoustic stimulus there was an observed slight increased hyalinocytes and a (not significant) slight decrease of granulocytes and semigranulocytes; • The haemolymph glucose level increased significantly, four times, in single and grouped specimens exposed to acoustic stimulus; • The total serum protein concentration significantly increased ~1.7% after exposure to acoustic stimulus in both single and grouped lobsters. Not focussed on seismic surveys.	Filiciotto et al., 2014
Lobster (*Janus edwardsii*)	Change in Catch Effort	Airguns	Various Arrays	0-150	NS	Assessment of the effects of thirty-three (33) MSS on catch rates of adult rock lobsters in western Victoria (1978-2004) identified no evidence of a decline in rock lobster catch rates for the period both on a long-term and short-term basis. The study found that most rock lobster fishing occurred in water less than 50–70 m deep, while most seismic surveys occurred in water deeper than 50 m. The spatial separation of seismic surveys and areas with high rock lobster fishing effort limited the statistical power of analyses of short-term effects of seismic surveys in shallow water.	Parry & Gason, 2006
Lobster (*Neprops norvegicus*)	Change in Catch effort	Airguns	210 SPL	1150	≤ 149 SPL	Study was in 70-75 m water depths. No effect on short-term catch success in areas localised to the seismic operations was observed on the trawl catch success of cephalopods or Norway lobster (*Nephrops norvegicus*), or the gill netting success of mantis shrimp (*Squilla mantis*).	La Bella et al. 1996

Species/ Organism	Effect	Source Type	Source Levels (dB re 1μPa)	Distance from Source (m)	Received Sound Levels (dB re 1μPa)	Observed Effect	References/Study Type
CRAB Snow crab (*Chionoecetes opilio)*	Mortality Physical Trauma Stress bio-indicators Startle/escape response Change in catch effort Effects on eggs and larvae	40 in^3 airgun 200in^3 airguns	NS	2, 10 and 15 4, 50, 85 & 170	197-237 PK-PK 216 PK (eggs & larvae) 202 PK (caged crabs – startle test)	Field study to establish the acute effects of seismic airgun exposure upon adult snow crabs *Chionoecetes opilio* (haemolymph, hepatopancreas, heart, and statocysts) when compared with control crabs and behavioural impacts. Results include: • No immediate or delayed crab mortality during study; • No evidence of statocyst damage; • No significant difference in in refractive index, enzyme activity, haemolymph (stress indicators), organ or tissue pathology (heart and hepato-pancreatic); • Catch per Unit Effort (CPUE) greater post survey compared with pre-survey; • Field animals did not leave the vicinity after exposure to seismic energy. Caged animals did not exhibit any startled response at the onset of seismic shooting. • Eggs exposed to seismic showed an increase in egg mortality and delayed development to the big-eye stage. Tests conducted at distances 2 m from the source. Authors note in normal situations eggs would never be this close to array.	Christian et al., 2003 Field/Lab Study
Snow crab (*Chionoecetes opilio)*	Reproductive effects of seismic	1310 in^3 airgun array	NS	NS	NS	DFO (2004) looked at the impacts of seismic energy on the reproductive biology of female snow crabs expanding on the work of Christian et al. (2003). Results identified the following: • Survey did not cause any acute or mid-term mortality to crab nor evidence of changes in feeding; • Survival of the embryos carried by female crabs and locomotion of the larvae after they hatch were unaffected by the survey (findings differed from Christian et al. 2003 study); • In the short-term antennae, gills and statocysts were soiled in the test group but they were found to be completely clean when sampled 5 months later; • Metabolic indices and levels of enzymes in the blood were comparable between groups. Several significant differences were observed between the test and control group however it was uncertain whether it was due to environmental differences between the test and control sites (environmental conditions significantly different). This included: • The hepatopancreas and ovaries were found to be bruised in the test site (later found to have a high correlation with length of time in cage for both control and exposed group); • One test group, embryo hatch was delayed by 5 days on average and larvae were slightly smaller than control. Oceanic and habitat condition differences were confirmed in subsequent studies undertaken in New Foundland (Payne et al, 2008).	DFO, 2004 Field Study (Caged experiment)

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
Snow crab (*Chionoecetes opilio)*	Catch Rate	4880 in^3	229 dB re $1\mu Pa^2.s$	Various	Various	A Before-After-Control-Impact study was undertaken over two years to assess the effects of industry scale seismic exposure on catch rates of snow crab along the continental slope of the Grand Banks of Newfoundland. Results did not support the contention that seismic activity negatively affects catch rates in shorter term (i.e. within days) or longer time frames (weeks). However, significant differences in catches were observed across study areas and years. While the inherent variability of the CPUE data limited the statistical power of the study, the results suggest that if seismic effects on snow crab harvests do exist, they are smaller than changes related to natural spatial and temporal variation.	Morris et al. (2017) Field Study
Shore crab (*Carcinus maenas*)	Foraging	Recorded Ship noise	N/A	0.1	148-155	Study showed the metabolic rate of shore crabs (*Carcinus maenas*) were affected by exposure to ship playback noise with subjects consuming 67% more oxygen in comparison with playback harbour noise [108–111 SPL]. The study also found that while ship noise did not impair the ability of *C. maenas* to find food, those undertaking feeding were more likely to suspend feeding activity following exposure to ship noise in comparison with ambient noise. Also, while there was no difference in recorded reaction to predator stimulus, crabs exposed to ship noise took longer time to return to shelter than those experiencing ambient noise. Not focussed on seismic surveys.	Wale et al., 2013
SHRIMP	Metabolic Rate (includes food consumption, respiration)	Ambient	Unspecified	<1	Unspecified	Higher levels of ambient noise have been found to be associated with increased levels of respiration among brown shrimp (*Crangon crangon*). Subjects were found to consume 15% more oxygen when exposed to elevated levels of ambient noise (versus silent controls) in laboratory trials (Regnault and Lagardère, 1983; cited in Edmonds et al. 2016).	Regnault and Lagardère, 1983
	Change in catch or effort	Airgun	196	2-5	Unspecified	Andrigetto-Filho et al. (2005) studied the yields of a non-selective commercial shrimp fishery before and after (12-36 hrs post survey) the use of a four air-gun array with a peak pressure of 196 dB re 1µPa (@ 1m) (PK) in north-eastern Brazil. The study found there was no statistically significant deleterious effect on shrimp fishing yields. The study suggests that the shrimp stocks are resilient to the disturbance by air-guns under the conditions of the survey. In companion experiments designed to assess acute effects of exposure to air-guns on shrimp, southern white shrimp (*Litopenaeus schmitti)*, southern brown shrimp (*Farfantepenaeus subtilis)*, and the Atlantic seabob (*Xyphopenaeus kroyeri)* were placed in cages at varying distances from the transect of the air-guns. No mortality was observed even when air-guns were operating at very close distances from the caged shrimp. A detailed study of their gonads, branchiae and hepatopancreas showed negligible histopathological damage attributable to exposure to the pressure wave from air-guns.	Andrigetto-Filho et al. (2005)
CEPHALOPODS	Mortality	NS	NS	NS	246-260 PK	Preliminary observations indicate short-term tolerance to high rise time shocks of up to 260 dB for the small *Alloteuthis subulata* while the larger *Loligo vulgaris* were fatally injured by peak pressures of 246-252 dB and died within 3-11 minutes.	Norris & Mohl, 1983

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
CEPHALOPODS	Physical Trauma Behavioural	NS	NS	~2	157 SPL 175 PK 50-400Hz	Controlled experiments exposing animals to 50-400 Hz sinusoidal wave sweeps with 100% duty cycle and a 1 second sweep period over 2 hours, revealed lesions in statocysts of four cephalopod species consistent with trauma. This also included damage to cilia on hair cells and neuron swelling. Species showed immediately after the start of sound exposure, a light startle response (firing ink sacs on some occasions) before remaining motionless at the bottom of the tank for the remainder of the experiment. Immediately after exposure, all remained motionless, breathing regularly in the middle of the water column or close to the surface showing no activity (no eating, mating or laying eggs). Lesions on statocysts became more pronounced with increased exposure (12 to 96hrs). The author identified that there were limitations with this study with respect to seismic activity in that the animals were caged in a small tank and unable to move away; and the nature of the sound exposure was different to seismic impulses.	Andre et al., 2011 Sole et al., 2012 Tank Study
	Behavioural	0.33 Bolt PAR 600B @ 1500psi	192 SEL	5-800	120-184 SEL	Squid exhibited alarm responses, changes to swimming patterns and vertical position as a result of exposure. Squid responses occurred at lower SELs throughout the study indicating the animals became accustomed to noise at low levels (i.e. habituating). From the results it would appear that noise levels greater than 147 SEL are required to induce avoidance behaviour in this species. The results also suggest that a ramped (i.e. gradual increase in signal intensity) air gun signal and prior exposure to air gun noise decreases the severity of the alarm responses in this species. If damage to the statocysts was present in this study, it appears that any alteration in hearing ability resulting from the noise exposure was not permanent, as the same squid were used in later trials with a similar number of alarm responses observed in both trials.	Fewtrell and McCauley, 2012 Field (Cage) Study
	Behavioural	Underwater Speaker 80-1000Hz	110-165 SPL	~1	85-187 SPL	Squid responded to sounds from 80-1000 Hz with response rates diminishing at the higher and lower ends of the frequency range. Generally, animals were responsive to low frequencies below 1000 Hz, and were most sensitive to sounds below 300 Hz. Inking was confined to the lower frequencies/highest sound levels and jetting was more wide-spread across a range of frequencies and levels although responses were still concentrated at lower frequencies and higher sound levels. Lowest sound levels which induced inking occurred at 150 Hz. Startle responses were not observed very often and were concentrated at the lower frequencies. All responses (inking, jetting, pattern change) are clustered around similar sound levels. At higher frequencies, responses are more divergent and occur at relatively low sound levels, suggesting sound has a different function at these frequencies, perhaps orientation, soundscape assessment or other auditory scene analyses. Squid exhibited relatively few startle responses and were observed to habituate.	Mooney et al., 2016 Tank Study
	Catch data (Gould's Squid)	Airgun	215 SEL	36-61	146 (M) 170 (E)	Study looking into the effects of seismic on catch rates of commercial species in the Gippsland Basin. No change in catch rate for the squid was observed before and after a seismic survey.	Prezeslawski et al. 2016

Species/ Organism	Effect	Source Type	Source Levels (dB re 1µPa)	Distance from Source (m)	Received Sound Levels (dB re 1µPa)	Observed Effect	References/Study Type
CEPHALOPODS (Con't)	Startle/Escape Behavioural	Bolt 600B Air-gun		0.9-1.5 2.1-5	174 SPL 156-161 SPL	Study assessed the effects of air gun noise on caged squid (*Sepioteuthis australis*). No sub-lethal injury or mortality as a result of exposures in this study was observed. In the first trial, several squid showed alarm responses to the start-up of an air-gun by firing their ink sacs and/or jetting away from the source (at received level 174 SPL or 163 SEL) but this was not observed for similar or greater levels if the signal was ramped up. It is noted that general habituation was observed with a decrease in alarm responses with subsequent exposures. During this trial the squid showed avoidance to the air-gun by keeping close to the water surface at the end of the cage furthest from the airgun (within the sound shadow). During trials there was a noticeable increase in alarm responses once the gun level exceeded 156-161 dB re 1µPa (SPL) (or 145 – 150 dB re 1µPa^2.s (SEL)). There was no consistent avoidance behaviour observed but there was a trend for the squid to increase their swimming speed on air-gun approach and then to slow at the closest approach at air gun signals and remain close to the water surface during the operation. McCauley suggests a threshold of 166 SPL would give an indication of the extent of disruption of a survey by significant alteration in swimming patterns.	McCauley et al, 2000 Field (cage) Study
	Change in Catch effort	Airgun array (total volume 2500in3)	210 SPL	1150	≤ 149 SPL	La Bella et al. (1996) identified there was no change in the short-finned squid catch (*Illex coindetti*) in an area exposed to received SPLs greater than 149dB re 1µPa. Airgun operated for 10-12 hours at 25 s intervals in 70-75m of water.	La Bella et al. 1996

<u>*Extent/duration of exposure and identified potential impacts*</u>:

Habitats: There are no BIAs or critical habitats present in the Dorrigo MSS area for crustaceans. The Dorrigo MSS area spatially overlaps State fishing areas where there is active fishing for giant crab and SRL. Acoustic modelling predicts, based upon the conservative threshold of 202 dB re 1µPa (PK-PK), the area where physiological impacts to crustaceans may occur, is within a horizontal distance of 505 m[41] at Site 2 (105 m water depth) from the operating acoustic array (Warner et al, 2018). Spatially, including all the Dorrigo MSS full-fold acquisition area, associated run-in/run-out lines and an additional buffer of 505 m around this area; this equates to a total area of 2203 km^2 (1277 km^2 in Victorian waters and 926 km^2 in Tasmanian waters). The Victorian western zone SRL/giant crab fishery covers an area of approximately 39,050 km^2 and the Tasmanian SRL/giant crab fishery (Zone 5) covers an area of approximately 74,300 km^2.

The areas and proportion of overlap for both the Southern Rock Lobster (SRL) and Giant Crab (GC) fisheries have been calculated by using the conservative threshold of 202 dB SPL which is predicted to extend 505m horizontally from the survey area. As previously outlined, this threshold is conservative for SRL because the research shows SRL exposed to 209 dB SPL elicited a behavioural response and damage to statocysts, but did not influence survivorship, fecundity, or larval quality (Day 2016). Therefore, it is possible that exposure to 202 dB SPL of seismic noise may not cause this level of effect. While GC exposed to 202 dB SPL of seismic noise did not exhibit a behavioural response, statocyst damage, stress response or mortality.

Southern Rock Lobster (SRL) Fishery Impact Assessment

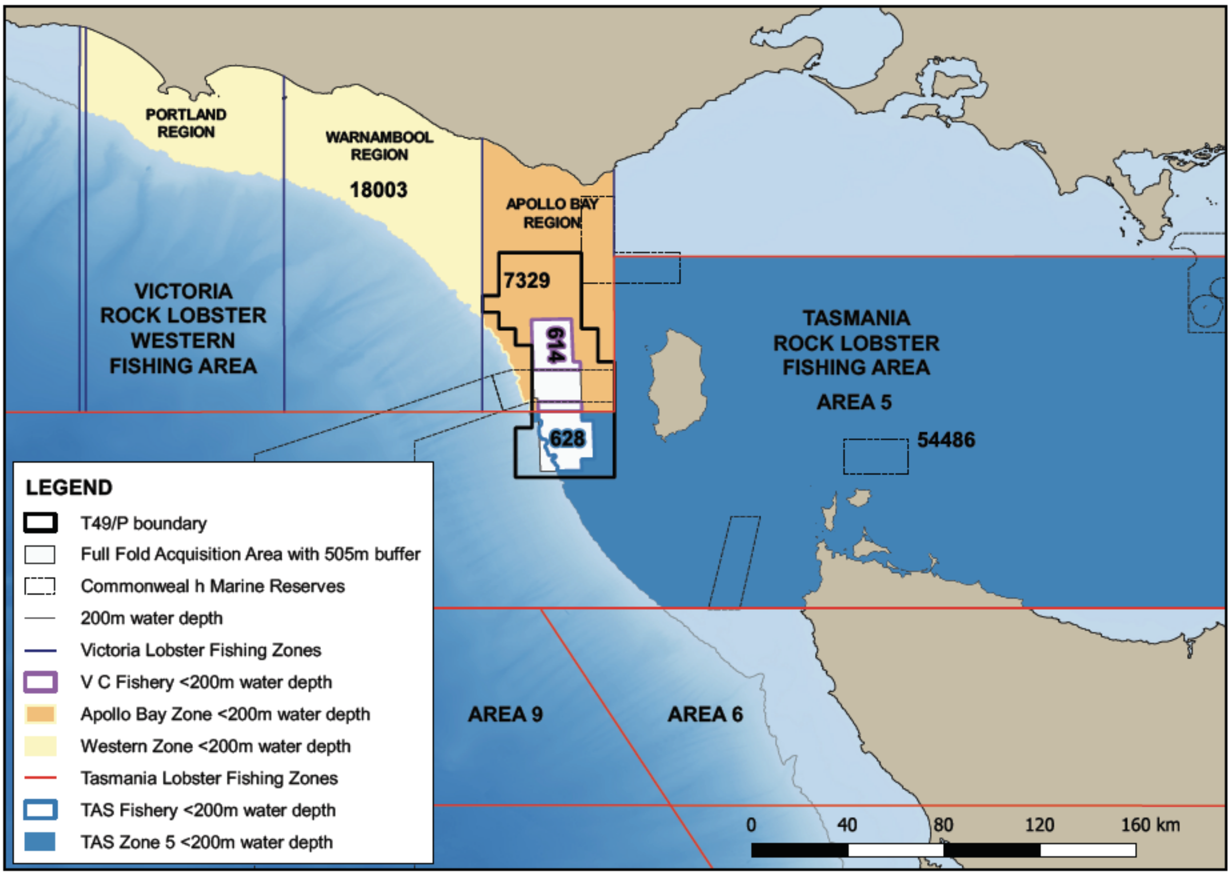
Site specific data on the areas fished for SRL are not accessible as they are confidential. However, SETFIA/Fishwell 2018 (Appendix 4) report that SRL are caught in waters of depths up to 200m. This depth has therefore been used as a proxy to estimate SRL habitat with the area of seabed shallower than 200m within the fishery considered available SRL habitat. The data in **Figure 7-7A** and **Table 7-10A** show that an extremely small proportion of the management zones of the Tasmanian and Victorian fisheries are intersected by acoustic noise that may elicit an effect on SRL. For both the Victorian and Tasmanian SRL fisheries the impacts are likely to be negligible due to the impacts not being lethal to individuals and not impacting reproduction or larval development (Day et al, 2016; Payne et al, 2007) in combination with the extremely small area of overlap with both fisheries.

Table 7-10A Details the area and the proportion of overlap of the seismic activity with the available habitat within management areas of both the Victorian and Tasmanian SRL fisheries.

SRL fishery	Total area (km^2)	Proportion of habitat in mgt area 5 (%)	Proportion of habitat in Apollo Bay (%)	Proportion of habitat in Western Zone (%)
TAS	628	1.15	-	-
VIC	614	-	8.38	3.41

41 This is the maximum horizontal distance at any depth across the modelled survey areas.

Figure 7-7A Depicts the overlap of the seismic survey with available habitat within both the Victorian and Tasmanian SRL fisheries.



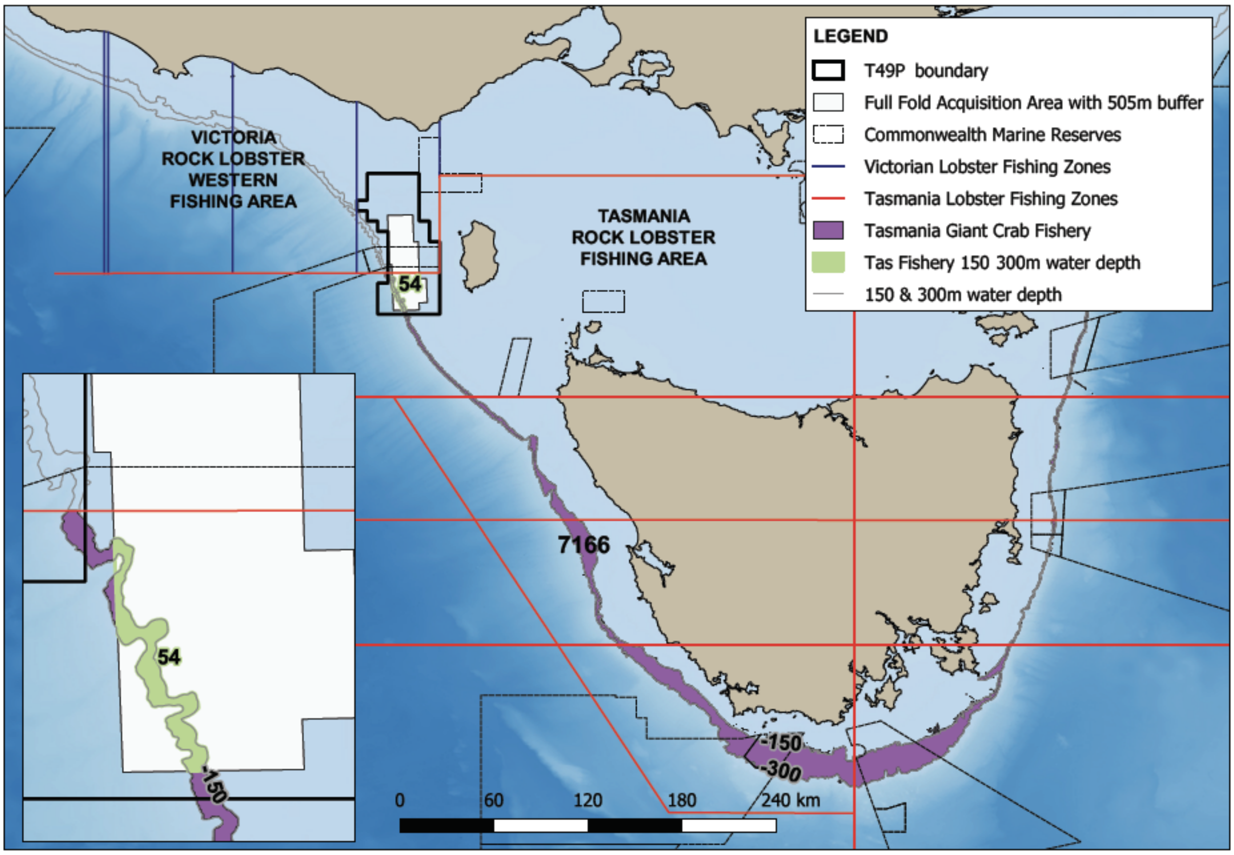
Giant Crab (GC) Fishery Impact Assessment

Similarly, for Giant Crab, site specific data on the areas fished for GC are not accessible as they are confidential. However, SETFIA/Fishwell 2018 (Appendix 4) report that GC are predominantly caught in waters depths between 150 and 300m. Consultation with Tasmanian GC fishers confirmed these water depths (Appendix 8, pp 868). Therefore, this depth range has been used as a proxy for available GC habitat within the Victorian and Tasmanian fishery. The data in **Figure 7-7B** and **Table 7-10B** show that an extremely small proportion of the GC fishery in Tasmania overlaps the survey area, while in the Victorian fishery the survey does not overlap any preferred habitat of the GC. The discrepancy between the no overlap with habitat presented here and the data on stock and catch affected in Victoria in Table 7-11, can be explained by the data presented in Table 7-11 incorporating the catch from all of the Victorian Western Zone and the amount and proportional impact assuming a even distribution of GC stock across the entire Western Zone. This highlights the benefit of using more specific data on the areas fished to produce a more accurate estimate of potential impacts. Comparing the seismic survey area with the preferred habitat of GC shows the impact to the Victorian fishery to be smaller than originally predicted and still extremely small in the Tasmanian fishery. These data when combined with the conservative threshold used suggests the impact to the GC fishery will be extremely small.

Table 7-10B Details the area and the proportion of overlap of the seismic activity with the available habitat within management areas of both the Victorian and Tasmanian GC fisheries

Giant crab fishery	Total area (km^2)	Proportion of habitat in TAS fishery (%)	Proportion of habitat in VIC fishery (%)
TAS	54	0.75	-
VIC	0	-	0

Figure 7-7B Depicts the overlap of the seismic survey with available habitat within both the Victorian and Tasmanian GC fisheries



Impacts to Biomass: Commercial fishery managers set TACCs over fishery stock to ensure the sustainable management of fishing 'catch' on a long-term basis. **Table 7-11** provides details of SRL and giant crab 2016-17 TACCs, 2016-17 catch data, SRL and giant crab stock levels which may be affected by the Dorrigo MSS and the consolidated 'catch' plus affected stock figures. This information has been provided in **Section 5.7.5** based upon a fishing survey undertaken for the region (SETFIA/Fishwell Consulting, 2018). As the SRL and giant crab stock is continuous across the Dorrigo MSS area, Victorian and Tasmanian TACCs and catch have been combined to allow for biomass assessment across the survey area.

Table 7-11: Crustacean species TACs and catch data within the Dorrigo MSS area (sound levels > 202 dB re 1µPa (PK-PK)) [42]

Fishing Stock	Latest Fishing Year TACC (tonnes)		Annual Catch – Latest Fishing Year (tonnes)		Stock Levels affected by Seismic (tonnes)		Total (Stock affected + Total Catch) (tonnes)		% Exceedance of TACC	
	State	Combined	State	Combined	State	Combined	State	Combined	State	Combined
SRL (Vic)	230	1280.7	[redacted][43]	[redacted]	1.7	9.4	[redacted]	[redacted]	0.7% (1.7t)	NA
SRL (Tas)	1050.7		[redacted]		7.7		[redacted]		NA	
GC (Vic)	10.5	31.2	[redacted]	[redacted]	0.08	1.98	[redacted]	[redacted]	NA	NA
GC (Tas)	20.7		[redacted]		1.9		[redacted]		NA	

As seen in **Table 7-11**, based on the combined state TACCs, SRL/giant crab stock affected by seismic operations within the Dorrigo MSS when added to actual annual catch figures is not expected to fall above TACC levels and be detrimental to the long-term sustainability of crustacean biomass within the fisheries.

Based upon the available studies, the following broad conclusions can be drawn about exposure from acoustic sources on SRL/giant crab stock within the Dorrigo MSS area:

- Exposure is not expected to result in mass mortalities to adult SRL (Day et al, 2016; Payne et al, 2007);
- Exposure is not expected to result in mortality (acute or chronic) to crabs (Christian et al, 2003; DFO, 2004; Payne et al; 2008) or expected to cause physiological or stress-related changes in crab species (Christian et al, 2003; 2004);
- Sound exposure in SRL might lead to increased stress and neurological impairment with a higher risk of shorter-term predation or long-term mortality. Day et al (2016) observed no effect from seismic exposure on SRL survival and only one study from four identified a reduced refractive index indicating the potential for reduced nutritional status to 120-345 days post exposure. No other condition indices suggested that exposed lobsters were negatively affected. The authors concluded that impacts to statocyst morphology, behavioural reflexes and immune response functions in adult lobsters with seismic exposure was relatively minor, but this depended upon the fitness of the exposed animal. Day et al (2016) did not explore impacts associated with reduced mobility and immunity with respect to the survival of affected lobsters in the wild or whether these sub-lethal effects could reduce a lobster's ability to compete for food or avoid predation. However, studies into lobster populations where statocyst damage is known to exist, has identified very high survival rates and are at near carrying capacity (Kordjazi et al, 2015);
- It is noted that the Day et al (2016) assessment is considered conservative given the water depths in the Dorrigo MSS area (100m+). Scientific studies have detected impacts in shallower water depths (~5-10 m), and as scientific literature identifies, behavioural and

[42] Calculations of affected stock are provided in Section 5.7.5.3 (Victorian SRL), Section 5.7.5.4 (Victorian giant crab), Section 5.7.5.5 (Tasmanian SRL) and Section 5.7.5.6 (Tasmanian giant crab).

[43] A portion of this quota was retired due to purchase from Origin. Actual catch was 209 tonnes (SETFIA, 2018).

physiological responses in crustaceans are likely to be related to particle motion effects, located close to the operating array, rather than pressure effects (Carroll et al, 2017);
- SRL and crab stock affected across the Dorrigo MSS area is small (0.73% SRL TACC and 6.4% giant crab TACC). Sustainability of stock will not be affected by the small proportion of the stock affected;
- SRLs are fished primarily from coastal reefs with most of the catch coming from inshore waters less than 100 m deep (VFA, 2018). Note that the minimum depth within the Dorrigo MSS is 100 m;
- Survey activities do not physically damage the seabed which might in turn affect SRL/crab habitat/stock.

Within the context of the Dorrigo MSS seabed habitat, impacts to SRL/giant crab[44] are expected to sub-lethal with evidence of adaption/survival with these sub-lethal impacts, localised to a small proportion of the fishery; integrity of the seabed ecology preserved and not affecting the stock sustainability which is fully recoverable.

Impacts to Moulting SRL: The available research on temporal moulting patters in adult SRL in Tasmanian waters including King Island, which tracked over 4000 tagged individuals, shows that female SRL mainly moult between February and May while male SRL moult mainly in August and September with the greater majority of males moulting in August (Gardiner and Mills 2013). As such, it is expected that the majority of the SRL breeding population will have moulted by the commencement of the seismic survey. The exact effects of seismic exposure on soft shelled SRL after moulting is not well understood. However, Gardiner and Musgrove (2004) present data that shows the shell only remains soft for approximately 20 days. Therefore, it is anticipated that the majority of the SRL population will not have soft shells during the period of the seismic survey.

Commercial Crustacean Fishery Catchability/Abundance Impacts: Based upon the available studies, the following broad conclusions can be drawn about commercial catch/catchability of SRL/giant crab stock within the Dorrigo MSS area:
- Research undertaken to date has not identified any change to invertebrate catch rates from seismic surveys (Carroll et al, 2017; Morris et al, 2017; Parry & Gason, 2006; Christian et al, 2003; La Bella et al, 1996);
- The proportion (spatially) of the fishing area within the SRL/giant crab fishery affected by the Dorrigo MSS area is 3.3% Victoria (Western Zone) and 1.3% Tasmania (Zone 5). Based upon fishing data obtained from VFA and IMAS, the total estimated stock affected by the Dorrigo MSS is 0.7% (SRL) and 6.4% (giant crab) based upon combined TACCs;
- Most SRL catch is taken from waters less than 100 m deep (VFA, 2018).

Given these factors, any impacts to SRL or giant crab are expected to affect only a small proportion of the TACC within the fisheries and a small area of the fisheries. From available literature any catchability/abundance impacts within the Dorrigo MSS area are expected to be incidental, localised and recoverable within the fishery.

[44] Impacts to early life stages of the SRL and giant crab are assessed under plankton.

Temporal Impacts to SRL and GC Fishing Activities
The data and reasoning presented above shows the impacts to individuals and the stock in the fishery are likely to be very small due to limited effects of the sound exposure and the very small spatial overlap. This very small effect should also be considered with the small temporal overlap with fishing activities by scheduling the seismic survey to occur in September and October. The fishery regulations state that the Victorian SRL and GC fisheries are closed between 15th September and 15th November. Similarly, in the Tasmanian SRL fishery closures prevented the take of females between 1st May to mid-November and closure to take of males usually occurs between mid-September to mid-November. These closures also align with the lowest take of SRL for both fisheries (Section 5.7.5 of EP). Therefore, the proposed timing of the seismic survey will have the least amount of disruption to fishing activities of both SRL fisheries.

The survey does not overlap with GC habitat in the Victorian fishery, so interruptions to this fishery are not expected. In Tasmania, fishing for male GC occurs year-round with the take of females closed 1st June to 14th November. However, historically the lowest level of fishing effort for GC on the west coast of Tasmania is in September and October (Section 5.7.5). Therefore, the disruption to the fishery is expected to be very low.

<u>*Summary*</u>:

Consequence (Impacts to crustacean biomass): If the Dorrigo MSS activity results in impacts to crustaceans, these effects are sub-lethal. Localised, short-term effects to species present in the survey area is possible (minor consequence).

Consequence (Impacts to commercial crustacean catchability/abundance): The Dorrigo MSS activity is not expected to impact on crustacean catch rates (negligible consequence).

Controls assessment to limit impacts to decapod abundance and commercial catch:

An assessment of controls to limit impacts to decapods (& associated fishing impacts) from seismic activities is provided in **Table 7-12**.

Table 7-12: Assessment of potential control measures to reduce impacts to decapods

Control Measure	Practicable	Will it be Implemented?	Justification
Temporal Exclusion: Avoid undertaking surveys in peak recreational and commercial seasons	NO	NO	Victorian Fishery Exclusions recommended by the VFA cover most of the year. The remaining months of the year (i.e. April, May) lie within biologically important areas for pygmy blue whale for foraging. In accordance with EPBC Policy Statement 2.1 (Interaction between offshore seismic exploration and whales: industry guidelines), seismic survey periods should avoid BIAs at biologically important times. Adherence to this policy requires data acquisition to occur outside the foraging period (nominally November to April/May). 3D Oil cannot accommodate this mitigation strategy. Tasmanian Fishery The proposed schedule of the seismic survey between 1st September to 30th October 2019 aligns with the periods of lowest catch rates or fishery closure for both SRL and GC in Tasmanian waters.

Control Measure	Practicable	Will it be Implemented?	Justification
Spatial Exclusion: Avoid Key Fishing Grounds	YES	YES	Victorian Fishery 3D Oil understands that the Dorrigo MSS does not overlap key **Victorian fishing grounds** for either the SRL or giant crab based upon fishing data obtained by the VFA and feedback from Victorian giant crab and lobster fishermen. Tasmanian Fishery The survey only overlaps with 1.15% of the available SRL habitat in Management Area 5 and 0.75% of the GC habitat available in the Tasmanian fishery. With the spatial overlap being so small, further reducing this would be of little additional benefit to the fishery as a whole, but would come at a grossly disproportionate cost to 3D Oil because it would compromise the commercial viability of the survey.
Temporal Exclusion: Avoid spawning period	No	No	Victorian and Tasmanian Fisheries SRL eggs hatch into larvae between September and November which overlaps the timeframe of the Dorrigo MSS. Larvae (*phyllosoma*) remain in the pelagic environment for 12-18 months and is widespread over continental shelf waters. Giant crab carry eggs for approximately 4 months and eggs hatch in the October/November timeframe dispersed over large spatial scales for approximately 50 days before settling. Pearson et al (1994) observed no difference in larval mortality or abundance for crabs from seismic exposure and similarly Day et al (2016) observed no effects on the mortality, abnormality, competency, or energy content of lobster larvae (*J. edwardsii*) after exposure of early embryonic stages to airgun shots with sound levels > 185 dB re 1μPa^2.s. Given the widespread dispersal of larvae and the small footprint of the Dorrigo MSS area relative to that dispersal area, crustacean population exposure is not expected to be significant. Acquisition within the September/October timeframe prevents spatial overlap with fishermen.
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	Victorian and Tasmanian Fisheries 3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field.
Spatial Conflict: Minimise exclusion period of fishers from fishing grounds and transit routes.	YES	YES	Victorian and Tasmanian Fisheries 3D Oil has selected a period (September-October) whereby, due to fishery closures, spatial conflicts with **Victorian** and Tasmanian fishermen will be predominantly eliminated.
Targeted Research: Investigate undertaking targeted research during operations to better understand impacts.	NO	NO	A substantial number of studies have been undertaken to assess the impacts of acoustic noise on the SRL/crab species. 3D Oil does not consider studies to replicate existing knowledge on crustaceans, particularly given the low-level presence of species in the Dorrigo MSS area is warranted.
Consultation Advice: Consult with fisheries to provide awareness of activity and commencement and prevent spatial conflicts.	Yes	Yes	3D Oil has been undertaking consultation with fisheries since March 2018 to understand potential fishermen affected and spatial conflicts. As the Dorrigo MSS timeframe is primarily within seasonal closure periods **for Victoria**, spatial conflicts are expected to be low, however spatial management arrangements will be agreed with fishing representatives as part of stakeholder consultation.

Control Measure	Practicable	Will it be Implemented?	Justification
Loss of Catch Compensation: Prepare Compensation Arrangements for stock damage associated with sesimic survey activities.	NO	NO	Scientific literature identifies that mortality or catch related impacts have not been experienced by decopods even in very close proximity to an operating array. Sub-lethal impacts are possible, however given the proportion of the fishery which may be affected, the TACC and sustainability of the fisheries is not threatened. There is also very little spatial overlap of the Dorrigo MSS with Victorian and Tasmanian fisheries based upon the evidence presented in Figures 7-7A and 7-7B and Tables 7-10A and 7-10B and the schedule of the survey optimises the temporal overlap to the least impact possible to fishing activity. Fish catch studies for both lobster and crab identify there is no significant channge in catch attributable to seismic survey activities. Catchability impacts to active fishing grounds are not expected to arise based upon this literature.
Notification to Fishers of Commencement of Survey and Ongoing Updates on Survey Duration and Completion	Yes	Yes	Commercial fishers actively operating in the survey area and will be issued a 7 to 10 day forecast prior to activities commencing in the survey area and will be issued weekly updates on progress until completion of the survey.
Consultation Advice/Feedback:			Victorian Fishery Most Victorian fishermen identified they do not fish as far south as the Dorrigo MSS or transit only through the area. Victorian fishermen have identified that they are concerned about the affect that seismic will have on fishing stock. One fisherman **[Stakeholder #38]** identifies that almost 100% of his yearly effort is within the Dorrigo MSS area and that survey operations should not be conducted during the spwaning period (June to December). Stock impacts will exacerbate reduced stock levels from over-fishing. There is no good timeframe and the activity should be cancelled. *3D Oil is obliged to undertake survey activities and cannot cancel activity*. 3D oil cannot also modify timeframe outside of spawning period as this then encroaches into threatened species presence in the Otway area. No other mitigation suggestions provided. Tasmanian Fishery TSIC expressed concerns relating to the timing of the survey would compromise fishing activities. However, it is noted the survey overlaps the period during which fishing for SRL is closed or during periods of lowest catch. Also, the period chosen for the activity timeframe will avoid upwelling events and associated foraging by marine fauna including the endangered Blue Whales (Protected under Commonwealth legislation).
Spatial Buffers: Adopt spatial buffer around shelf break area where giant crab fishermen obtain catch.	NO	NO	The survey already completely avoids overlap with the preferred habitat for GC in the Victorian fishery. In the Tasmanian fishery the overlap is only 0.75% overlap of the available habitat within the fishery. Therefore, further reduction of the survey area would yield little benefit to the Tasmanian GC fishery, but would come at a grossly disproportionate cost to 3D Oil because it would compromise the commercial viability of the survey.

Abalone
Species Sensitivity:
Many molluscs, including gastropods and bivalves, possess statocysts which assist the animal in maintaining balance and orientation in its immediate environment (Carroll et al, 2017).

Statocysts are fluid-filled, capsule-like sensory organs, usually including ciliated hair cells and containing a single dense body (statolith) or multiple smaller ones (statoconia). The statocyst and/or statoconia interact with the cilia lining in the capsule, probably (as has been shown in gastropods and cephalopods) conveying information about orientation to the organism. This may also enable the animal to detect low-frequency pressure waves in sediment – either in porewater or as vibrational signals associated with the movement of sediment particles (Wethey and Woodin, 2005). It has been postulated that the statocyst organs may be receptive to the particle acceleration component of a sound wave, possibly in the far-field (Hawkins and Myrberg; cited in McCauley, 1994). Franzen showed that tellinid bivalves (*malcoma balthica*) are sensitive to frequencies in the range 50-200 Hz, which corresponds to shear-wave vibration that propagates along the sediment surface. A study on the ox-heart clam (*Glossus humanus*) has demonstrated sensitivity to vibrations and hypothesised that the sensitivity was related to sensing breaking waves on the incoming tide (Frings, 1964; cited in McCauley and Kent, 2008). *Donax variabilis*, a coquina clam, responded to pressure signals in the range 20 Pa, or a sound pressure of 140 dB re 1µPa (SPL) (Ellers, 1995).

In another bivalve mollusc, response to sound has been evident by changes in aggregations. Low frequency sound (30 to 130 Hz) has been demonstrated as an effective control measure for zebra mussel fouling (Donskoy and Ludyanskiy, 1996).

Beyond the distances of impact outlined in McCauley (1994), no information is available concerning the distances over which bivalve molluscs may be able to detect either the pressure or particle motion components of a sound wave. Wethey and Woodin (2005) concluded that a conquina clam could probably detect defecation signals generated by a polychaete worm at 60 cm in sediment.

Mortality/Potential mortal injury and impairment: The most recent critical review of potential marine seismic surveys on fish and invertebrates (Carroll et al, 2017) identified only one study where a mortality response in bivalve molluscs was recorded at realistic exposure levels (Day et al, 2016b). This study in Bass Strait found that exposure to a seismic source (single airgun of either 45in^3 or 150 in^3 and maximum exposure levels of 191-213 dB re 1µPa PK-PK) did not cause any incidence of immediate mass mortality, however repeated exposure increased mortality and mortality risk with time as the majority of mortalities were recorded at the 120-day sample point (Day et al, 2016b). This dose-dependent increase in mortality translates into an annual increase in mortality of between 9.4% and 20%. This falls towards the low end of what might be expected when compared with natural mortality rates in wild scallop populations, which range from 11-51% with a six-year mean of 38% (Day et al, 2016b).

It is noted that limitations exist within the Day et al (2016b) study which means the finding of increased mortality must be treated with caution. As detailed in Przeslawski et al (2016a), the Day et al (2016b) study:

- Used a manipulative approach in which scallops were transplanted to the study area, exposed to an operating airgun and then held captive during subsequent monitoring;
- The scallop populations were obtained from commercial sources or transplanted from other regions to coastal waters, rather than using in-situ populations in Bass Strait. Stress associated

with handling during translocation may have contributed to impacts. Transplanted populations had increased mortality, inability to maintain homeostasis, reflex changes, depressed immune response after they had been exposed to an air-gun in shallow water;

- A single airgun was used in water depths of 10-12 m (i.e. very close-range impact) rather than a commercial airgun array in deeper waters;
- Identified long-term impacts after rearing scallops in suspended lantern nets such that the scallops were not in their natural environment (i.e. buried beneath sediment), thereby adding potential, though undetected stress.

Therefore, it seems likely that the observation of increased mortality, albeit minimal when compared to natural mortality rates, is probably related to other factors such as stress caused by transportation and the rearing of animals in the water column rather than in seabed sediments.

Przeslawski et al (2016a; 2016b) studied the effect of a 2530in^3 commercial airgun array at water depths between 36-61 m to an in-situ scallop population in seabed sediments. The study recorded no impact of seismic exposure on adult scallop mortality rates or a range of physical attributes two months after exposure although this study had several issues with the presented acoustic sound levels, both measured and modelled. While this study should not be used to interpret the effects of sound on in-situ scallops in seabed sediments, the results of this study, identified no mass mortality of molluscs correlating with the results of Day et al (2016b).

All other studies reviewed by Carroll et al (2017) found no response with respect to mortality effects in bivalve molluscs including two studies using the scallop *Pectin fumatus* (Parry et al, 2002; Harrington et al, 2010). Parry et al (2002) found that mortality rate and adductor muscle strength of scallops suspended in the water column and exposed to the operating airgun array (at a minimum distance of 11.7 m) was not significantly different from controls. However, it should be noted that the scallops were suspended in nets during exposure, and as such, were not subject to the relevant ground borne vibrations. Harrington et al (2010) conducted a scallop (*Pectin fumatus*) dredge before and two months after exposure to a 2000 psi airgun array. No evidence of short-term or long-term impacts on the survival or health of adult specimens was detected.

Studies have also looked at two oyster species and the effect of detonation of high explosives underwater and found the species to be resilient to the shock-waves created by underwater detonation. LeProvost et al (1986) studied the effects of underwater explosions on the pearl oyster and found no mortality occurred in the exposed animals over a 13-week period and at a minimum range of 1 m from the blast centre. Seismic sources cause less impact to invertebrates than explosives, therefore it is likely that molluscs would need to be within a very close range of a seismic source to receive sound levels associated with immediate mortality – with available evidence suggesting 1-2 m. It is more difficult to determine the distances at which sub-lethal impacts (morphological, biochemical and physiological changes as stress indicators) could occur. Note there are limited studies done specifically on gastropods and so conclusions must be drawn from studies done on similar species.

Behavioural responses: Most studies undertaken on behavioural impacts from seismic to molluscs have utilised commercial scallop species. As for other invertebrate studies results are mixed between impacts and no impacts (Carroll et al, 2017). Typically impacts are seen in laboratory studies or in field studies where there have been repeated exposures.

La Bella et al (1996) examined biochemical indicators of stress in bivalves exposed to seismic noise and found that hydrocortisone, glucose and lactate levels between test and control animals were

significantly different (P>0.05) in the venerid clam *Paphia aurea* showing evidence of stress caused by acoustic noise. This was at a minimum exposure range of 7.5 m. La Bella et al (1996) also reported catch rates of gastropods via gillnet methods were significantly reduced the day after the seismic survey ceased and concluded the motility of the species was affected. No differences were observed in gastropod catch rates via hydraulic dredge methodology. These observations were associated with an operational array emitting a source level of 210 dB re 1µPa in water depths of 15m. Received sound levels are not stated (Moriyasu et al, 2004).
Extent/duration of exposure and identified potential impact:

Habitats Present: The closest abalone area to the Dorrigo MSS area is Waterwitch Reef located 26 km from the nearest Dorrigo MSS acquisition line. Other abalone fishery areas are in coastal waters around King Island which also measure ~26 km from the nearest MSS survey line.

Based upon the available studies, the following broad conclusions can be drawn about noise exposure from the Dorrigo MSS acoustic source on gastropods which lie in coastal areas adjacent to the Dorrigo MSS area:

- Abalone are present in water depths of ~40 m and there is no direct spatial overlap with these reef areas. Based upon research to date, mortality and injury impacts to molluscs have been reported in studies where MSS is at close range to the target species with particle motion, rather than sound pressure a more important factor for molluscs (Ellers, 1995; Frings 1964; cited in McCauley and Kent, 2008; Whethey and Woodin, 2005);
- Most studies found no response with respect to mortality effects in bivalve molluscs (Carroll et al, 2017; Parry et al, 2002; Harrington et al, 2010). Mortality impacts which have been observed for bivalves directly exposed to MSS noise lie within natural mortality rates (Day et al, 2016b); and are unlikely to have long-term or population impacts;
- Physiological impacts identified in molluscs (La Bella et al, 1996) are also unlikely given the distance to commercial abalone harvesting areas from Dorrigo acquisition activities (> 25 km).

Summary: As the Dorrigo MSS is spatially separated from abalone reef areas, mortality or physiological impacts to abalone is not predicted. Any impacts would be incidental in the environmental setting, localised and recoverable (negligible consequence).

Controls assessment to limit impacts to abalone abundance:

An assessment of controls to protect abalone from seismic sound activities is provided in **Table 7-13**.

Table 7-13: Assessment of potential control measures to reduce impacts to abalone

Control Measure	Practicable?	Will it be Implemented?	Justification
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. **Control adopted.**

Cephalopods

Species sensitivity:
Other invertebrate species that may occur in the area are cephalopods, a pelagic species, which have a very broad distribution throughout southern Australian waters.

Cephalopods respond to sound in the frequency band 80-1000 Hz with more sensitivity to sounds below 300 Hz. Differing behavioural responses have been observed at differing frequencies and intensities of sound (Mooney et al., 2016). Cephalopods have statocysts (as per crustaceans), and epidermal hair cells which help them to detect particle motion in their immediate vicinity (Kaifu et al., 2008) and are comparable to lateral lines in fish. Accordingly, the component of the sound field likely perceived by cephalopods is particle acceleration and not sound pressure (Mooney et al., 2016).

Cephalopods have also exhibited the potential for habituation to sound in scientific studies however this has not been studied in detail. Samson et al. (2014) exposed *S. officinalis* (European cuttlefish) to repeated exposures at 200 Hz at differing sound levels. Habituation was observed as response intensity decreased but response elimination was not achieved.

Mortality Response: Norris and Mohl (1983) in laboratory conditions, observed that the European squid (*Alloteuthis subulata*) showed short-term tolerance to sound levels of 260 dB re 1µPa (PK), however the larger *Loligo vulgaris* was fatally injured by sound levels of 246-252 dB re 1µPa (PK) within 3-11 minutes of exposure. The lowest impact sound pressure for the larger squid was not determined.

Guerra et al. (2004) observed pronounced statocyst and organ damage in seven stranded giant squid (*Architeuthidae spp*.) after nearby seismic surveys (Guerra et al., 2004) however there was no direct evidence to link the suggested cause and effect (Salgado-Kent et al, 2016; cited in Santos, 2018).

Andre et al., (2011), demonstrated in controlled experiments exposing four cephalopod species to a 50-400 Hz sinusoidal wave sweep with a period of 1 second over a period of 2 hours, lesions in statocysts consistent with trauma at received sound levels of 175dB dB re 1µPa (PK). Lesions became more pronounced with increased exposure (12 to 96 hrs) and alteration of the haemolymph was observed. This study design and the sound exposure to test specimens is not representative of seismic surveys.

Behavioural Response: Studies have shown that acoustic sound can elicit a behavioural response in cephalopods. McCauley et al. (2000a, 2000b) in an experiment on caged squid (*Sepioteuthis australis*) did not observe injury or mortality, however observed squid alarm (inking, jetting) responses to airgun start-up at a received level 174 dB re 1µPa (SPL) or 163 dB re 1µPa^2.s (SEL). Fewer alarm responses were observed with subsequent exposures. Squid also showed avoidance behaviours by keeping close to the water surface (within the sound shadow) during exposures. For trials using ramped start-up (rather than near-by sudden start-up), the strong startle response was not observed but a noticeable increase in alarm responses occurred at received levels exceeding 156-161 dB re 1µPa (SPL). No consistent avoidance responses were seen in the trials but there was a general trend for the squid to increase their swimming speed on the approach of the air-gun and then slow at the closest approach and to remain close to the water surface during the airgun operations. Fewtrell and McCauley (2012) noted that exposure modelling using thresholds of 161-166 dB re 1µPa (SPL) would give an indication of the extent of disruption for specific seismic surveys. This threshold is adopted to assess species displacement effects for the Dorrigo MSS area.

The potential effects on catch rates/abundances have been tested on cephalopods and no significant differences have been detected between sites exposed to seismic operations and those not exposed (Carroll et al, 2017). It is likely that cephalopods in the survey area may show a behavioural response to the seismic noise and move away from the source. There is insufficient information to gauge the scale of this movement, and the displacement distance, however it is likely they will move back to the area once the seismic has passed.

La Bella et al. (1996) assessed changes to catch rates for the squid species, *Illex coindetti*; bivalve species *Paphia aura* (clam), *Anadara inaeqivalvis*; and gastropod *Bolinus bandaris* pre and post seismic survey. Results indicated no significant reduction in any catch rate except for *Bolinus bandaris* caught by the gillnet method, as opposed to the dredge methods which remained unchanged. La Bella et al. (1996) identified the received levels of test species during this study were < 147 dB re 1µPa (SPL).

Extent and Duration of Exposure and Identified Impact:

Habitats:
There are no BIAs or critical habitats present in the Dorrigo MSS area for cephalopods. No foraging BIAs are present in the Dorrigo MSS area for other marine species which forage on cephalopods.

The Dorrigo MSS area does spatially overlap fishing areas used for squid jig fishing during 2017 (confidential levels of fishing only) (refer **Section 5.7.5.3**). This fishery is active during the period January to June each year.

Potential Impacts:
Cephalopods, a pelagic and highly mobile species, can inhabit deep waters off the continental shelf (500-1000 m deep) preying on fish and other molluscs, and are known to inhabit the canyon systems on the continental slope. Acoustic modelling predicts, based upon the 160 dB re 1µPa (SPL) behavioural isopleth, avoidance might be observed to a maximum of 9.64 km horizontal distance from the operating array (Warner et al, 2018). At any one time the ensonified area based upon this horizontal distance is 265.8 km^2.

Based upon the available studies, the area of impact should be viewed in the following context:

- Cephalopods are sound sensitive and will displace from areas of high sound intensity (Fewtrell & McCauley 2012; McCauley et al, 2000). Immediate mass mortalities of cephalopod species exposed to operational seismic arrays have not been observed (refer references in **Table 7-10);**
- Damage to cephalopods might occur if an acoustic array started at full power adjacent to the animal. In reality, with EPBC Policy Statement 2.1 soft-start procedures implemented, mortality to cephalopod species is not expected, however avoidance behaviour is possible;
- On a per-shot basis at any one time, the behavioural isopleth of 160 dB re 1µPa (SPL) at any one time represents a spatial overlap of 0.7% of the Otway bioregion. This bioregion is representative of the broader area where the MSS is located;
- Based upon the observed catch data for cephalopods pre and post MSS activities, it is likely the species will move back into the area once the acoustic array has passed (La Bella et al, 1996; Przeslawski et al, 2016);
- Cephalopods are known to inhabit canyon systems. The Dorrigo MSS area spatially overlaps 0.3% of the West Tasmanian canyon system;
- The survey vessel is constantly moving noise impacts in specific locations will be temporary and recoverable;
- The Dorrigo MSS area overlaps seabird foraging BIAs for albatross (wandering, antipodean, Tasmanian shy, Buller's, Campbell, black-browed and Indian yellow-nose); petrels (common diving, white-faced storm petrel); and short-tailed shearwater. Bird species feed on multiple prey species and have widespread foraging areas. While cephalopod displacement may result in the displacement of these birds, this impact is localised, temporary and recoverable in any one location. Given their widespread foraging areas (ACAP, 2018) and the small area possibly affected by prey displacement, seabirds are not expected to be impacted by reduced net foraging opportunities by celphalopod displacement;
- Other fish species such as southern bluefin tuna also consume cephalopods as a prey species. As above, any displacement of cephalopods would be expected to also displace wide-ranging SBT species, however net foraging opportunity loss is not expected. Given the constant movement of the vessel, any impact would be localised, temporary and recoverable;

- The squid jig fishery, active in the area between January and June, does not temporally overlap with the Dorrigo MSS activities. As catch data for cephalopods pre and post MSS activities indicates no impact to catch data (La Bella et al, 1996; Przeslawski et al, 2016), any impacts to the species are localised, temporary and recoverable and should not affect commercial fishing activities.

Summary:

Cephalopod Impacts: Cephalopods may be injured on a localised basis if a seismic array commences operation at full power immediately next to the species. With controls adopted, cephalopods are expected to displace from areas around the operating array. This effect is temporary, localised and recoverable (negligible consequence).

Controls assessment to limit impacts to cephalopod abundance:
An assessment of controls to protect cephalopods from seismic sound activities is provided in **Table 7-14.**

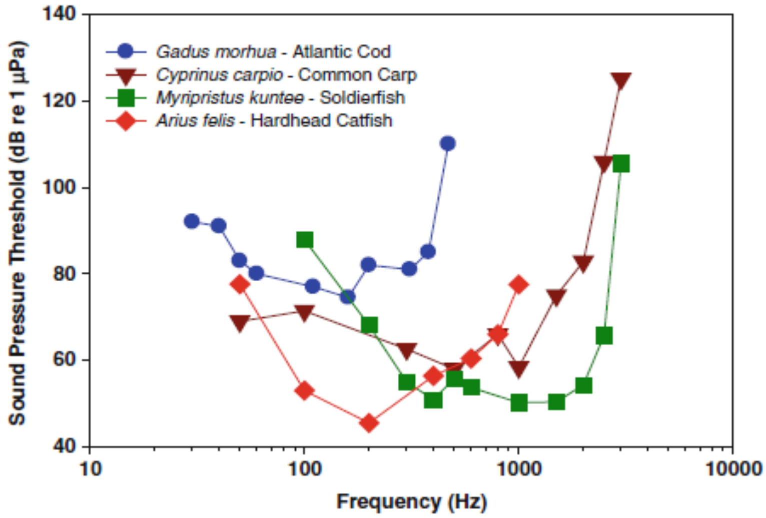
Table 7-14: Assessment of potential control measures to reduce impacts to cephalopods

Control Measure	Practicable?	Will it be Implemented?	Justification
EPBC Policy Statement 2.1 (Part A): Implement soft-start procedures to limit injury impacts to cephalopods.	YES	YES	Control measure adopted to limit impacts to all sensitive sound species. Environmental benefit outweighs cost. **Control adopted.**
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. Environmental benefit outweighs cost. **Control adopted.**
Temporal Overlap with Squid Jig Fishery	YES	YES	3D Oil has selected the period September to October to acquire sesimic data. This fallso outside the recognised fishing period for this fishery in the area (January to June). **Control adopted.**

7.2.3.3 Fish (including sharks and rays)

Sensitivity:
All fish studied to date identify fish can detect sound with most fish species detecting sound from below 50 Hz up to 500–1,500 Hz. A small number of species can detect sounds to over 3 kHz, while a very few species can detect sounds to well over 100 kHz (refer **Figure 7-8**). The predominant frequency range of the Dorrigo seismic array is below 500 Hz which is in the hearing range of most fish.

Figure 7-8: Underwater hearing threshold for the Atlantic Cod, Common Carp, Soldier Fish and Hardhead Catfish (Popper et al. 2014)



The main auditory organs associated with teleost (bony) fish are the otolithic organs. The inner ears of cartilaginous fish (sharks, rays and their relatives) possess similar structures with the addition of a *macula neglecta*. Hearing in fish primarily involves the ability to sense acoustic particle motion via inertial stimulation of the otolithic organs or their equivalent. There have been no demonstrations to date of damage to lateral line systems resulting from exposure to intense man-made sounds or other signals although it is conceivable that damage may occur (Popper et al., 2014). Many species also detect sound using an indirect path of sound stimulation involving gas-filled chambers such as a swim bladder. In these species, fluctuations in sound pressure generate particle motion causing the gas-holding chambers to oscillate in volume which in turn stimulates the inner ear. The proximity of the gas-filled chamber and/or their direct mechanical connection to the inner ear improves hearing enhancing their detectable frequency range and lowering their sound pressure threshold. Swim bladders also make fish more susceptible to pressure-related injuries compared with species lacking a swim bladder (Carroll et al., 2017).

There are substantial differences in auditory capabilities from one fish species to another and anatomy is used to distinguish the different sensitivity groups. Popper et al., (2014) has categorised fish into three main categories to assist in assessing the effects of sound to the species. Categorisation is based upon the presence or absence of gas-filled structures and the ability for those structures to improve hearing range and sensitivity. They are:

- *Fish that detect particle motion only (Type 1)*. This includes cartilaginous fish (elasmobranchs) which detect the particle motion component of sound only. Evidence suggests that pelagic species have more sensitive hearing than demersal species however the hearing sensitivity of most elasmobranchs is poorly understood. The lateral line system is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg, 2001);
- *Fish with swim bladders which is close to the ear (Type 2)* but not internally connected and hearing does not involve the swim bladder. This group are susceptible to physical injury such as barotrauma, although hearing is through particle motion not sound pressure. This group can hear up to about 500 Hz.
- *Fish with swim bladders which contributes to hearing (Type 3)*. This group is sensitive to particle motion and sound pressure through the gas bladder connection to the inner ear. This serves to increase hearing sensitivity and broaden hearing bandwidth extending to several kilohertz. This group is generally more sensitive to sound pressure than other groups (Hawkins and Popper, 2016)

The Working Group on the Effects of Sound on Fish and Turtles reviewed scientific literature available for sound on fish. From this review, sound exposure guidelines for fish and sea turtles were developed (Popper et al., 2014) and accredited with the American National Standards Institute (ANSI). The guidelines provide sound exposure metrics, for the different types of fish, for three immediate effects:

- Mortality, including injury leading to death;
- Recoverable injury including injuries unlikely to result in mortality such as hair cell damage and minor haematoma; and
- Temporary Threshold Shifts (TTS) in hearing.

Within these guidelines, where insufficient data existed to make a guideline 'threshold' metric, the guidelines recommend a subjective approach using 'relative risk' to assess risk at three distances from the source. Masking and behavioural effects are therefore assessed within this EP using a 'relative risk' approach and because the presence or absence of a swim bladder has a role in hearing, fish susceptibility to injury from noise has been classified based on the role of any swim bladder in hearing (refer **Table 7-15**). The following is relevant to these guidelines:

- Despite mortality being a possibility for fish exposed to airgun sounds, Popper et al. (2014) does not reference any scientific studies where mortality has occurred and no lethal effects resulting from MSS have been reported. In Popper et al. (2014), mortality and recoverable injury guidelines are derived from impulsive sounds established during pile driving studies by Halvorsen at al., (2012). This proxy has been used as research to date has not identified a seismic threshold level where mortality has been observed. Since the issue of these guidelines, Popper et al. (2016) has added further information into the threshold levels of impulsive airgun sound to which adult fish can be exposed without immediate mortality. The study found that two fish species (pallid sturgeon and paddlefish) with body masses in the range 200-400 g, exposed to a single shot of maximum received level of 231 dB re 1µPa (PK) or 205 dB re 1µPa^2.s (SEL) remained alive for seven days after exposure and the probability of mortal injury did not differ between exposed and control fish. They also found no difference in injuries between fish exposed at closer distances to the source compared to those further away. Accordingly, this study using an actual seismic source, shows no mortality at higher sound thresholds than the "mortality, potential mortal injury and recoverable injury" thresholds for fish published by Popper et al. (2014) and applied to the Dorrigo survey. Carroll et al (2017) from a review of studies into impacts of seismic airgun exposure on fish (refer **Figure 7-9**) also support this observation of no mortality impacts.
- No scientific studies are available on elasmobranchs response to seismic sound.

Table 7-15: Sound exposure guidelines for mortality, impairment and behavioural change in fish (Popper et al. 2014)

Type of Fish	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
TYPE I Fish: no swim bladder (particle motion detection)	> 219 dB SEL_{cum} or > 213 dB PK	>> 216 dB SEL_{cum} or > 213 dB PK	>> 186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
TYPE 2 Fish: swim bladder is not involved in hearing (particle motion detection)	> 210 dB SEL_{cum} or > 207 dB PK	203 dB SEL_{cum} or > 207 dB PK	>> 186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
TYPE 3 Fish: swim bladder involved in hearing (primarily pressure detection)	> 207 dB SEL_{cum} or > 207 dB PK	203 dB SEL_{cum} or > 207 dB PK	186 dB SEL_{cum}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Definitions:					
Mortal and mortal injury	Immediate or delayed death.				
Recoverable injury	Injuries including hair cell damage, minor internal or external haematoma, etc. None of these injuries are likely to result in mortality.				
Temporary Threshold Shifts	Short or long-term change in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6 dB or greater that persists and has been selected as the working group considers that anything less than 6 dB will not have a significant effect from a hearing standpoint.				
Masking	Impairment of hearing sensitivity by greater than 6 dB in the presence of noise.				
Behavioural effects	Substantial change in behaviour for the animals exposed to sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction or alteration in migration patterns. This criterion does not include effects on single animals or where animals have become habituated to the stimulus or small changes in behaviour such as a startle response or small movements.				
Note: Peak and rms pressure levels are dB re 1µPa; SEL dB re 1µPa^2.s. All criteria are presented as sound pressure since no data on particle motion exists. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) (tens of metres), intermediate (I) (hundreds of metres) and far (F) (thousands of metres) (Popper et al. 2014).					

Note: For this survey the time standard applied to the SEL metric is 24 hours.

Mortality, including injury leading to death and recoverable injury

Available Research:

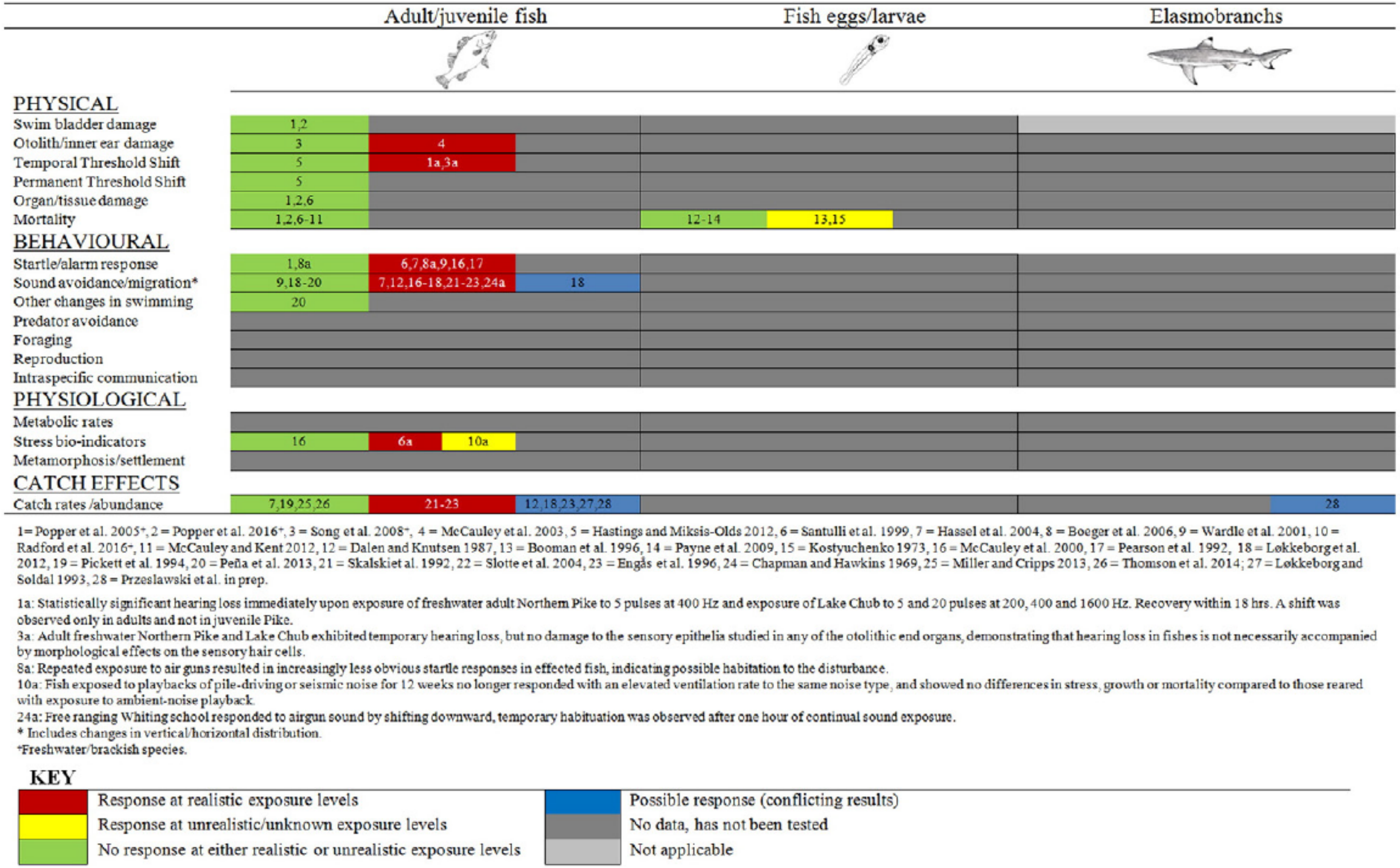
Fish: Available scientific literature has demonstrated no direct mortality of adult fish in response to airgun emissions under field operating conditions (DFO, 2004b; Carroll et al., 2017; Popper et al., 2014; Popper et al., 2016). DFO (2004) notes that for some MSS, fish kill detection programs has been undertaken by 'follow-on vessels' instructed to watch for fish kills resulting from seismic and none have been observed. Fish deaths have been reported during cage experiments (Hassel et al., 2004) however these fatalities occurred as a result of the study methodology where a closing jaw of the grab sampler injured fish rather than an acoustic impact. Within this study no significant difference in mortality was observed between control and exposed sandeel groups (demersal Type I fish) from a 3090 in^3 acoustic array of source pressure 256.9 dB re 1µPa (PK) (vertical) and 247.7 dB re 1µPa (PK) (broadside) in approximately 54 m water depth (Hassel et al., 2003).

For free-swimming pelagic fish which can move away from acoustic sound sources as they approach, the potential for lethal physical damage from airgun emissions is further reduced. Reef or demersal fish, particularly those which show greater site attachment, may be less inclined to move away from acoustic sound and may exhibit greater effects. While studies indicate some physical damage and physiological effects are possible, no mortality was recorded.

The following studies support these observations:

- McCauley et al. (2003b) in field trials of seismic gun exposure to caged fish demonstrated some damage to the sensory hair cells of the pink snapper (*Pagrus auratus*) (a demersal fish) which increased for at least 54 days post exposure. There was no evidence of repair or replacement up to 58 days of exposure. The captive fish were located 5-15 m from the operating array (at the airgun's closest approach) with a source level of 222.6 dB re 1µPa (PK-PK) or 203.6 dB re 1µPa (SPL). No mortalities or physiological changes to blood cortisol/glucose levels were observed and functional hearing was not tested. Study limitations include the caged nature of the study (the monitoring video suggested that fish would have fled the source if possible). The impact of exposure on the survival of fish was also unclear.
- Boeger et al. (2006) observed coral reef fish in enclosures before during and after seismic source exposure to a 635 in^3 airgun source (source pressure of 196 dB re 1µPa (PK)) at a distance varying from 0-7 m. Despite the severe conditions the experiments did not result in mortality or obvious external damage.
- Wardle et al. (2001) exposed marine fish (juvenile saithe, juvenile cod (demersal), adult pollock (demersal) and mackerel (pelagic)) received pressure levels of 229 dB re 1µPa PK (@ 1.5m) and 218 dB re 1µPa (PK) (@ 5.3 m) using a triple G. air gun and detected little effect on the "day–to–day" behaviour of resident reef fish. The fish were not restricted inside field enclosures. The fish did not show any signs of movement away from the reef nor was any mortality recorded. Received sound is above the Popper et al (2014) mortality thresholds.
- Popper et al. (2005) exposed three caged fish (northern pike (demersal), broad whitefish (pelagic) and lake chub) to a 730 in^3 array varying in distance from 13 – 17 m from the cage with received levels from 205.2 dB re 1µPa (PK) to 209.9 dB re 1µPa (PK). Fish anatomy post exposure did not show any effect, swam normally post exposure and all fish held for 24 hours post exposure survived with no apparent adverse effects.
- Song et al., (2008) exposed three fish species to 5 or 20 pulses from a 730 in^3 airgun array with the mean received sound per shot from 205 to 209 dB re 1Pa (PK). There was no damage to the sensory epithelia in any of the otolithic end organs in any of the fish species exposed, however the adult northern pike and lake chub exhibited TTS demonstrating that hearing loss in fish is not necessarily accompanied by morphological effects on the sensory hair cells.
- Santulli et al (1999) exposed caged European sea bass (*Dicentrarchus labrax*) (demersal) to a moving seismic airgun array of volume 2500 in^3 with a source of ~ 256 dB re 1µPa (PK) with a 180m minimum distance between fish and seismic source. The received sound was not reported but were estimated to be approximately 195 dB re 1µPa^2.s (SEL). There was an absence of mortality or physiological damage during and 24 hours after the test, however biochemical stress responses as measured by serum adenylates, cortisol, glucose, and lactate levels were observed. The was a decrease in serum adenylates and elevated levels of cortisol, glucose, and lactate returned to pre-exposure levels within 72 hr of exposure.

Figure 7-9: A summary of potential impacts to low-frequency seismic sound on fish. Impacts are classified according to the sound exposure treatments as realistic (i.e. short-bursts of low frequency sound at a distance of >1-2m) or unknown/unrealistic (i.e. long duration and/or short distance of < 2m to sound source, nearby sound exposure in aquaria) (Carroll et al, 2017)



- Woodside's Maxima 3D MSS at Scott Reef in 2007 evaluated the impacts of dual airguns each with a total capacity of 2055 in^3 with a source of 220-240 dB re 1 μPa^2.s @ 1 m (SEL) on reef fish. Target fish species utilised within experiments included the: blue-green damselfish (*Chromis viridis*) - non-fleeing, Type II fish; bluestripe seaperch (*Lutjanus kasmira*) - fleeing, Type II fish; sabre squirrelfish (*Sargocentron spiniferum*) - non-fleeing, Type II fish; pinecone soldierfish (*Myripristis murdjan*) - non-fleeing, Type III fish; and miscellaneous species from the Family *Holocentridae*, primarily from the genus *Sargocentron*. Results on fish pathology, physiology and hearing sensitivity identified the following (Woodside, 2012b):
    - *Hair cell damage*: There was a significantly greater level of damaged hair cells on fish that had been exposed to airgun sound. This damage was marginal (i.e. involved only small numbers of hair cells) and appeared to be confined to one treatment group. There was no apparent or statistically significant trend in epithelia damage with cumulative SEL or fish grouping. These results implied << 1% of hearing capability was likely to have been impaired in the species tested. While minor damage in exposed fish was evident after initial exposure to airgun noise emissions, the damage appeared to have been repaired 60 days after exposure.
    - *Clinical and pathological damage*: No structural abnormalities or tissue trauma/lesions commonly associated with high intensity noise emissions were found. Ulcerative and necrotising lesions and mortalities were observed in some experimental and control subjects, but these were attributed to myxobacterial infection in some of the test fish unrelated to the experimental sound exposures.
    - *Auditory Brainstem Response (ABR) of fish hearing sensitivity:* No significant differences in auditory thresholds were found among exposure groups, or between exposure groups and baseline or control thresholds, at any test frequency for the bluestripe sea-perch or the pinecone soldier-fish. The pinecone soldier-fish (Type III fish) did not exhibit any TTS within the first six hours after receiving airgun noise emissions at the highest exposure level (cumulative SEL of 190 dB re: 1 μPa^2-s).

Other studies undertaken at lower received levels than the Popper et al. (2014) guideline thresholds showed no mortality impacts (Radford et al, 2016; Dalen and Knutsen, 1987).

<u>Elasmobranchs (Sharks):</u> Sharks and rays differ from bony fish in that they have no accessory organs of hearing (i.e., a swim bladder) and therefore are unlikely to respond to the pressure component of the sound field (Myrberg, 2001). Elasmobranchs sense sound via the inner ear and organs and as they lack a swim bladder it is thought that only the particle motion component of acoustic stimuli is detected (Myrberg, 2001). Elasmobranchs have the highest sensitivity to low frequency sound (~20Hz to 1500 Hz) particularly in the range 100-150 Hz and can respond to a low frequency source from a distance of up to 250 m (Myrberg, 2001) with evidence suggesting that pelagic species have more sensitive hearing (thresholds at lower frequencies) than demersal species (Carroll et al., 2017). However, studies have only been conducted on a small number of species to date and the hearing sensitivities are generally very poorly understood (Carroll et al, 2017).

Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1 μPa above background ambient noise levels) when approaching within 10 m of the sound source. Free ranging sharks are attracted to sounds possessing specific characteristics – irregular pulse, broadband frequency and transmitted with a sudden increase in intensity (i.e. resembling struggling prey). At very loud levels an elasmobranch can discriminate between sounds based upon the phased difference between particle motion and acoustic pressure (Lobel, 2009).

The US Navy observed that coastal and oceanic sharks (18 species) would often approach underwater speakers broadcasting low-frequency, erratically pulsed sounds as far away as several hundred meters. A sudden onset loud (20-30 dB above ambient) sounds played when a shark approached would result in startling the shark and it would turn away from the area. In most cases involving attraction and repelling, the sharks would habituate to the stimuli after a few trials (Casper et al, 2010). The available evidence indicates sharks will generally avoid seismic sources, so the likely impacts on sharks are expected to be limited to short-distance and short-term behavioural responses, such as avoidance of waters around the operating seismic array (Carroll et al, 2017).

There is a dearth of information worldwide on the effects of sound on sharks and rays. For the purposes of this assessment sharks are considered as fish without swim bladders (Type 1 fish)
3D Oil considers that the Popper et al. (2014) threshold of 213 dB re 1µPa (PK) for elasmobranchs and 207 dB re 1µPa (PK) for fish with swim bladders suitable, justifiable and conservative thresholds for the Dorrigo MSS to assess for possible mortality (including injury levels leading to mortal impact through stress responses).

<u>Extent and duration of exposure and Identified Potential Impact</u>:

Modelling Results:
Acoustic sound modelling results for the Dorrigo MSS, measured in PK metrics for possible mortality, mortal injury or recoverable injury are provided in **Table 7-16**. The SEL_{24hr} metric associated with possible mortality, potential mortal injury, and recoverable injury to fish from Popper et al. (2014) was not reached. As per the Popper et al (2014) criteria, the PK metric is applied to assess for possible impacts to fish. Popper et al. (2014) identifies one major difference between the basis of the mortality threshold, pile driving studies, and seismic airguns is that it is harder to determine SEL_{24hr} for airguns as received SEL changes from shot to shot due to vessel movement and varying distances of the source to the fish. On this basis, utilising the PK guideline is potentially more useful. Modelling was performed at one site representative of the bathymetry of the Dorrigo MSS and in the shallowest water (worst case) hence calculated distances are conservative.

Table 7-16: Maximum (R_{max}) horizontal distances from the 3260 in^3 array to modelled seafloor PK. A dash indicates the threshold was not reached (Warner et al., 2018)

Type of Animal	Mortality, Potential Mortal Injury or Recoverable Injury	Distance R_{max} (m)
		Site 2 (105m)
Type 1 Fish: no swim bladder (particle motion detection)	> 213 dB PK	76
Type 2 Fish: swim bladder is not involved in hearing (particle motion detection)	> 207 dB PK	191
Type 3 Fish: swim bladder involved in hearing (primarily pressure detection)	> 207 dB PK	191

<u>*Specific Dorrigo MSS Fish and Elasmobranch Sensitivities*</u>:

The NCVA (DoEE, 2018b) identifies the Dorrigo MSS area as a known distribution BIA for the white shark in coastal, shelf and upper slope waters (to 1000 m isobath) reflecting use by the species, particularly juveniles, as they move between nursery areas opportunistically feeding in autumn, winter and spring. White sharks have a broad global distribution and are found in low densities in coastal and offshore waters of most temperate and some tropical seas. In Australia they are likely to occur in all EEZ water adjacent to their coastal distribution in Australia (DoEE, 2018b).

There are no spatially defined fish-related KEFs within the Dorrigo MSS area.

The Dorrigo MSS also overlaps commercial fisheries. This includes the Commonwealth trawl sector (demersal fish) and GHaT sector (shark and demersal scale-fish).

Predicted Mortality, Potential Mortal Injury and Recoverable Injury Impacts:
Modelling predicts for fish with a swim bladder (i.e. Type 2 or 3 fish), mortality, potential mortal injury, and recoverable injury effects might be expected in continental shelf waters within a maximum horizontal distance of 191 m from the operating array. For fish species, the calculated affected area[45] where the array is at full power is approximately 1625 km^2 (or 4.3% of the Otway bioregion) over a 35-day period or 46 km^2 per day (0.1% Otway bioregion per day). Spatially, affected fish populations are expected to be small on a bioregional basis given there is no presence topographical features leading to fish aggregations within the Dorrigo MSS area.

Modelling predicts for fish without a swim-bladder (e.g. sharks, Type 1 fish) mortality or recoverable injury sound thresholds might be expected within a maximum horizontal distance of 76 m from the operational array. For Type 1 fish species present, the affected area within the Dorrigo MSS is 647 km^2 or 1.7% of the Otway bioregion or 18.4 km^2 per day (0.05% Otway bioregion per day). Affected populations within this area are expected to be very localised (on a bioregional basis).

Fish and elasmobranch mortality, potential mortal injury, and recoverable injury is very unlikely within the Dorrigo MSS area given the following scientific study observations and local conditions:

- Available scientific literature has demonstrated no direct mortality of adult fish in response to airgun emissions under field operating conditions (DFO, 2004b; Carroll et al., 2017; Popper et al., 2014; Popper et al., 2016);
- The area affected by sound levels sufficient to cause mortality or recoverable injury is localised in a bioregional context (Type 1: 1.7% bioregion and Type 2/3: 4.3% bioregion over 35 days) and has been conservatively estimated. The adopted sound thresholds to determine impact are derived from impulsive pile driving studies as isopleths for mortality from seismic have not been observed/measured (Popper et al, 2014). Popper et al (2016) has since shown that seismic sound higher than the adopted thresholds does not result in "mortality, potential mortal injury and recoverable injury" in fish species;
- *Elasmobranchs*: Injury in shark species are considered remote given their:
    - Biology (i.e. no swim bladder), their observed response to sound through near-field particle motion (Myrberg, 2001; Klimley & Myrberg, 1979; Casper et al, 2010) and their unlikely potential to remain close enough to the operational source to suffer physical injury or changes in hearing. Additionally, there are no documented cases

[45] For the Dorrigo MSS the affected distance is based on a total survey line length of 4255 km (refer Table 7.7) and a 191m buffer around each of these survey lines.

of mortality in the more 'sound-sensitive fish' types (i.e. with swim bladders) from seismic exposure under experimental or field conditions (Carroll et al, 2017); and

- Distribution which is widespread for the EPBC-listed shark species having habitat within the Dorrigo MSS area (Last and Stevens, 2009). White sharks are generally observed between the coast and the 100 m depth contour (Bruce et al, 2006) with frequent encounter around seal colonies particularly when juveniles are present (EA, 2002). The Dorrigo MSS is located ~44 km from the nearest seal colony (Reid Rocks) and temporally does not significantly overlap the seal pupping period (late October to late December) (Shaughnessy, 1999; Warnecke, 2005).
- The Dorrigo MSS area does not lie in proximity to any white shark breeding or juvenile aggregation areas (DoEE, 2018b) and early lifecycle stages are not expected to be affected by survey operations.

- *Pelagic fish* present on the continental shelf are wide-ranging and likely to move from areas of high sound (Slotte et al, 2004; Carroll et al, 2017 - *refer also behavioural effects*). Injury impacts might occur if an acoustic array commences at full power adjacent to the fish. In reality, soft-start procedures allow for the detection of increasing sound and for displacement of species. It is noted that the lack of significant impacts observed in site attached species in reef habitats (Woodside, 2012b; Boeger et al, 2006; Wardle et al, 2001) supports that pelagic fish displacing from sound disturbance are unlikely to be at risk of mortality or recoverable injury from seismic sound;
- *Demersal/site-attached fish:* The Dorrigo MSS area spatially overlaps KEFs (non-spatially defined shelf rocky reef and hard substrate and west Tasmanian canyons [spatial overlap 0.3% KEF]) and their associated habitats (i.e. sponges) which may support demersal/site-attached fish. These species may be less inclined to move away from high levels of sound and damage to hearing hair cells (McCauley et al, 2003b; Woodside, 2012b) or short-term biochemical stress responses (Santulli et al, 1999) might occur. In this context, sensory hair cells are constantly added in fishes (Popper and Hoxter, 1984; Lombarte and Popper, 1994) and replaced when damaged (Lombarte et al, 1993; Schuck and Smith, 2009). Therefore, impacts to demersal/site-attached fish are expected to be temporary and recoverable in the short-term. It is noted however, the effect of these temporary stressors on fish survival is unclear and they may be more susceptible to predation or other environmental stressors than non-stressed fish through lower fitness depending on the fish life history (Hastings and Popper, 2005).
- *Reproductive success (pelagic/demersal/site-attached species):* As identified in **Section 5.4.4**, most species present in the Dorrigo MSS have spawning periods outside the Dorrigo MSS location/timeframe with eggs/larvae widespread in the marine environment. For fish species which spawn during the Dorrigo MSS period, eggs/larvae area also widespread. As identified in **Section 7.2.3.1** (plankton), scientific studies identify impacts to eggs/larvae occur in close range to the operating array (Kostyuchenko, 1973; Dalen and Knutsen, 1987; Matishov, 1992; Pearson et al, 1994; Boorman et al, 1992; Payne et al, 2009; Cox et al, 2011; Bolle et al, 2012) with low impacts compared to the natural mortality rates for fish larvae of 21.3% per day (Houde and Zastrow, 1993; cited in Fuiman and Werner, 2002).
- *Commercial/Recreational Fish impacts (Indirect Impact):*A conservative assessment of possible commercial fishery (biomass) impacts (pelagic and demersal) from the Dorrigo MSS, assuming impacts lead to mortality in the area for active fisheries within the MSS area is provided in **Table 5-22** and **Table 5-25**. On this conservative basis, possible impacts to commercial stock identify that the fishery 'take' together with the estimated 'stock affected by the Dorrigo MSS' do not exceed the TAC/TACC for the fishery. On this basis, impacts

to fish stock (including shark) from Dorrigo MSS activities is not expected to affect fish stock sustainability. While this assessment relates to key commercial and recreational species, the assessment is also considered valid for other non-target non-commercial species which have a similar widespread distribution across the OA. These species are considered to have less sustainability pressure as they are not the subject of a commercial/recreational catch placing additional pressure on the fish biomass (i.e. stock biomass carries less sustainability threats).

Summary:
Consequence:

- *For shark species*: Impacts are expected to be localised, temporary displacement around the operating array recoverable within very short timeframes (Negligible consequence).
- *For pelagic fish:* Impacts are expected to be localised, and temporary displacement around the operating array which is recoverable within very short timeframes (Negligible consequence).
- *For demersal fish*: Recoverable injury impacts might be found in the fish which are exposed to these high sound levels. Impacts are localised, with short-medium term effects but with full recovery expected (Minor Consequence).

Temporary Threshold Shifts (ecological assessment)

Available Research:
TTS, as defined in the Popper at al. (2014) guidelines, is the temporary reduction in hearing sensitivity caused by exposure to intense sound. TTS has been demonstrated in some fish with variable magnitude and duration. TTS results in temporary changes to the sensory hair cells of the inner ear and/or damage to the auditory nerve. Sensory hair cells in fish are constantly added and replaced hence effects may be mitigated over time additional hair cells (Popper et al, 2014). After sound termination which causes TTS, normal hearing returns over time dependent on the sound exposure (intensity & duration). While in a TTS condition, fish may have decreased fitness in terms of communication, detecting predators or prey and assessing their environment.

Guideline thresholds for TTS developed by Popper et al. (2014) are based upon exposure of several riverine species to a variable number of seismic array pulses over five minutes with a SEL_{24hr} of 186 dB re 1 µPa^2.s (Popper et al., 2005). This exposure in caged outdoor tanks resulted in up to 20 dB of TTS loss in the lake chub (*Couesius plumbeus*) with a maximum TTS loss at 200 Hz and 400 Hz (species has a connection between the swim bladder and inner ear). Approximately 20 dB of TTS occurred at 400 Hz in adult northern pike (*Esox lucius*), a species that does not have such a connection. TTS did not occur at other frequencies. Another species without a connection between the ear and swim bladder, the broad whitefish (*Coregonus nasus*), showed no TTS to sounds after exposure at the same level. These effects were seen only in adults and not juvenile pike. In all cases fish with TTS recovered to normal hearing levels in 18-24 hours (Popper et al., 2005).

As identified in **Table 7-15**, Popper et al., (2014) recommends a threshold of >>186 dB re 1µPa^2.s SEL_{24hr} for fish with no swim bladder (e.g. Type 1 fish, elasmobranchs) and for fish with a swim bladder which is not involved in hearing; and for fish with a swim bladder involved in hearing a threshold of 186 dB re 1µPa^2.s $SEL_{24hr.}$ Woodside (2012b) studies are consistent with the Popper et al. (2014) studies, while other studies indicate that TTS may occur at levels as high as 205-209 dB re 1µPa (PK) (Song et al, 2008; Popper et al., 2005).

Extent and Duration of Exposure and Identified Potential Impact:

Modelling Results:
Table 7-17 provides results for the maximum range and area affected by TTS sound criteria. TTS in fish is predicted to occur within a horizontal radius of 5.05 km from the operating array for pelagic species (i.e. maximum over depth) and 3.58 km of the operating array for seabed (demersal) receptors. In any 24-hr period, ensonification, sufficient to cause TTS, of 1100 km^2 (2.9% Otway bioregion) for demersal species and 1550 km^2 (4.1% Otway bioregion) for pelagic species is predicted.

Table 7-17: Modelled distances and areas ensonified to SEL_{24hr} Recoverable Injury and TTS criteria (Warner et al. 2018)

Criteria	SEL_{24hr} Isopleth (dB re 1µPa^2.s)	Location	Rmax(km)	Area (km^2)
TTS	186	Maximum-over-Depth	5.05	1550
		Seafloor	3.58	1100

Specific Dorrigo MSS Sensitivities:

BIAs: The NCVA (DoEE, 2018b) lists a low-level abundance distribution BIA for the white shark. The species is generally observed between the coast and the 100 m depth contour (Bruce et al, 2006) and seal colonies when juveniles are present (EA, 2002). No other fish-related BIAs are nominated.

Spatially-defined fish-related KEFs: No spatially defined KEFs supporting demersal or pelagic fish species are identified within the Dorrigo MSS area.

Predicted Impacts: The following broad conclusions can be drawn about acoustic sound exposure to fish and elasmobranchs regarding TTS impacts:

- The Dorrigo MSS design consists of "racetracks" with the longest lines (~100 km) expected to take 12+ hours and the shortest lines (~31 km) expected to take 4+ hours before any sequential lines, located 10 km apart are acquired. Any site-attached/demersal species within a distance of 3.58 km from the operational array for a period of 24 hrs, may experience TTS (2.9% Otway bioregion). Site-attached/demersal species are generally less mobile than pelagic species. More realistically, fish would not stay at the same range for 24 hours, particularly given the constant movement of the vessel at 8.1 km/hr (4.5 nm/hr) and the survey "racetrack" design. The reported radius for a 24 hr SEL criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather the animal could be exposed to a sound level associated with injury if it remained in that range for 24 hours (Warner et al, 2018).
- Pelagic species present in the Dorrigo MSS area, are likely to displace from areas of high sound (Slotte et al, 2004; Carroll et al, 2017) limiting TTS potential. In addition, the constant movement of the MSS vessel and small area affected (4% of Otway bioregion) over each 24-hr period, TTS in pelagic species within the MSS area is very unlikely.
- Species experiencing TTS may suffer from decreased fitness in terms of communication, detecting predators, obtaining prey and assessing their environment (Popper et al, 2014).

This may lead to increased predation or foraging impacts however TTS effects are temporary and fully recoverable (Popper et al, 2014).

- Fish with TTS recovered to normal hearing levels in 18-24 hours (Popper et al., 2005; Popper et al, 2014). The US National Marine Fisheries Service (NMFS) applies a resetting of SEL_{cum} after 12 hours of non-exposure (Stadler and Woodbury, 2009; in Popper & Hawkins 2012).
- The Dorrigo MSS area is not located in BIAs are present for aggregating fish or elasmobranchs (DoEE, 2012b). Species present are wide-ranging across the Otway bioregion.

On the basis of this assessment TTS impacts to fish and elasmobranchs is very unlikely, with any TTS impacts temporary and recoverable.

<u>Summary:</u>

Consequence:

- *For pelagic fish/shark species*: TTS impacts are very unlikely due to species sound displacement from source, the localised nature of impact and the temporary and recoverable nature of TTS (Negligible Consequence).
- *For demersal fish/shark species*: TTS impacts are possible but limited and localised due to the design of the survey. TTS is temporary and full recovery would be expected over a short timeframe (~hrs) (Negligible Consequence).

Behavioural impacts (ecological assessment)

Available Research:

Behavioural sound thresholds for fish have not been established due to limited and varying scientific data and the specific nature of behavioural responses amongst fish species which is context specific (i.e. one threshold does not fit all). Behavioural responses are observed to vary by species, size, age class and motivation and may be linked to the circumstances of the animal, the activities in which it is engaged and the context in which it is exposed to sounds (Pena et al., 2013; Ellison et al, 2016). Behavioural effects are considered more likely than physical and physiological effects at lower sound levels and may provide a more useful indicator of sound impacts over a large spatial scale. Behavioural responses to sound are variable but include:

- Startle/alarm responses;
- Leaving the area of the sound source (avoidance);
- Spatial changes in schooling behaviour/swimming patterns;
- Changes in depth (vertical distribution).

These effects are expected to be short-lived, with duration of effect less than or equal to the duration of exposure, are expected to vary between species and individuals, and be dependent on the properties of received sound (DFO, 2004b). The ecological significance of such effects is expected to be low, except where they may influence a dispersion of spawning aggregations or deflections in migration paths, however, the magnitude of effects will be dependent on the biology of the species and the extent of the dispersion or deflection (DFO, 2004b).

Studies identify that a sudden onset of sound may cause a startle response in fish. This has also been observed by Myrberg (2001) where elasmobranchs can withdraw immediately if sound intensity suddenly increases by 20 dB re 1µPa (10 times) or more above the previous transmission close to a sound source. However, it is also noted that behavioural response studies for elasmobranchs are limited. Bruce et al (2018) in their Gippsland Basin study during a MSS, monitored the displacement of the gummy shark and saw-shark from the survey area during survey activities. Tagged sharks were observed to move out of the monitoring area but this was largely prior to the commencement of the survey. Individuals of both shark species were observed to move in and out of the monitoring area through the study period, and two gummy sharks returned to the monitoring zone during the MSS.

Startle responses have also been observed in captive fish however sound thresholds have been shown to vary amongst species. For example:

- Pearson et al. (1992) identified for caged olive and black rockfish (*S. serranoides* and *S. melanops*), a startle response threshold was between 200 and 205 dB re 1µPa (PK). Other rockfish species also responded to sound at different thresholds with the general threshold for alarm responses at 180 dB re 1µPa (PK) and more subtle responses at 161 dB re 1µPa (PK) based upon regression analysis.
- McCauley et al. (2000b) found a common fish 'alarm' response (swimming faster, swimming to the bottom, tightening of school structure) at sound exposures of 161-166 dB re 1µPa (SPL) at 2 – 5 km from the operating seismic airgun.
- Caged European sea bass exhibited a startle response to an approaching seismic source at 2500 m (i.e. a few individual fish) and at 800 m a larger proportion of fish also exhibited this behaviour. After exposure, and with the source at 1 nm, startle responses were no longer evident and within 1 hr the fish were reoriented with stream flow (Santulli et al., 1999).
- Woodside's Maxima 3D MSS studies on caged fish at Scott Reef observed alarm responses and agitation in all four-caged species when passed by the seismic airgun. Alarm responses (including startle responses) were too infrequent to analyse. Agitation levels increased with increasing exposure, at 155-165 dB re 1µPa^2.s (SEL), for three of the caged species, but were not detected for one species the bluestripe perch (Woodside, 2012b).

Collectively, caged studies provide an indication of acoustic and environmental conditions where fish may show behavioural responses to seismic noise, but captive fish may have little or no resemblance to response in open conditions. Behavioural studies on unrestrained fish exposed to airguns sound are scarce. Wardle et al. (2001) observed free ranging fish behaviour (primarily juvenile saithe, adult pollock, juvenile cod, and adult mackerel) on a reef system exposed to operating airguns (195-218 dB re 1µPa (PK)). Fish exhibited startled responses to received levels but no avoidance behaviours were observed. Fish did not move away from the reef in response to sound, and their diurnal rhythm appeared unaffected. When the source was placed on the seabed (depth 14 m) visible to the fish, fish were seen to turn and flee during airgun shots. When the source was suspended midwater (5 m depth) and just outside visible range, the fish exhibited a C-start and then continued to swim towards the source position, their intended swimming track apparently unaltered.

Woodside's Maxima 3D MSS studies on free swimming fish at Scott Reef observed that the species type, their abundance and behaviour had only immediate and short-term effects with no lethal or sub-lethal effects near the operating array. At close range, 50-240 m, the airgun sounds appeared to cause a prominent, short-term effect on fish behaviour with the fish ceasing normal behaviours and moving downward from the water column to the seabed. Fish began to feed and behave normally within 20 minutes after the passage of the vessel. Once the vessel had travelled beyond ~1.5 km, fish numbers and behaviour returned to baseline levels (Woodside, 2012b).

Changes in depth distribution due to acoustic exposure has been observed in studies which may indicate vertical rather than horizontal movement could be a short-term reaction to seismic sound:

- Chapman and Hawkins (1969) observed a changed depth distribution of free-ranging whiting (*Merluccius bilinearis*) expose to an airgun at estimated received sound levels of 178 dB re 1µPa (SPL). The fish shifted vertically to a depth of ~ 55 m where they formed a compact layer. Habituation to sound was observed after 1 hour of exposure.
- Pearson et al. (1992) observed on sound exposure, caged blue rockfish (*S. mystinus*) milled in increasingly tighter schools of black rockfish collapsing to the bottom of the cage. Vermilion (*S. miniatus*) and olive rockfish formed stationary schools near the bottom of the cage and on sound exposure either rose in the water column or moved to the bottom and became almost motionless. All species returned to pre-exposure behaviour within 20-60 minutes of sound ceasing.
- Slotte et al (2004) examined effects on pelagic fish abundance (herring, blue whiting and mesopelagic species) from a seismic airgun array (source 222.6 dB re 1µPa (PK-PK)) prior to and after seismic transect acquisition. No difference was found indicating seismic operation had insignificant short-term scaring effects, however blue whiting and mesopelagic species were found approximately 10 m and 50 m deeper respectively during periods of seismic acquisition.
- Fewtell and McCauley (2012) assessed impacts of sound on captive trevally (*Pseudocaranx dentex*) and pink snapper (*Pagrus auratus*)) from a single airgun of source 192 dB re 1µPa^2.s (SEL) with received sound ranging from 120-180 dB re 1µPa^2.s (SEL). Changes to the caged trevally schooling behaviour and vertical positioning commenced at 147-151 dB re 1µPa^2.s (SEL) where the fish were observed to swim faster and form more cohesive groups towards the bottom of the cage. The pink snapper also moved to the lower section of the cage, however loose cohesive groups were observed more often during the exposure to noise. Pink snapper appeared to habituate to the sound compared to trevally.
- Woodside (2012b) detected via sonar at Scott Reef during MSS activities that free-swimming fish tended to move lower in the water column on approach of an operating array consistently out to 400 m of either side of the survey test line. Within 200 m of the survey test line, fish schools moved to the seabed after passage of the operating airgun array and stayed significantly closer to the seabed out to 63 minutes post exposure.
- Przeslawski et al. (2016a) observed tagged tiger flathead which increased their swimming speed during the survey period and changed diel movement patterns after the survey but showed no significant displacement. While some flathead departed the survey area, there was no indication this was a result of the seismic survey, with the fish which departed possibly reflecting an impending movement away from the area as part of a normal seasonal cycle (Bruce et al, 2018 (In press)).

Masking: Masking impairs an animal's hearing with respect to the relevant biological sounds normally detected within the environment. In effect, masking raises the threshold for detection by an animal. While the consequences of fish masking have not been fully examined, long lasting effects on survival, reproduction and population dynamics may result (Popper et al. 2014). Data on hearing for all vertebrates tested to date, including fish, show that the degree of masking relates both to the level of the masking noise and the frequencies it contains. In fish, pure tone sounds are masked most readily by noise at the same and immediate adjacent frequencies, falling within a critical band (Popper et al. 2014).

Masking may occur where a noise exceeds the absolute hearing thresholds of an animal and is likely to occur for most fish at some locations due to the varying level of background noise in all aquatic environments. Data on masking by seismic airguns are not available for any species. Masking is possible for the time that fish are exposed to airgun sound and may occur when animals are sufficiently far from the source where sounds merge and become more or less continuous (Nieukirk et al. 2004). Popper et al. (2014) surmised that "*It is likely that increments in background sound within the hearing bandwidth of fish may render the weakest sounds undetectable, render some sounds less detectable, and reduce the distance at which sound sources can be detected. Energetic and informational masking may increase as sound levels increase, so that the higher the sound level of the masker, the greater the masking*".[46] However, masking only occurs while the interfering sound is present, and therefore masking resulting from a single pulse of sound (such as an airgun shot) or widely separate pulses would be distinguishable and unlikely to significantly affect an individual's overall fitness and survival.

<u>Extent and Duration of Exposure and Identified Potential Impact:</u>

There are no recommended exposure criteria for fish behaviour or masking. The expert working group into sound impacts to fish (Popper et al. (2014)) found no sufficient data trends to recommend behavioural or masking sound thresholds and instead recommended "relative risk" criteria to determine masking and behavioural effects (refer **Table 7-15**). This qualitative criterion describes risk potential for the observed behaviour or masking at distances relative to the source. The ranges, relative to the source, were quantified as **near** (within tens of meters); **intermediate** (within hundreds of metres) and **far** (in thousands of meters). Based upon Popper et al. (2014) and the studies assessed, behavioural response is likely near the seismic source with diminishing responses further from the source. Behavioural effect in the context of this risk criterion is defined as "*substantial change in behaviour for the animals exposed to a sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements*".[47]

[46] Popper et al (2014) p18

[47] Popper et al (2014) p36

Predicted Impacts:
Based upon the available behavioural scientific literature, the following broad conclusions can be drawn about behavioural responses in fish when expose to acoustic sound:

- High levels of sound can elicit various types of behavioural responses, some of which may negatively affect a population (reduced rate of foraging or predator avoidance) and others which may pose no overall risk (e.g. startle response) (Carroll et al, 2017). The degree of behavioural response to acoustic sound varies by species, age and motivation and is linked to the particular circumstance and environmental context of the affected animal (Pena et al, 2013; Ellison et al, 2016).
- A range of wild-fish behavioural responses to man-made sound has been observed. Some fish have shown change in swimming behaviour and orientation, including startle reactions (Pearson et al. 1992; Wardle et al. 2001; Hassel et al. 2004). The response may habituate with repeated presentations of the same sound. Sound can also cause changes in schooling patterns and distribution (Pearson et al. 1992). For example, the horizontal and vertical distributions of both pelagic and demersal fishes were altered during and after airgun operations (e.g., Dalen and Knutsen 1987; Engås et al. 1996; Engås and Løkkeborg 2002; Slotte et al. 2004; Løkkeborg et al. 2012 a, b).

Within the context of the Dorrigo MSS activities, the following behavioural impacts (direct and indirect) to marine species may be observed:

- *Sharks*:
  Popper et al (2014) identified the behavioural response to sound for fish without swim bladders (i.e. elasmobranchs) **near** the acoustic source is high with a low risk of behavioural response at **far** distances. Shark species are known to respond via the lateral line to the relative motion between its body surface and surrounding water (Popper et al, 2014). This relative motion detection takes place very close to the sound source where there is a steep gradient of sound pressure and particle motion and the operational range of the lateral line is usually restricted to no more than one or two body lengths away from the source (Popper et al. 2014). This impact has the following implications within the Dorrigo MSS area:
  - Behavioural responses/change in shark species is predicted only in close proximity to the operational array (Popper et al, 2014), consistent with evidence of shark bites on hydrophone cables in proximity to the source array (McCauley et al, 1994) and responses to sudden sound increase close to sound sources (Myrberg, 2001). Ensonified areas affecting behaviours will be localised and temporary in any one location given the movement of the survey vessel.
  - Sharks are wide-ranging within the Otway bioregion and the subsumed Dorrigo MSS area with no aggregation areas (e.g. pinniped colonies) present in proximity to the MSS area (Shaughnessy, 1999). The proportion of shark population affected by behavioural change within the Dorrigo MSS over the period of the survey (35 days) is small on this basis (4.2% of Otway bioregion).
  - Behavioural effects are expected to be short-lived, with duration of effect less than or equal to the duration of exposure (DFO, 2004b).
  - White shark exposure to sound levels causing behavioural disturbance is expected to be low given the species is generally observed in coastal areas to the 100 m depth contour (Bruce et al, 2006) and near seal colonies when juveniles are present (EA, 2002). The shallowest depth of acquisition in the Dorrigo MSS is 100m and temporal overlap of the survey is prior to the pupping season (mid-October to January).

- *Pelagic Fish Species*:
  Pelagic Type 3 fish (most sensitive species with swim bladder connected to hearing – e.g. sardines, herring) have a higher risk of behavioural response to the array at near/intermediate distances (tens/hundreds of metres) and a moderate risk of behavioural response at thousands of meters (Popper et al, 2014). This impact has the following implications within the Dorrigo MSS area:
  - Behavioural impacts in pelagic species have been shown to be short-term (Slotte et al, 2004; Woodside, 2012b) and localised (Pena et al, 2013; Woodside, 2008b);
  - Pelagic fish present during the survey are wide-ranging in the Otway bioregion and the subsumed Dorrigo MSS area with no aggregation areas identified in the MSS area. The proportion of the pelagic fish population affected by short-term and localised behavioural change within the Dorrigo MSS over the period of the survey (35 days) is small on this basis (4.2% of Otway bioregion);
  - The Dorrigo MSS is not recognised as significant for pelagic species as the area does not spatially overlap any pelagic species KEFs (DoEE, 2018b) or pelagic commercial fisheries (refer **Section 5.7.5**). On a comparative basis with other commercial fishing areas, pelagic species numbers affected within the Dorrigo MSS area is expected to be small (i.e. no significant population exposed to survey operations).

- *Demersal/Site-attached Fish Species*:
  Demersal Type 2/3 fish may also have a moderate risk of behavioural response at thousands of meters from the operational array (Popper et al, 2014). This impact has the following implications within the Dorrigo MSS area:
  - Behavioural impacts have been shown to be localised and temporary within demersal fish species (Chapman and Hawkins, 1969; Przeslawski et al, 2016a; Wardle et al, 2001) and in site-attached species during MSS activity (Millar and Cripps, 2013; Woodside, 2012b). Fish species were observed to either return to pre-exposure behaviour within a short-period of the MSS activity ceasing (Pearson et al, 1992; Woodside, 2012b) or experienced habituation to the sound after a short period of exposure (Chapman and Hawkins, 1969; Fewtrell and McCauley, 2012).
  - Demersal and site-attached fish present in the MSS area are widely represented in the Otway bioregion and the subsumed Dorrigo MSS area with no specific topographical features within the Dorrigo MSS leading to fish aggregations. The proportion of the pelagic fish population affected by short-term and localised behavioural change within the Dorrigo MSS over the period of the survey (35 days) is small on this basis (4.2% of Otway bioregion)
  - The Dorrigo MSS area does not spatially overlap any spatially-defined demersal fish KEFs (e.g. ancient coastline) (DoEE, 2018b);
  - Spatial overlap with active commercial demersal fisheries is confidential (i.e. low-level) in nature except for the southern shelf-break location where there is low intensity CTS fishing (refer **Section 5.7.5**). On a comparative basis with other commercial fishing areas, demersal species affected within the Dorrigo MSS area is expected to be small (i.e. no significant population exposed to survey operations).

Masking: Popper et al. (2014) risk criteria identifies a low risk of masking in all fish types at near and intermediate distances from the operating array, however at greater distances (~kms) there is a moderate risk of masking in Type 3 fish species. If masking did occur, mechanisms have been found in terrestrial animals and marine mammals which reduce the masking effect (i.e. 'masking-release' mechanisms) including: spatial or temporal release from masking, within-valley ('dip' – i.e. quieter gaps) listening or comodulation masking release (Erbe et al., 2016).

Given the oceanic nature of the Dorrigo MSS area, the widespread area occupied by fish, the short-term nature of the Dorrigo MSS and the constant movement of the survey vessel, effects in any one area are localised and temporary with rapid recovery after survey completion.

Summary:

- *Behaviour (Elasmobranchs):* Impacts to sharks are expected to have negligible, localised and temporary impacts around the operational array (Negligible consequence).
- *Behaviour (Demersal & Pelagic):* Fish displacement/behaviour modification will be localised, temporary and recoverable around the operational array. The Dorrigo MSS area does not spatially overlap fish aggregation areas or identified spawning locations (Negligible Consequence).
- *Masking (Demersal & Pelagic):* Masking impacts are assessed as low risk for near and intermediate distances from the operating array and medium risk for far distances (~kms) for the most sensitive fish species. This may lead to temporary, localised effects to fish species present in the surrounding environment, effects are recoverable (Negligible consequence).

Commercial Fishing (Catch and Abundance Effects)

The potential impacts of seismic survey activities on commercial/recreational fisheries are:

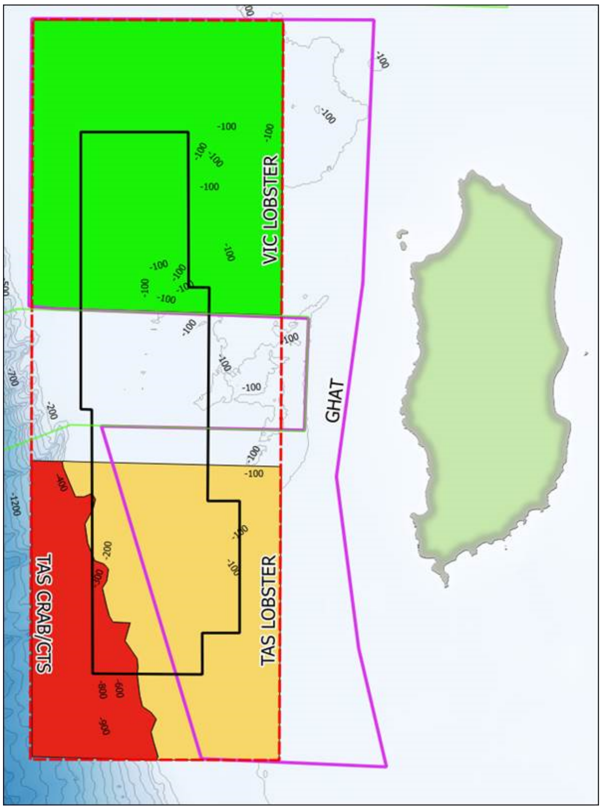
- Localised and temporary exclusion of fishing operators from fishing grounds due to survey activities with the potential for decreases in catch/income (*refer to Section 7.8 – Disruption to Commercial Vessels*); and
- Physiological or behavioural changes in target species resulting in altered catch within fisheries.

Commercial and recreational fisheries which operate within the Dorrigo MSS area, their spatial overlap area, target bathymetry, number of licencees present in the area and seasonality of fishing within the Dorrigo MSS area is summarised in **Table 7-18** and **Figure 7-10**. This information should be read in conjunction with **Section 5.7.4** and **Section 5.7.5**. Note only commercial fisheries which have been identified as actively fishing within the Dorrigo MSS area listed.

Table 7-18: Commercial Fisheries within Dorrigo MSS Area

Fishery	**No Fishers recorded in Dorrigo MSS Area**	**Target Species within Dorrigo MSS Area (SETFIA/Fishwell Consulting, 2018)**	**Demersal / Pelagic**	**Fished Area (bathymetry) overlap with Dorrigo MSS Area (km^2)**	**Target Bathymetry for Species (AFMA, 2018)**	**Fishing Period**
Commonwealth Trawl Sector	6-9 (Since 2008)	Blue Grenadier (T) Silver Warehou (T) Pink Ling (T)	Demersal Demersal Demersal	Acquisition: 85 km^2 Operational Area: 622 km^2	Continental Slope (200-1000 m) Continental Shelf /Slope (50-600 m) Continental Shelf/slope (20-1000 m)	October to March (Effort Highest) February-March (Highest Catch) October (Highest No of shots)
Gillnet Hook and Trap Fishery	18 (Since 2008)	Gummy Shark (T) School shark (T) Pink Ling (T)	Demersal Demersal Demersal	Acquisition: 980 km^2 Operational Area: 2730 km^2 **Note fishery has advised that gillnet fishermen fish inshore of the MSS area near to King Island.**	Continental Shelf/Outer Margin (80-350 m) Continental Shelf /Outer Margin (0-300 m) Continental Shelf/slope (20-1000 m)	September to April (Highest Effort) November to April (Highest Catch)
Squid Jig Fishery	< 5 vessels per annum	Gould's squid (T)	Pelagic	Acquisition: 639 km^2 Operational Area: 1898 km^2	Continental Shelf (50-120m)	January to July (*Fishery is not present during Dorrigo MSS activities*)
Giant Crab Fishery (Victoria)	< 5 vessels per annum	Giant Crab (T)	Demersal	Acquisition: 157 km^2 Operational Area: 497 km^2	Shelf-break (150 to 300 m)	Fishery Open: 15 Nov – 31 May (Females) Fishery Open: 15 Nov – 14 Sept (Males)
Giant Crab Fishery (Tas)	Not Available	Giant Crab (T)	Demersal	Acquisition: 85 km^2 Operational Area: 622 km^2	Continental Shelf (140 to 270 m)	Fishery Open: 15 November – 31 May (Females) Fishery Open: All year (Males) November to May (Highest catch)
SRL Fishery (Victoria)	< 5 vessels per annum	Southern Rock Lobster (T)	Demersal	Acquisition: 306 km^2 Operational Area: 1164 km^2	Continental Shelf (0-150m)	Fishery Open: 15 Nov – 31 May (Females) Fishery Open: 15 Nov – 14 Sept (Males) December-January (Effort Highest)
SRL Fishery (Tasmania)	Not Available	Southern Rock Lobster (T)	Demersal	Acquisition: 756 km^2 Operational Area: 1285 km^2	Continental Shelf (0-150m) Note: Most catch is harvested from water depths < 40 m on coastal reefs (SETFIA/Fishwell Consulting, 2018) (Outside Dorrigo area)	Fishery Open: 15 Nov – 30 April (Females) Fishery Open: 15 Nov – 30 Sept (Males) December-April (Highest Catch)

Figure 7-10: Summary of Commercial Fisheries which overlap Dorrigo MSS area



Relevant Research:
Some effort to relate fishing catch data to MSS effects has been undertaken, but to date none of the Australian efforts to relate catch data with MSS have yielded significant results. Elsewhere, the potential effects of seismic operations on fish distribution, local abundance or catch has been examined for some teleost species with varying results (Carroll et al., 2017).

A range of behavioural responses have been observed wild fish in the presence of anthropogenic sound. Studies suggest that fish will generally move away from a loud sound source to minimise their exposure, but this response may depend upon the animal's motivational state. Anthropogenic sound (including MSS) has been shown to cause changes in schooling patterns and distribution (Engas et al., 1996; Engas and Lokkeborg, 2002; Slotte et al., 2004; Lokkeborg et al., 2012a; Popper at al., 2014; Streever et al, 2016) potentially reducing the availability of commercially valuable species or recreationally targeted species.

The following studies have relevance to fish species with respect to their catchability:

- The effects of a MSS on demersal long-line and trawl catch rates of Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) in Norway after a MSS were shown to fall by 45% and 70% respectively five days after survey completion (Engas et al., 1996). Based upon this decline Engas et al. (1996) hypothesised a reduction in catch rates due to fish avoidance behaviour, but this was not quantified. Similar reductions in catch rates (52% decrease in catch per unit effort (CPUE)) relative to controls) has been observed in the hook-and-line fishery for rockfish during controlled discharges of a single airgun (Skalaski et al. 1992). The authors suggest that the CPUE decline may not be dispersal but a decreased responsiveness to baited hooks from alarm response behaviour. A companion behavioural study showed the alarm and startle responses were not sustained following the removal of the sound source (Pearson et al., 1992; Skalski et al, 1992) suggested fishing effects may be transitory, primarily occurring during the sound exposure.

- Lokkeborg et al. (2012) observed, following airgun exposure, gillnet catches increased substantially for redfish (*Sebates norvegicus*) and Greenland halibut (*Reinharditius hippoglossoides*) by 86% and 132% respectively compared with pre-shooting levels, while longline catches of Greenland halibut and haddock decreased by 16% and 25% respectively compared with pre-survey catch. These contradictory results were explained by greater swimming activity versus lowered food search behaviour in fish when exposed to air-gun emissions. Changes in catch rates of all species studied, including saithe and ling, found all species responded to air-gun sounds. Except for saithe (a pelagic hearing sensitive fish), acoustic mapping of fish abundance did not suggest displacement from fishing grounds.
- Sonar observations by Pena et al. (2013) observing real-time behaviours of pelagic herring schools exposed to an acoustic source approaching from a distance of 27 km to 2 km over a two-hour period found no changes in school size, swimming speed or direction. The lack of response was interpreted as a combination of a strong motivation for feeding, a lack of suddenness of the airgun stimulus and an increased tolerance to seismic shooting.
- Przeslawski et al. (2016a) in catch studies undertaken as part of a MSS in the Gippsland Basin found no clear evidence of adverse effects on scallops, fish or commercial catch rates. The study followed 15 species caught by Danish seine and demersal gillnet and identified in the six months which followed the survey, six species showed increased catch. For Danish seine this included tiger flathead, goatfish and elephantfish. For demersal gillnet this included boarfish, broadnose shark and school shark. Three species showed decreased catch caught via Danish seine - gummy shark, red gurnard, sawshark. No change was observed in the remainder of species. No change to gummy shark catch was observed for demersal gillnet capture techniques. These results support previous studies in which the effects of seismic surveys on catch seem transitory and vary among species and gear types.

Accordingly, the effect of seismic on catch and abundance varies by fish type and capture method. Most studies identify that the effects of the survey are transitory, if the effects are measured at all.

<u>Extent and Duration of Exposure and Identified Potential Impact:</u>

Predicted Impacts:
Review of commercial fishing activity in the Dorrigo MSS area identifies that the following fisheries may be present at the time of MSS activities:

- Commonwealth Trawl Fishery (CTS) present along the continental slope in the south-west section of the MSS area (spatial overlap of 85km^2 with acquisition area);
- Gillnet, hook and trap fishery (GHaT) (predominantly gillnet in waters < 183 m) located in the eastern section of the MSS area (spatial overlap of 980 km^2 with acquisition area);
- Victorian SRL fishery in continental shelf waters between 1 to 14 September (spatial overlap of 306 km^2 with acquisition area although most catch is taken in water depths less than 100m (VFA, 2018b);
- Victorian giant crab fishery at the shelf break between 1 to 14 September (spatial overlap of 157 km^2);
- Tasmanian SRL fishery in continental shelf waters between 1 to 30 September (spatial overlap of 756 km^2 with acquisition area although most catch is taken in water depths less than 40m (SETFIA/Fishwell Consulting, 2018); and

- Tasmanian giant crab fishery at shelf-break in south-west of acquisition area (spatial overlap of 85 km^2 with acquisition area).

Catch and catchability impact assessment of the invertebrate fisheries is provided in **Section 7.2.3.2**.

Within the context of the Dorrigo MSS area, and the scientific literature available on fish catchability studies, the following implications for fisheries present at the time of the survey are:

- For the CTS (demersal trawl):
    - Catchability impacts for demersal trawl species present in the Dorrigo MSS would appear to vary depending upon the target fish species. Demersal trawl catches rates of Atlantic cod and haddock in Norway in an area exposed to seismic were shown to fall by 45% and 70% respectively five days after survey completion (Engas et al., 1996). Przeslawski et al. (2016a) identified in the six months following a MSS in the Gippsland Basin, deviations in fishery catch were gear specific. Importantly, from the 15 species monitored, no species indicated significant before and after deviations in catch across more than one gear type. Within this study, of the CTS target species targeted within the Dorrigo MSS area, for Danish seine gear type, John Dory and Morwong did not show any significant decrease in catch (Przeslawski et al., 2016a). The tiger flathead significantly increased in catch after the MSS (Przeslawski et al., 2016a; Bruce et al; 2018). The flathead and morwong, based upon available catch data, does not appear to be landed in the Dorrigo MSS (SETFIA/Fishwell Consulting, 2018). On the basis of this data, for the fish species targeted by the CTS, catch is expected to remain unchanged or increase as a result of the Dorrigo MSS activity.
    - Catch effects are expected to be transitory on the basis of demersal fish studies (Pearson et al, 1992; Przeslawski et al., 2016a);
    - Proportion of the CTS catch taken in Dorrigo MSS area is [redacted] t ([redacted]% of CTS catch in 2017-18) (SETFIA/Fishwell Consulting, 2018) and therefore fish catch affected by MSS activities is very small.
    - The highest catch rates for CTS in the MSS area is during February and March so key catch season not effected (SETFIA/Fishwell Consulting);
    - The Dorrigo MSS spatially overlaps only a small area of the continental slope (85 km^2) which is the target bathymetry of the CTS fishery. CTS fishery met 44% of TAC (2017-18) and therefore the fishery is not limited in catch. Fishermen have access to other areas within the fishery (i.e. MSS area does not offer unique features and fishing rights are non-exclusive) and the MSS area does not block access to these fishing areas which are more productive and generally closer to port (refer **Section 5.7.5.1**).

  Catch and abundance impacts are therefore expected to be incidental, localised, short-term and recoverable within the CTS fishery.
- For the GHaT (demersal gillnet/hook – shark species):
    - Catchability impacts for demersal gillnet/hook species in the Dorrigo MSS, based on available studies is expected to vary by fishing gear type. Gillnet catches have been observed to increase substantially for demersal species by 86-132% and for longline catches decrease by 16-25% compared with pre-survey (Lokkeborg et al, 2012). The gummy shark, the primary target species of the fishery, showed no catch impacts from demersal gillnet in six months following a MSS in Bass Strait (Przeslawski et al, 2016a; Thompson et al, 2014; cited in Carroll et al, 2017). Catch rates by gillnet

may increase on a short-term basis after the MSS. Note the Dorrigo MSS area is predominantly fished by gillnet gear types alhough the overall fishing level in the MSS area is low and closer to King Island (refer **Section 5.7.5.2**).
  - Catch effects are expected to be transitory on the basis of demersal fish studies (Pearson et al, 1992; Przeslawski et al., 2016a);
  - Proportion of the GHaT catch (shark) taken in Dorrigo MSS area is [redacted] t ([redacted]% of GHaT (shark) catch in 2017-18) (SETFIA/Fishwell Consulting, 2018). Therefore fish catch affected by MSS activities is very small.
  - The highest catch rates for GHaT in the MSS region occurs between November and April so key catch season not effected (SETFIA/Fishwell Consulting);
  - The Dorrigo MSS spatially overlaps only a small area of the continental shelf (980 km^2) which is the target bathymetry (water depth < 183 m) of the GHaT fishery. This compares with the total area fished in 2017-18 by the GHaT (gillnet) fishery of 307,750 km^2 (0.3% fishery area) and GHaT (hook) fishery of 385,974 km^2 (0.25% fishery area). The GHaT fishery (shark) met 81% of TAC (2017-18) and therefore the fishery is not limited in catch. Fishermen have access to other areas within the fishery (i.e. MSS area does not offer unique features and fishing rights are non-exclusive) and the MSS area does not block access to these fishing areas which are more productive and generally closer to port (refer **Section 5.7.5.2**).

  Catch and abundance impacts are therefore expected to be incidental, localised, short-term and recoverable within the GHaT (shark) fishery.

- For the GHaT (demersal hook – scalefish species):
  - Catchability impacts for demersal hook species in the Dorrigo MSS, based on available studies may decrease based upon studies by Lokkeborg et al (2012).
  - Catch effects are expected to be transitory on the basis of demersal fish studies (Pearson et al, 1992; Przeslawski et al., 2016a);
  - Proportion of the GHaT catch (scalefish) taken in Dorrigo MSS area is 5.7 t (max) (0.9% of GHaT (scalefish) catch in 2017-18) (SETFIA/Fishwell Consulting, 2018). Therefore fish catch affected by MSS activities is very small.
  - The highest catch rates for GHaT in the MSS area is between November and April so key catch season not effected (SETFIA/Fishwell Consulting);
  - The Dorrigo MSS spatially overlaps only a small area of the continental shelf (980 km^2) which is the target bathymetry (water depth < 183 m) of the GHaT fishery. This compares with the total area fished in 2017-18 by the GHaT (scalefish) fishery of 344,834 km^2 (0.28% fishery area). The GHaT fishery (scalefish) met 44% of TAC (2017-18) and therefore the fishery is not limited in catch. Fishermen have access to other areas within the fishery (i.e. MSS area does not offer unique features and fishing rights are non-exclusive) and the MSS area does not block access to these fishing areas which are more productive and generally closer to port (refer **Section 5.7.5.2**).

  Catch and abundance impacts are therefore expected to be incidental, localised, short-term and recoverable within the GHaT (scalefish) fishery.

Summary:
<u>Consequence</u>: Catch and abundance impacts are predicted to be incidental, localised, short-term and recoverable within the fisheries active in the Dorrigo MSS area (Negligible consequence).

Controls assessment to limit impacts to fish and fish abundance:

An assessment of controls to limit impacts to fish from seismic activities is provided in **Table 7-19.**

Table 7-19: Assessment of possible controls to reduce impacts to fish

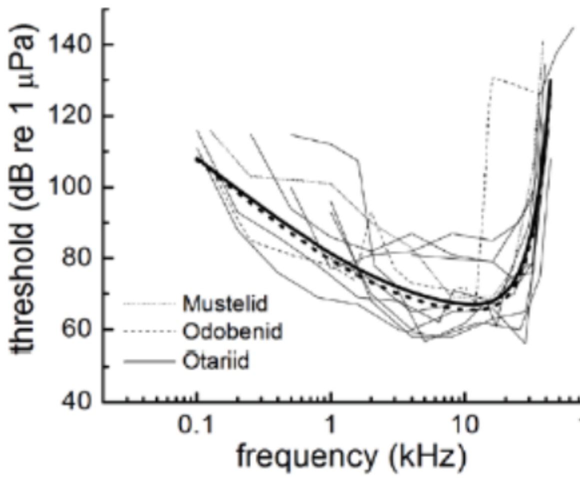
Control Measure	Practicable?	Will it be Implemented?	Justification
EPBC Policy Statement 2.1 (Part A): Implement soft-start procedures to alert fish species of pending survey activities and allow displacement.	YES	YES	Control measure adopted to limit impacts to all sensitive sound species. **Control adopted.**
Spatial Separation: Do not undertake survey activities in the areas which overlaps the White Shark Distribution BIA	NO	NO	The Dorrigo MSS area spatially overlays the white shark Distribution BIA by 100%. Elimination is not possible. White sharks present in the MSS area are low level (DoEE, 2018) and generally occupy to 100m water depth (EA, 2002). Shark species are not significantly affected by acoustic sound – only in close proximity to the array. Given the potential to injure sharks species is low, plus the low encounter rate of the species expected at the edge of this BIA, elimination of survey within the BIA would not result in a significant environmental impact reduction and does not achieve survey objectives. Control not practical. **Not adopted.**
Alternate Technology: Use of quieter technologies (air gun bubble curtains, marine vibrators, DTAGS)	NO	NO	3D Oil has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators, DTAGs) for the Dorrigo MSS. Other than eSource (a technolology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to 3D Oil and geophysical objectives of the survey may not be met resulting in large gaps of data. 3D Oil would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration. Control not adopted.
Streamers: Utilise a larger number of streamers to reduce the potential for cumulative TTS impacts to site-attached species.	NO	NO	Survey vessel uses the maximum feasible within the capability of the vessel while maintaining geophysical objectives. Maximum utilisation of vessel capability is used in all survey activities. Control not adopted.
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. **Control adopted.**
Reduce the Survey Area: Eliminate areas from the survey footprint which have fishing activity (i.e. SW corner)	NO	NO	At the request of SETFIA an assessment was made to reduce the MSS foofprint on the SW corner. After provision of the reservoir target data, SETFIA could understand the need to assess the area. SETFIA's prefenece was that the area should be assessed as one survey and not two by segmenting the SW area for a future date. **Control not adopted.**

Control Measure	Practicable?	Will it be Implemented?	Justification
Reduce the number of lines or shots	NO	NO	The survey design has been developed to obtain acquisition information in the most effective manner. The shot point spacing, which impacts the number of shots has been optimised to adequately image the data. If the shot-point spacing is increased (reduction in shots) it becomes less effective to be able to differentiate between primary signal and unwanted noise. The survey lines hav ebeen designed to be the least and shortest while still meeting the acquisition objectives. The shortest and least number of lines reduces the time and cost of the survey. **Control not adopted.**
Shut source down on line turns	YES	YES	Reduces the number of sound impulses placed in the environment. Environmental benefit outweighs cost. **Control adopted.**

7.2.3.4 Pinnipeds

Pinniped species present within the Dorrigo MSS area include the Australian fur seal and the New Zealand fur seal, both otariids pinniped species. NMFS (2016) defines the functional hearing of otariid pinnipeds under water between 60 Hz and 39 kHz. **Figure 7-11** provides the audiogram of otariids compared with mustelids (sea otters) and odobenids (walruses). This functional hearing frequency overlaps the frequencies emitted by an operational acoustic array.

Figure 7-11: Psychophysical hearing thresholds measured underwater of otariids, mustelid and odobenid species (NMFS, 2016)



Biologically Important Areas: The Dorrigo MSS does not spatially overlap any BIAs for the Australian fur seal or the New Zealand fur seal, however is also coincident with their foraging areas.

Temporary and Permanent Hearing Loss

Receptor Sensitivity:

Studies of impact of acoustic sound on pinnipeds are limited. Underwater sound exposures that elicit TTS in pinnipeds have been measured for harbour and northern elephant seals (both phocid pinnipeds) and Californian sea lions (otariid pinniped). Kastak et al. (2005; cited in Southall et al. 2007) identified that, under continuous, TTS occurred in harbour seals at 183 dB re 1µPa^2.s (SEL), in Californian sea lions at 199 dB re 1µPa^2.s (SEL) and the northern elephant seal at 204 dB re 1µPa^2.s (SEL). All animals showed full recovery in 24 hours after exposure.

Further studies involving phocid pinnipeds (harbour seals) when exposed to a continuous source of 180 dB re 1µPa^2.s (SEL), animals experienced TTS (Kastelin et al., 2012); and when two spotted and two ringed seals were exposed to single pulses from a 10 in^3 airgun there was no measurable TTS (maximum unweighted SEL 181 dB re 1µPa^2.s, SPL ~ 203 dB re 1µPa PK) (Reichmuth et al., 2016). Underwater TTS-onset data in pinnipeds exposed to pulses is limited to a single study. Finneran et al. (2003: cited in Southall et al. 2007) identified that there was no measurable TTS following exposure of two Californian sea lions to single impulses at received sound levels of 183 dB re 1µPa PK-PK or maximum unweighted SEL of 163dB re 1µPa^2.s however the two test animals showed avoidance responses at these levels. Based on the Kastak et al. (2005) results using non-pulse sounds, the absence of TTS for the sea lions following such exposures was not unexpected.

Southall et al. (2007) in a synthesis of scientific information on sound impacts to pinnipeds identified that harbour seals experienced TTS at lower exposure levels than the Californian sea lion or northern elephant seal.

Adopted Thresholds:
As no measured PTS data exists for pinnipeds (in water), TTS onset thresholds and known pinniped-to-cetacean differences in TTS-onset have been used to extrapolate PTS onset thresholds for pinnipeds (Southall et al. 2007). For groups such as octariid pinnipeds where impulsive TTS onset data does not exist, Finneran (2015) derived impulsive TTS onset thresholds using the relationship between non-impulsive TTS onset thresholds and impulsive TTS onset thresholds for MF and HF cetaceans.

Southall et al. (2007) recommended dual acoustic injury criteria for impulsive sound including a peak pressure level (PK) and SEL_{24hr} threshold. The peak pressure criterion is not frequency weighted whereas the SEL_{24hr} is frequency weighted for pinnipeds in water. In 2016, after substantial public and expert input, NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing. This guidance describes injury criteria with new thresholds and frequency weighted functions for pinnipeds (phocid and otariid) described by Finneran and Jenkins (2012). Based upon the sensitivity studies identified above, 3D Oil considers these thresholds are suitable for assessing impacts to pinnipeds from acoustic sound produced during the Dorrigo MSS. A summary of these thresholds is provided in **Table 7-20**. Note that the pinnipeds within the Dorrigo MSS are otariid, impacts to phocid pinnipeds will not be considered further in this EP.

Table 7-20: Marine mammal injury (PTS onset) and TTS onset thresholds for pinnipeds (NMFS, 2016).

Hearing Group	NMFS (2016)			
	Injury (PTS)		Temporary Threshold Shift (TTS)	
	Weighted SEL24h (dB re 1µPa^2.s)	PK (dB re 1µPa)	Weighted SEL24h (dB re 1µPa^2.s)	PK (dB re 1µPa)
Phocid Pinnipeds in water	185	218	170	212
Otariid Pinnipeds in water	203	232	188	226

Extent and Duration of Exposure and Identified Potential Impact:

Acoustic Modelling Results: Modelling results for:

- PTS (PK and SEL_{24hr}) thresholds for otariid pinnipeds at differing locations/water depths across the Dorrigo MSS area did not meet PTS thresholds (Warner et al, 2018). On this basis, no PTS impacts to the Australian and New Zealand fur seal is predicted.
- TTS (PK and SEL_{24hr}) thresholds of otariid pinnipeds did not meet TTS thresholds based upon PK criteria. For the weighted SEL_{24hr} metric, TTS is predicted within 50 m of the operational array affecting an area of 4.78 km^2 over a 24-hr period (or 0.01% of the Otway Bioregion) for otariid pinnipeds (Warner et al, 2018).

Given these results, based upon the SEL_{24hr} metric (only), pinnipeds may be exposed to cumulative sound levels sufficient to cause TTS assuming the animal is consistently exposed to noise levels within 50 m of the operational array for 24 hours. This represents an unlikely worst-case scenario. More realistically, pinnipeds would not stay in the same location or at the same range for 24 hours, therefore a reported radius for SEL_{24hr} does not mean the pinniped travelling within that radius of the source will be injured but rather that an animal could be exposed to a sound level associated with TTS if it remained within that range for 24 hours (Warner et al, 2018). Fur-seals may be exposed to sound levels sufficient to cause TTS if the acoustic source starts suddenly or operates in proximity to the animal. In circumstances where the arrays are already operating, it is expected individual animals would implement avoidance measures before entering ranges at which physical damage may occur. Protective measures for sound sensitive species adopted during seismic operations (e.g. pre-startup observations, soft–starts and shutdowns) will allow individual pinnipeds to more away and minimise potential exposure to sound levels which might result in physical damage.

The Dorrigo MSS area does not contain habitat or topographical features leading to fur-seal aggregation. Areas affected by ensonification at TTS levels are very localised, temporary and with controls adopted, not expected to effect individual pinnipeds.

Summary:
Consequence Level (PTS/TTS): Without controls, impacts to pinnipeds are localised, temporary and recoverable (MINOR consequence). With controls adopted, pinnipeds should not experience injuries (NEGLIGIBLE consequence).

Behavioural Disturbance

Receptor Sensitivity:
Southall et al. (2007) extensively reviewed marine mammal behavioural responses to sound and identified behaviours as variable, context-dependent, and less predictable than effects of noise exposure on hearing or physiology. Studies varied in their lack of control groups, imprecise measurements, inconsistent metrics and the animal's study context including the animal's activity state. Southall et al. (2007) identified that the context-specificity of behavioural responses in animals generally made extrapolation of behavioural data inappropriate and assessment of the severity of behavioural disturbance should consequently rely more on empirical studies with carefully controlled acoustic, contextual, and response variables than on extrapolation based on shared phylogeny or morphology.

Few studies have been undertaken which document the reaction of pinnipeds to seismic sound however pinnipeds have been observed during seismic monitoring studies. Within these studies some pinnipeds showed avoidance to airguns, but their observed avoidance reactions are generally not as strong or consistent as cetaceans (LGL, 2009). Monitoring studies (Harris et al. 2001) undertaken on the behaviour of phocid seals, more sensitive to sound than otariid pinnipeds, during a near-shore seismic program in Alaska observed that:

- During daylight hours seals were seen at nearly identical rates during periods where there were no airguns firing, one airgun firing and the full array operational;
- Seals tended to be further away during full array seismic. Swimming away was more common during full array operation than no airgun periods, but relative behaviours (looked, approached, swam parallel to boat's track, dive or swam away when full array was firing) did not differ significantly among the distance categories;
- Approximately 79% of seal sightings were within 250 m of the seismic vessel. There was partial avoidance of the zone less than 150 m from the vessel during full array seismic, but seals did not move much beyond 250 m at any time.

Received levels of noise pulses from the full array were ≥ 180 dB re 1µPa SPL out to a radius of 1 km. Despite this, many seals showed little or no obvious avoidance and no obvious tendency to avoid diving (Harris et al. 2001).

Thompson et al. (1998; cited in Gordon et al., 2003) conducted controlled exposure experiments with small airguns (215 – 224 dB re 1 µPa PK-PK) over 1 hr observing harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) fitted with telemetry devices. The telemetry packages allowed the movement, dive behaviour, and swim speeds of the seals to be monitored and thus provided detailed data on their responses to seismic pulses. Two harbor seals equipped with heart rate tags showed evidence of a fright responses when playbacks started: their heart rates dropped dramatically from 35-45 beats/min to 5-10 beats/min. However, these responses were short-lived and following a typical surfacing tachycardia; there were no further dramatic drops in heart rate. In six out of eight trials with harbor seals, the animals exhibited strong avoidance behaviour, swimming rapidly away from the source. Stomach temperature tags revealed that they ceased feeding during this time. Only one seal showed no detectable response to the guns and approached to within 300 m. The behaviour of harbor seals seemed to return to normal soon after the end of each trial. Similar avoidance responses were documented during all trials with grey seals: they changed from making foraging dives to v-shaped transiting dives and moved away from the source. Some seals hauled out (possibly to avoid the noise); those that remained in the water seemed to have returned to pre-trial behaviour within two hours of the guns falling silent.

Studies undertaken on the reaction of pinnipeds to other pulsed sources (i.e. pile-driving) have included:

- A study on the effects of pile driving on the ringed seal (*Phoca hispida*) in Alaska did not show dramatic reactions to underwater impulses with mean levels of at least 151-157 dB re 1µPa (SPL) (145 dB re 1µPa^2.s SEL) at 63m. Underwater SPLs were <180 dB re 1µPa at all distances. Ringed seals swam in open water throughout construction activities and as close as 46 m from the pile-driving operation (Blackwell et al. 2004);
- Observations of pile driving in connection with wind farms in the western Baltic found a significant effect on the haul-out behaviour of harbour seals (Edren et al. 2004; cited in Masden et al. 2006). This study conducted over a period of three months showed a 10% to 60% reduction in the number of seals hauled out on a sandbank approximately 10 km away during pile driving compared with periods of no pile driving. Sound levels in the water were not measured and no observations were made of seals in the water. It is therefore not known whether the seals reacted to underwater noise by leaving the area or reacted to airborne noise by remaining in the water, but the reaction seemed short-term as a concurrent aerial survey did not show any decrease in the general abundance of seals during the construction period as a whole (Teilmann et al. 2004; cited in Masden et al. 2006).

Adopted thresholds:
Southall et al. (2007) found that most marine mammals exhibited varying behavioural responses between 140 and 180 dB re 1µPa SPL but inconsistent results between studies made choosing a single behavioural threshold difficult. NMFS has historically used a relatively simple sound level criterion for potentially disturbing a marine mammal. For impulsive sounds this threshold is 160 dB re 1µPa SPL.

Based on the limited studies available, 3D Oil considers the current NMFS sound level criterion for behavioural disturbance to pinnipeds from impulsive sounds is conservative, but suitable for pinnipeds which are transiting or foraging within and adjacent to the Dorrigo MSS area.

Extent and Duration of Exposure and Identified Potential Impact:

Acoustic Modelling Results:
Table 7-21 provides a summary of the maximum horizontal distance from the operational array where the ensonified area exceeds 160 dB re 1µPa SPL based upon water depth for three locations across the Dorrigo MSS area.

Table 7-21: R_{MAX} horizontal distance (in km) from the 3260 in^3 array to modelled maximum over for the 160 dB re 1µPa SPL (Warner et al. 2018)

Topographical Feature	Site (Depth)	R_{MAX} (km)	Ensonified Area (km^2)
Continental Shelf	Site 1 (116 m)	9.47	282
Continental Shelf	Site 2 (105m)	9.64	292
Shelf break	Site 3 (133 m)	9.58	288

Potential Impacts (foraging): Modelling predicts for the Dorrigo MSS area ensonification above 160 dB re 1µPa SPL might occur to out to 9.62 km (horizontal distance) from the operating array or 292 km^2 at any time during the survey. Ensonification of this area is expected to have only incidental impacts to foraging fur-seals based on the following:

- Ensonified areas are localised in the context of the Otway bioregion (0.8% Otway bioregion) with the Dorrigo MSS area representative of the more general bioregional area (i.e. not containing islands or topographical features which may cause aggregations of fur seals;
- Fur-seal reaction to seismic activities, based on the small observed reaction of phocid pinnipeds (more sensitive to sound than otariids) to seismic activities (Harris et al, 2001) indicates that foraging displacement distances used in this assessment are conservative; and
- The diversity of target prey and the predicted response of prey species (cephalopod, pelagic fish), which are also expected to displace as a result of sound impacts (refer **below**), are not expected to limit foraging opportunities for pinnipeds;
- Ensonified areas are temporary and impacts (e.g. indirect prey displacement) are recoverable.

Potential Impacts (Coastal Colonies): The nearest fur-seal colony is located at Reid Rocks (~44 km east) and Lady Julia Percy Island (~145 km NW). Reid Rocks lies in an acoustic shadow of King Island for the majority of the Dorrigo survey with sound exposure possible when data is being acquired in the southern section of the Dorrigo MSS area. Sound exposures at these closest colonies, predicted by modelling are:

- Reid Rocks < 140 dB re 1µPa (SPL)[48];
- Lady Julia Percy Island <130 dB re 1µPa (SPL)[49].

Based on this sound exposure at these coastal locations, SPLs at colonies are predicted to be less than 160 dB re 1µPa SPL, the threshold for behavioural impacts in pinnipeds (i.e. avoidance). Any behavioural impacts at colony locations are expected to be localised, incidental, temporary and fully recoverable.

Potential Indirect Impacts (Prey Displacement): An assessment of the acoustic impact to pinniped prey from an operating array (i.e. fish, invertebrates, cephalopods) has been undertaken in **Section 7.2.3.2** and **Section 7.2.3.3**). These sections identified:

- *Pelagic fish*: Behavioural effects in pelagic fish vary according to the presence or absence of a swim bladder and its function in the animal's hearing. The most sensitive fish type present in the area (swim bladder connected to hearing) has a moderate risk of displacement kilometres from the operating array based upon thresholds adopted by Popper at al. (2014). On this basis, fish displacement around an operational array is localised, constantly moving and not expected to cause significant impacts to foraging pinnipeds.
- *Cephalopods:* Cephalopods, a sound sensitive species, are expected to respond to acoustic sound displacing from areas of high ensonification. The cephalopod threshold utilised for avoidance behaviours is 161-166 dB re 1µPa SPL (McCauley (2012)) which, is greater than the adopted threshold for pinniped behavioural impacts. Therefore, cephalopods would be expected to displace to a lesser extent than pinnipeds when exposed to an equivalent level of acoustic sound.

48 This is based on the footprint from Site 2 (shallowest water site modelled and closest to Reid Rocks) (Warner et al, 2018)

49 This is based on the footprint from Site 1 (closest modelled point to Reid Rocks) (Warner et al, 2018)

- *Invertebrates:* Benthic invertebrates cannot move large distances in response to acoustic sound. Based upon scientific literature, sound exposure to invertebrates such as lobsters are not predicted to cause mortality impacts, however sub-lethal physiological impacts may be observed (e.g. righting times, etc.). On this basis, Dorrigo MSS activities are not expected to have a significant impact on prey (lobster) availability to foraging pinnipeds.

In summary, pinniped prey species which are sound-sensitive, based upon their observed behavioural response to noise, are expected to displace from areas immediately around the operating acoustic array to similar, or an equivalent distance from the array as pinnipeds. Any impact to prey availability is localised, transient, recoverable and not expected to limit pinniped foraging opportunities.

Summary:
Consequence Level (foraging): No population level impacts are expected from behavioural disturbance. Impacts are predicted to be localised, transient and recoverable (NEGLIGIBLE Consequence).

Controls Assessment:
Table 7-22 provides an assessment of possible controls to reduce impacts to pinnipeds from the Dorrigo MSS activity.

Table 7-22: Assessment of possible controls to reduce impacts to pinnipeds

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part A) procedures *(pre-startup visual observation)*	Yes (at close range)	Yes (at close range)	Visual observation of pinniped species to distances of 3 km from the seismic vessel cannot be achieved given the characteristics of pinnipeds in the marine environment (i.e. no visual breathing spout, small surface presence/size). However, based upon seismic survey monitoring studies (Harris et al., 2001) detection of pinnipeds at distance ~ 500m is possible. At these distance TTS impacts are not predicted. As pinnipeds do not remain beneath water for extended time (~ 8 minutes (Taronga Zoo, 2017)), pinniped surveillance prior to array start-up is a practicable measure in close proximity to the seismic vessel as the array starts-up. 3D Oil will adopt the following control to protect pinnipeds from high sound levels during start-up. If, during pre-start observations prior to initiation of source soft start, a qualified observer detects a pinniped within 200 m of the source, start-up will be delayed until: • A MFO confirms the pinniped has moved to a point that is more than 200 m from the source, or • Despite continuous observation, 10 minutes has passed since the last detection of a pinniped within 200 m of the source and the mitigation zone remains clear. Control will ensure that pinnipeds are not exposed to TTS impact on soft-starts. Control is adopted for other species Environmental benefit outweighs cost. **Control adopted.**
Implement EPBC Policy Statement 2.1 (Part A) procedures *(soft start procedures)*	Yes	Yes	Soft-start procedures will assist in displacing sound sensitive species from areas where ensonification may be damaging. Environmental benefit outweighs cost. **Control adopted.**

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part A) procedures (*Implementation of precaution and shutdown zones*)	Yes	Yes	Visual observation of pinniped species to 3 km is unlikely but possible given the size of the pinniped and observation in closer proximity to the source is possible (refer above). Modelling identifies that potential TTS impacts to pinnipeds is restricted to very close ranges to the operating array (i.e. within 50m of the source for 24 hrs). Pinnipeds present in the area are expected to displace to areas of non-damaging sound during operation and soft-starts. Given these species characteristics, shutdown and power-down zones will be implemented. **Control adopted**.
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. **Control adopted.**
In addition to whale management, MFOs and crew will monitor for pinnipeds and other marine fauna.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds and seabirds. **Monitoring adopted**.
Use of quieter technologies (silenced (air bubble curtain) air guns, marine vibrators, DTAGS)	No	No	3D Oil has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Dorrigo survey. Other than eSource (a technology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to 3D Oil and geophysical objectives of the survey may not be met resulting in large gaps of data. 3D Oil would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration. **Control not practical for the survey.**

7.2.3.5 Marine Reptiles

Species Sensitivity:

Marine turtles may potentially use sound for navigation, locating prey and avoiding predators (CoA, 2017). Acute noise, or temporary exposure to loud noise, may result in avoidance of important habitats and in some situations physical damage to turtles. Morphological studies of green and loggerhead turtles (Ridgway et al. 1969; Wever 1978; Lenhardt et al. 1985) found that the sea turtle ear is similar to other reptile ears but has some adaptations for underwater 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 middle ear cavity, and hence they hear best underwater (Willis 2016).

Underwater audiograms are only available for three species. Two of these species, the red-eared slider (Christensen-Dalsgaard et al. 2012), the loggerhead turtle (Martin et al. 2012), both demonstrated sensitivity at around 500 Hz (Willis 2016). Recent work on green turtles has refined their maximum underwater sensitivity to be between 200 and 400 Hz (Piniak et al. 2016). Yudhana et al. (2010) measured auditory brainstem responses from two hawksbill turtles in Malaysia and found that peak frequency sensitivity occurred at 457 Hz in one turtle and at 508 Hz in the other.

Studies using auditory brainstem responses of juvenile green and Ridley's turtles and sub-adult green turtles showed that juvenile turtles have a 100 to 800 Hz bandwidth, with best sensitivity between 600 and 700 Hz, while adults have a bandwidth of 100 to 500 Hz, with the greatest sensitivity between 200 and 400 Hz (Bartol & Ketten 2006). Piniak et al. (2012) found that leatherback turtle hatchlings detected sounds between 50 – 1000Hz, with maximum sensitivity between 100-400 Hz. Like other species of marine turtle, they have a relatively narrow, low-frequency range of hearing sensitivity; however, these frequencies overlap the frequency range of the maximum energy from an operating acoustic array.

It is possible that seismic airgun exposure may damage turtles that are very close to the source, although preliminary data suggest that sea turtles are highly resistant to high intensity explosives (Ketten et al. 2005), indicating they may be resistant to damage from seismic airguns. It is also likely that there would be recoverable injury or TTS.

There is a paucity of data regarding responses of turtles to acoustic exposure and no studies of hearing loss due to exposure to loud sounds. Nelms et al. (2016) conducted a review of seismic surveys and turtles which considers the studies detailed below. A common theme was the complex nature of the studies (i.e. behavioural response interpretation due to airguns or vessel noise/presence) through to difficulties in visually detecting animals. Most studies looking at the effect of seismic noise on marine turtles have focused on behavioural responses as physiological impacts are more difficult to observe in living animals. Relevant studies include:

- Caged green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles increased their swimming the absence of definitive data activity in response to an approaching seismic array in 100 m water depth at received SPLs of approximately 166 dB re 1μPa SPL (SEL - 155 dB re 1μPa^2.s) and behaved erratically (agitated state) above 175 dB re 1μPa SPL (SEL - 164 dB re 1μPa^2.s). This corresponded to behavioural changes at ~2 km, and avoidance from ~1 km (McCauley et al., 2003).
- Moein et al. (1994) found caged loggerhead turtles showed an initial response to an operating air gun at a mean range of 24 m however further trials several days afterwards did not elicit any significant behaviour change. Physiological measures recorded during the study did show evidence of increased stress, but the effects of handling turtles for sampling were not accounted for and therefore the stress increase could not be attributed to the air gun operations. A temporary reduction in hearing capability was evident from the neurophysiological measurements but this effect was temporary, and the turtles hearing returned to pre-test levels at the end of two weeks. The study quotes three air gun levels received by the turtles, 175, 177 and 179 dB @ 1m (units not defined).
- Weir (2007) observed 240 turtle responses to a seismic survey during a 10-month seismic survey off the coast of Angola concluding that "*there was indication that turtles occurred closer to the source during guns-off than full array, with double the sighting rate during guns-off in all distance bands within 1000 m of the array*". This reduction in numbers of turtles is reasonably consistent with McCauley et al. (2003). However, there was no significant difference in the median distance of turtle sightings from the airguns during full-array or guns-off. While this result apparently indicates a lack of movement away from active airguns, it is possible that turtles only detect airguns at close range or are not sufficiently mobile to move away from approaching airgun arrays (particularly if basking for metabolic purposes when they may be slow to react). Apparent responsive dives were noted for 20 turtles, six during full-array seismic and 14 during guns-off. Thirteen turtles dove in apparent response to the vessel, nine of which startle dove at the bow (full-array=2;

guns-off=7). Seven turtles startle dove in apparent response to seismic equipment, including six in response to towed surface floats (full-array=1; guns-off=5) and one in apparent response to the inactive airgun array. An assessment of turtle behaviour in relation to seismic status was therefore hindered by apparent reaction of individuals to the ship and towed equipment rather than specifically to airgun sound. These reactions occurred at close range (usually <10 m) to approaching objects and appeared to be based principally on visual detection.

- Eckart *et al.* (2004) used GPS and Time Depth Recorders (TDR) to track movement and behaviour of two leatherback turtles exposed to seismic source noise. They found no change in behaviour or movement from turtles not exposed to seismic survey noise.
- DeRuiter and Doukara (2010) observed turtles and found a startle response (rapid dive) during active operation of the airgun. However, again, the authors could not distinguish the stimulus source of the startle response as they did not perform a control with the airguns off (DeRuiter and Doukara, 2010).

Adopted Thresholds:
In the Arctic Programmatic Environment Impact Statement (PEIS) (NSF, 2011) in the absence of definitive injury data for turtles, TTS or PTS onset were considered possible at an SPL of 180 dB re 1µPa (NSF, 2011). Popper et al. (2014) after consideration of available scientific literature and the way animals detect sound established sound exposure guidelines for sea turtles. These levels have been developed based on impulsive sounds (i.e. pile driving or explosives) given there is no quantified data for seismic airguns. The material used to inform the guidelines is limited to publications that provide full background information including measured sound exposure levels, received levels, controls, and appropriate experimental design. These guidelines suggest injury to turtles at 207 dB re 1µPa (PK) or above 210 re 1μPa^2.s (SEL_{24hr}). The Popper et al. (2014) threshold criteria are used in this assessment as it is based upon the latest available information.

Behavioural guidelines defined by Popper et al (2014) show that animals are likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of meters) and a low response if they are far (thousands of meters) from the airgun. McCauley et al. (2003) identified a behavioural threshold of 166 dB re 1µPa (SPL) for caged turtles and is adopted within this assessment to identify the level of potential displacement (avoidance) from the array. The SPL of 166 dB re 1µPa has been used as the behavioural disturbance response for sea turtles by the NFMS and applied to the Arctic Programmatic Environment Impact Statement (NSF, 2011). However, given behavioural observations during seismic survey operations, this behavioural threshold is considered highly conservative. **Table 7-23** summarises the sound impact threshold criteria.

Extent and Duration of Exposure and Identified Potential Impact:

Habitats:
The Dorrigo MSS is not located in a BIA for marine turtles (refer **Section 5.4.7**). While the EPBC protected matters database identifies three species of turtle as "likely to have habitat present" only the leatherback turtle, given its ability to endure cold-water, might be encountered (i.e. MSS is within the distribution range of the species). This presence is expected to be transitory only.

The Recovery Plan for Marine Turtles 2017-2027 (DoEE, 2017b) identifies noise interference as a general threat to sea turtles within Australian waters with a requirement for, in accordance with the EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines, all seismic survey vessels operating in Australian waters must undertake a soft start during surveys irrespective of location and time of year of the survey.

Table 7-23: Sound exposure guidelines for mortality, impairment and behavioural change in turtles (Popper et al. 2014)

Species	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Turtles	210 dB SEL_{cum} or > 207 dB PK	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low 166 dB SPL (McCauley et al. 2003)
Definitions:					
Mortal and mortal injury	Immediate or delayed death.				
Recoverable injury	Injuries including hair cell damage, minor internal or external haematoma, etc. None of these injuries are likely to result in mortality.				
Temporary Threshold Shifts	Short or long-term change in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6 dB or greater that persists and has been selected as the working group considers that anything less than 6 dB will not have a significant effect from a hearing standpoint.				
Masking	Impairment of hearing sensitivity by greater than 6 dB in the presence of noise.				
Behavioural effects	Substantial change in behaviour for the animals exposed to sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction or alteration in migration patterns. This criterion does not include effects on single animals or where animals have become habituated to the stimulus or small changes in behaviour such as a startle response or small movements.				
Note: Peak and rms pressure levels are dB re 1μPa; SEL dB re $1\mu Pa^2$.s. All criteria are presented as sound pressure since no data on particle motion exists. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) (tens of metres), intermediate (I) (hundreds of metres) and far (F) (thousands of metres) (Popper et al. 2014).					

Physical Injury: Results of the Dorrigo MSS acoustic modelling for mortality level thresholds in marine turtles in PK metrics measured a horizontal distance of 191 m from the operational array[50]. The SEL_{24hr} from Popper at al. (2014) was not reached (Warner et al, 2018). These results identify, based upon Popper et al, (2014) criteria, that marine turtles may possibly be exposed to sound levels sufficient to cause physical damage within 191 m of an operating array. It is noted that these levels are conservative as they are based on pile drive studies with a static source and not a moving seismic vessel and receptor. Injury may occur if the acoustic array starts suddenly with turtles nearby. In circumstances where the acoustic arrays are already operational, individual animals would be

[50] This metric was modelled in the shallowest water depth of 105 m as a conservative measure (Warner et al, 2018).

expected to avoid (behavioural impact) areas where physical damage might take place. With soft start procedures implemented, injury impacts to individual turtles exposed to these sound levels is not expected.

For this assessment, the estimated area ensonified by the PK levels which could cause physical impacts to turtles transiting the area at any one time is 0.12 km^2, representing 0.03% of the Otway bioregion, or for the complete survey period [51] (i.e. 35 days) approximately 1625 km^2 (4.4% of the Otway bioregion). The Dorrigo MSS area affected by ensonification is not biologically significant to turtles as the area is not located within, or adjacent to, areas which have known narrow, restricted migratory pathways or near areas important for feeding, breeding or nesting (NCVA, 2018). Any marine turtle presence in the Dorrigo MSS area is expected to be representative of their wider distribution in southern Australian waters in the September/October timeframe. Leatherback turtle, known to inhabit cooler temperate waters, feed mainly on pelagic soft-bodied creatures (e.g. jellyfish) which occur in greatest concentrations at the surface in areas of upwelling or convergence over continental shelf waters (DoEE, 2018ag). As the Dorrigo MSS is positioned outside of upwelling periods, the likelihood of encounter is low and given the small bioregion area which is affected on a transitory basis, encounter and impact to individual turtles is possible (without controls), however this is not considered significant at a population level.

Summary:

Consequence Levels: Localised, temporary impacts may occur to individual animals if present near array on start-up without soft-start procedure implementation. No population level impacts are expected (NEGLIGIBLE consequence).

Behavioural Disturbance: Scientific literature has identified that turtles exposed to detrimental sound levels may result in behavioural changes (e.g. increased swimming, avoidance). Dorrigo acoustic modelling identifies that the sound source levels exceed the turtle behavioural threshold (SPL 166 dB re 1µPa) lies in at a maximum range from the operating array of 5.44 km[52] when the array is operating at full power.

Within the context of the Dorrigo MSS area, this area affected by these sound levels:

- Based upon the maximum modelled horizontal distance of 5.44 km the area affected at any point in time is 93 km^2 (0.25% of Otway bioregion) where marine behaviour may be affected by sound (i.e. increase swimming or practice avoidance based upon caged turtles (McCauley et al, 2003)) around the source. Over the entire Dorrigo MSS survey area during the 35-day survey period, this area is ~3,500 km^2 (9.5% of Otway bioregion);
- The MSS area does not represent key foraging, breeding, migration or aggregation areas for marine turtles (DoEE, 2018b) and marine turtle presence in the MSS area is expected to be representative of their wide distribution in southern Australian waters in the September/October timeframe;
- The area of behavioural impact may be overstated based upon field observations where no significant difference in median distance from the operational area was observed during full-array operation or guns-off (Weir, 2007) or behavioural impacts were observed (Eckart *et al.* (2004);

[51] This assumes polygon dimensions and acquisition lines lengths as described in Table 7.7 utilising a 191m horizontal radius around the survey lines

[52] R_{max} figure utilising maximum-over-depth as leatherback turtles can forage to 1200 m.

- Sound impacts at any time will be localised and temporary around the survey vessel given its constant movement affecting only individual turtles at any one time (no significant population exposure).

While encounter with individual leatherback turtles is possible within the Dorrigo MSS area, behavioural impacts are predicted to be localised, temporary and recoverable.

Summary:

Consequence Levels: Localised, temporary and transient impacts may occur to individual animals if present in the Dorrigo MSS area. No population level impacts expected or impacts on critical habitats (NEGLIGIBLE consequence).

Controls Assessment:

Table 7-24 provides an assessment of possible controls to reduce impacts to turtles from the Dorrigo MSS activity.

Table 7-24: Assessment of possible controls to reduce impacts to marine turtles

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part A) procedures (*pre-startup visual observation to 3 km*)	Partially	Yes	Visual observation of turtles to distances of 3 km from the seismic vessel cannot be achieved given the characteristics of turtles in the marine environment (i.e. no visual breathing spout, small surface presence/size). However, visual detection within 500 m is possible based upon observation studies (Weir, 2007). Given injury impacts are predicted close to sound source (i.e. 191 m), observation within 500 m during the 30 min visual observation period will prevent acoustic arrays starting up when turtles are in close proximity. **Control will be adopted.**
Implement EPBC Policy Statement 2.1 (Part A) procedures (*soft start procedures*)	Yes	Yes	Soft-start procedures will assist in displacing sound sensitive species from ensonified areas where sound may be damaging. The Recovery Plan for Marine Turtles 2017-2027 identifies noise interference as a general threat to sea turtles within Australian waters with a requirement for, in accordance with the EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines, all seismic survey vessels operating in Australian waters to undertake a soft start during surveys irrespective of location and time of year of the survey. **Control is adopted**.

Control Measure	Practicable?	Will it be Implemented?	Justification
Implement EPBC Policy Statement 2.1 (Part A) procedures (*Implementation of precaution and shutdown zones*)	Yes	Yes	Visual observation of turtle species to 3 km is not possible given the size of the turtles and its lack of noticeable surface presence (i.e. no spout). However, visual detection of a turtle within 500 m of the operational array will result in a shut-down of the array to prevent turtles from being exposed to PTS levels. Modelling identifies that potential PTS/TTS impacts to turtles is high in a very close range to the operating array. Turtles present in the area will be expected to displace to areas of non-damaging sound during operation and soft-starts. Given the threatened status of turtles on a precautionary basis shutdown in considered prudent if observed at surfaces. The potential environmental benefit of non-injury to threatened turtle species outweighs the cost. **Control adopted.**
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. **Control adopted.**
In addition to whale management, MFOs and crew will monitor for pinnipeds and other marine fauna.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds, turtles and seabirds. This will assist with turtle detection. Environmental benefit outweighs the cost. **Control adopted**.
Use of quieter technologies (air guns with bubble curtains, marine vibrators, DTAGS)	No	No	3D Oil has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Dorrigo MSS. Other than eSource (a technology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to 3D Oil and geophysical objectives of the survey may not be met resulting in large gaps of data. 3D Oil would be unable to meet seismic data delivery requirements of the survey and may result in prolonging total survey duration. **Control is not practical.**
Undertake MSS outside of upwelling period to limit interaction with the leatherback turtle.	YES	YES	Survey design allows for this timeframe due to other environmental sensitivities present during upwelling periods. **Control adopted.**

7.2.3.6 Avifauna

Species Sensitivity:

Bird species within the Dorrigo MSS area during survey activities are unlikely to be directly affected by acoustic sound unless plunge diving underwater for prey. Although ear anatomy in aquatic birds is not well investigated, adaptations for diving have been found in a number of penguin species. Current available evidence suggests that hearing in seabirds is less vulnerable to damage from underwater sound than in marine mammals based on adaptations to protect the tympanum and middle ear from large, rapid changes in pressure which occur when diving (Dooling and Therrien 2012). The only published field study assessing the impact of seismic activities on diving birds

(Long-tailed Ducks *Clangula hyemalis*) found no difference in indices of site fidelity or diving intensity between the seismic area and two control areas (Lacroix et al. 2003).

The Dorrigo MSS area spatially and temporally overlaps in BIAs (foraging) for some listed avifauna (refer **Section 5.4.8**). This includes the:

- Albatross: Wandering albatross, antipodean albatross, Tasmanian shy albatross, Buller's albatross, Campbell albatross, black-browed albatross and Indian yellow-nosed albatross;
- Petrels: Common diving petrel and white-faces storm petrel;
- Shearwaters: Short-tailed shearwater and wedge-tailed shearwater;
- Cormorant: Black-faced cormorant; and
- Little penguin.

The area also has a diverse array of seabirds (predominantly albatross and petrels which are widespread in Australian waters) and some shoreline birds which may also be present in the coastal areas provisioning for young. In the event that individual birds or flocks are present in the survey area during operations, vessel movement is expected to temporarily deter them from foraging in the immediate vicinity of the vessel.

Extent and Duration of Exposure and Identified Potential Impact:

Survey activities may lead to:

- avifauna mortality, if bird diving pattern is close to the operational array;
- localised, temporary displacement of birds due to physical presence of vessel and equipment;
- altered prey abundance; or
- if close to colonies, disturbance to breeding birds.

Vessel/Streamer Displacement:
If individual birds or bird flocks are present in the survey area during operations, vessel movement will temporarily deter them from foraging in the immediate vicinity of the vessel. As this area of disruption is localised to immediate areas around the vessel and trailing equipment; the species present are wide-ranging with no key aggregation areas within the MSS area; and the vessel is in constant movement, any foraging-related impacts are localised, temporary and recoverable within the small population affected.

Injury/mortality:
The threshold for physiological damage on the auditory system for marine birds is unknown, however most seabirds are generally shallow divers and utilise surface waters where the acoustic signals 'destructively interfere' resulting in much lower sound exposure compared with deeper waters (Marine Technology Directorate, 1996: cited in SCAR, 2002) and the time of exposure underwater is short.

A flightless seabird, the little penguin, is capable of diving to 72 m but typically dives to 10-20m. The species is known to generally forage within 20 km of their nesting site during non-breeding season and 15 km of their nest during the breeding season (October to December) (Australian Wildlife, 2014). The nearest colony to the Dorrigo MSS area is Christmas Island Nature Reserve located 18 km from the nearest Dorrigo MSS operational boundary and 32 km from the nearest acquisition line. On this basis, encounter rates with the penguin in the acquisition area is considered unlikely.

Seabird foraging within the south-east marine region is wide-ranging targeting pelagic species such as fish and cephalopods. Cephalopod species are sound sensitive (McCauley et al, 2003) (refer **Section 7.2.3.2**) and expected to temporarily displace on a localised basis around the operational acoustic source. Equally, pelagic fish in close proximity to the operational array also exhibit localised short-term displacement in any one location, at least vertically around the operational array (Slotte et al, 2004; Woodside, 2012b). A lower density of pelagic species is expected in proximity to the survey vessel operations with seabird foraging unlikely close to the vessel. On this basis, a small number of birds during diving/plunge feeding may be exposed to high sound levels, however in any one location these impacts are localised and transitory.

Disturbance to breeding birds:
A vessel (seismic or otherwise) approaching too close to a breeding colony could disturb adult birds from nests in response to acoustic or visual stimuli. The nearest island where breeding impacts might occur during the Dorrigo MSS is Christmas Island, approximately 18 km from the nearest Dorrigo MSS operational boundary and 32 km from the nearest acquisition line. No significant impacts to breeding populations are expected on this basis. Received sound levels at this location are expected to be ~ 140 dB re 1µPa (Warner et al, 2018).

Behavioural Disturbance (Foraging):
General: An indirect impact to seabirds foraging in the area is the potential for localised and temporary lower abundances of prey species around the survey vessel (refer above). However, the extent to which a temporary 'descending' or 'tightening' or displacement effect (if it occurs) affects prey availability either positively or negatively, is not known. Most seabirds present in the acquisition area forage over wide-ranging areas so the area affected to small in comparison to this normal foraging range. In addition, the Dorrigo MSS area does not contain any topographical features (e.g. offshore islands) where species aggregate. Any temporary dispersal of prey species (e.g. pelagic fish, cephalopods) is not expected to result in a significant impact on prey species availability which would be of biological significance to foraging seabirds or result in a net reduction in feeding opportunities. With the survey vessel constantly moving, impacts are localised, temporary and recoverable.

Penguins: Penguins communicate via calls (vocalisations) for mate and chick recognition. The hearing capabilities of birds are complex and poorly understood and while some information is available on underwater hearing capabilities of cormorants, virtually no research has been undertaken on hearing in penguins (Pichegru et al, 2017). Inferences from taxonomically related birds and the vocalisation frequency suggests the little penguin hears best in frequency ranges above 1 kHz and below this, hearing becomes poor with a decrease in frequency (McCauley, 1994). This implies that the thresholds of perception for low frequency seismic sounds (10-300 Hz) will be high (McCauley et al, 1994). Joutventin (1982; cited in McCauley, 1994) observed that the spectral character of little penguin songs had a main frequency range of 200-1950 Hz with a mean spectral frequency peak at 601 Hz and a highest frequency between 700-6000 Hz. Joutventin (1982; cited in McCauley, 1994) found filtering out the low frequency portion of the song (< 500 Hz) had no effect on the penguin response, an observation which supports the notion that penguins have poor low frequency sensitivity (at least in air). No record of little penguins producing underwater sound is documented (McCauley, 1994). While knowledge of vocalisation at sea remains very limited, contact calls have been recorded for penguins at the surface when at sea (Pichegru et al, 2017).

Pichegru et al (2017) investigated the foraging behaviours of endangered African penguins (*Spheniscus demersus*) before, during and after seismic operations conducted within 100 km of the two largest breeding populations in South Africa over the period March to May 2009-2013. The study identified that when seismic activity took place in March 2013, the closest breeding population switched foraging direction and foraged significantly futher away from the centroid of the seismic activity during that period (i.e. 77 km, compared with ca 65 km on average in the absence of seismic activity). By contrast the second colony, regardless of seismic activity had no significant change in direction or foraging effort. Penguins foraging < 100 km from the active seismic operations showed a clear change of foraging direction, increasing their distance between feeding area and the location of the seismic. The 2D seismic survey utilised a 4230 in^3 source array at a shot point interval of 25 m over a 35-day period over water depths between 50 – 3000m.

Pichegru et al (2017) observed that the African penguins quickly reverted to normal foraging behaviour after the cessation of seismic activities, suggesting a short-term influence of seismic activity on these bird's behaviour and/or their prey. The study also noted that most bird and fish species have the capacity to regenerate lost or damaged sensory cells of the ear, although the study could not rule out potential longer-term impacts on hearing ability as the biological significance of altered behaviours during seismic surveys is difficult to measure. African penguins are known to respond to underwater vocalisation of predators (Frost et al, 1975; cited in Pichegru et al, 2017) and noise pollution may affect their capacity to detect the presence of a predator with potential negative consequences for survival. Increasing energy expenditure at sea to located food can also negatively affect penguins' reproductive output (Boersma & Rebstock, 2009; cited in Pichegru et al, 2017).

Based upon Pichegru et al (2017) sound produced from the Dorrigo MSS may affect the foraging behaviour of penguins located nesting Christmas Island for the duration of the survey (35 days). To place this impact in context the following is relevant:

- The penguin population on Christmas Island is estimated at ~11,900 breeding pairs (DoEE, 2018b) which is 6-11% of the Tasmanian population[53] or 2.5% of the Australian/New Zealand[54] population;
- The Dorrigo MSS is temporally positioned to avoid the higher productivity Bonney upwelling period (November to April) which is concident with chick raising (November to January) (PIPF, 2018) which requires higher feeding frequency and larger meals;
- The Dorrigo MSS is temporally positioned over the inter-breeding/egg-laying period of the reproductive cycle of the little penguin. During moult-recovery (March+) and prior to egg-laying, little penguins build and increase body mass via extended foraging trips with low presence at colonies as winter has the lowest productivity in temperate waters (Salton et al, 2015). For seasons where high body mass can be accrued, early egg-laying is possible (e.g. September versus a later November timeframe) leading to breeding success and assisting parents in fasting during egg incubation (Salton et al, 2015). This fasting ability is important for bi-parental care as it allows parents to continue incubation if the partner has an extended foraging trip (Salton et al, 2015). The Dorrigo MSS temporally overlaps either the egg-laying period (for early egg-laying penguins where the season has resulted in good conditioning) or the inter-breeding period. For behavioural disturbances which may lead to

53 Tasmanian estimates range from 110,000-190,000 breeding pairs (PWS, 2018).

54 The little penguin, endemic to Australia and New Zeakand is estimated at 469,769 breeding pairs (Birdlife International (2018).

a change in foraging, this stage of the reproductive cycle is not considered as significant as chick-provisioning;

- Foraging behaviours return to normal quickly after the cessation of survey activities (Pichegru et al, 2017).

Summary:

Consequence Level (Injury): The potential for injury to individual seabirds present in proximity to the operational array is possible, however with the displacement of pelagic species (i.e. reduced localised foraging potential) these impacts are unlikely. Impacts are localised, transitory and recoverable (Negligible consequence).
Consequence (Foraging Seabirds): Impacts to prey species are predicted to the localised, temporary and recoverable resulting in no net reduced feeding opportunities for seabirds (Negligible consequence).
Consequence (Foraging Penguins): Impacts to penguins located on Christmas Island are expected to be localised and short-term given the temporal overlay of the Dorrigo MSS with the reproductive cycle of the species. Localised, temporary and recoverable effects (Negligible consequence).

Controls Assessment:
Table 7-25 provides an assessment of possible controls to reduce impacts to avifauna from the Dorrigo MSS activity.

Table 7-25: Assessment of possible controls to avifauna

Control Measure	Practicable?	Will it be implemented?	Justification
Temporal Exclusion: No seismic acquisition undertaken in the Dorrigo MSS area during the Bonney upwelling (coincident with penguin chick-provisioning period).	Yes	Yes	3D Oil has positioned the Dorrigo MSS timeframe to not overlap the Bonney upwelling period and the period which covers chick provisioning activities. **Control effective and adopted.**
Spatial Buffers: Adopt spatial controls (i.e. 100 km) to the little penguin BIA surrounding Christmas Island to prevent foraging impacts.	No	No	Adoption of a spatial buffer to 100 km around the Dorrigo MSS area will eliminate all of the Dorrigo acquisition area. This will not meet 3D Oil's obligations to the Australian government. 3D Oil has adopted temporal buffers to prevent overlap with "high foraging" related activities associated with chick-raring. While some foraging impacts might be expected, the life-cycle stage affected (inter-breeding/egg-laying period) will not significantly affect the small population of penguins within 100 km. **Control does not offer significant environmental benefits compared with the cost of not meeting contractual obligations.**
Control: Implement EPBC Policy Statement 2.1 (Part A) procedures (*pre-start-up visual observation to 3 km*)	No	No	Visual observation protects marine mammals in proximity to the acoustic source from being exposed to high levels of sound in the water. Birds present on the water surface are not affected by sound in the water. Control is not relevant to avifauna.

Control Measure	Practicable?	Will it be implemented?	Justification
Control: Implement EPBC Policy Statement 2.1 (Part A) procedures (*soft start procedures*)	Yes	Yes	Soft-start procedures will assist in displacing sound sensitive prey species from areas where ensonification may be damaging. This will asssit in displacing prey species (fish, celphalopods) from the survey area which will inturn displace foraging bird species. Control adopted.
Control: Implement EPBC Policy Statement 2.1 (Part A) procedures (*Implementation of precaution and shut-down zones*)	No	No	Visual observation and implementation of precaution and shut-down zones protect marine mammals in proximity to the acoustic source from being exposed to high levels of sound in the water. Birds present on the water surface are not affected by sound in the water. **Control is not relevant to avifauna.**
Source Reduction: Minimise the sound intensity and exposure time of surveys	Yes	Yes	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. Control adopted.
Monitoring: In addition to whale management, MFOs and crew will monitor for other marine fauna including seabirds.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds, turtles and seabirds. **Control adopted.**
Alternate Technologies: Use of quieter technologies (silenced air guns, marine vibrators, DTAGS)	No	No	3D Oil has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Dorrigo MSS. Other than eSource (a technolology which reduces the amount of higher frequency components) which would cost $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis to 3D Oil and geophysical objectives of the survey may not be met resulting in large gaps of data. **Control not adopted.**

7.2.3.7 Cetaceans

Cetaceans use sound for foraging, orientation, communication, navigation, location of prey and predator avoidance and are therefore sensitive to underwater sound. High levels of anthropogenic sound can cause loss of hearing sensitivity, deafness, behavioural change, displacement from important habitat, induced stress responses and individuals' ability to detect, recognise and /or discriminate sounds used for foraging, conspecific communications, navigation and predator/hazard avoidance (Gomez et al., 2016).

The effect of sound on cetaceans depends on factors including the hearing sensitivity of the species, the sound exposure level, the location of the animal in relation to the sound, exposure history, repetition frequency and the ambient sound level. The context of the exposure plays a critical and complex role in the way in which the animal might respond (Gomez et al., 2016).

Hearing sensitivity in cetaceans is based upon the frequency range of hearing and their thresholds of hearing (i.e. level at which they perceived noise). Based upon the current knowledge of functional hearing, Southall et al. (2007) defined three functional hearing groups in cetaceans based upon the frequency range at which their hearing is sensitive: a) low frequency cetaceans (7 Hz to 35 kHz); b) mid-frequency cetaceans (150 Hz to 160 kHz); and c) high frequency cetaceans (275 Hz to 160 kHz) (NMFS, 2016). The cetacean species listed in the EPBC Protected Matters Database as possibly having habitat present in the Dorrigo MSS together with their functional hearing group are listed below.

Table 7-26: EPBC-listed cetaceans in the Dorrigo MSS Area

Scientific Name	Common Name	EPBC Act Status	Functional Hearing Group
Balaenoptera acutorostrata	Minke Whale	L	Low
Balaenoptera bonaerensis	Antarctic Minke Whale	M	Low
Balaenoptera borealis	Sei Whale	V,M	Low
Balaenoptera musculus	Blue Whale*	E, M	Low
Balaenoptera physalus	Fin Whale	V, M	Low
Berardius arnuxii	Arnoux's Beaked Whale	L	Mid
Caperea marginata	Pygmy Right Whale	M	Low
Delphinus delphis	Common Dolphin	L	Mid
Eubalaena australis	Southern Right Whale	E, M	Low
Globicephala macrorhynchus	Short-finned Pilot Whale	L	Mid
Globicephala melas	Long-finned Pilot Whale	L	Mid
Grampus griseus	Risso's Dolphin	L	Mid
Kogia breviceps	Pygmy Sperm Whale	L	High
Kogia simus	Dwarf Sperm Whale	L	High
Lagrnorhynchus obscurus	Dusky Dolphin	M	Mid
Lissodelphis peronii	Southern Right Whale Dolphin	L	Mid
Megaptera novaeangliae	Humpback Whale	V, M	Low
Mesoplodon bowdoini	Andrew's Beaked Whale	L	Mid
Mesoplodon densirostris	Blainville's Beaked Whale	L	Mid
Mesoplodon grayi	Gray's Beaked Whale	L	Mid
Mesoplodon hectori	Hector's Beaked Whale	L	Mid
Mesoplodon layardii	Strap-toothed Beaked Whale	L	Mid
Mesoplodon mirus	True's Beaked Whale	L	Mid
Mesoplodon ginkgodens	Ginkgo-toothed whale	L	Mid
Orcinus orca	Killer Whale	M	Mid

Scientific Name	Common Name	EPBC Act Status	Functional Hearing Group
Physeter macrocephalus	Sperm Whale*	M	Mid
Pseudorca crassidens	False Killer Whale	L	Mid
Tursiops aduncus	Indian Ocean Bottlenose Dolphin	L	Mid
Tursiops truncatus s. str.	Bottlenose Dolphin	L	Mid
Ziphius cavirostris	Cuvier's Beaked Whale	L	Mid

** BIA (foraging) present within Dorrigo OA for these species.*

Baleen whales (e.g. blue and SRWs) are considered the most sensitive of the marine mammals to seismic arrays due to their use of low-frequency signals (Range: 12 Hz-8 kHz but predominantly less than 1 kHz) for communication (McCauley, 1994). These species produce sounds with high source levels. McCauley et al. (2003) reported humpback whale song components reaching 192 dB re 1µPa (PK-PK) as well as 180-190 dB re 1µPa (PK-PK) for humpback pectoral fin slapping and breachings sounds.

Odontocetes (i.e. toothed whales) produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The frequency range of toothed whale sounds excluding echo location clicks are mostly <20 kHz with most of the energy typically around 10kHz, although some sounds may be as low as 100-900 Hz. Sound levels of these calls range from 100 to 180 dB re 1µPa (Richardson et al., 1995). The sounds produced (other than echolocation clicks) are very complex and used for communication between members of a pod and coordinating feeding activity.

<u>Temporary and Permanent Hearing Loss</u>

Species Sensitivity:

PTS occurs when an animal experiences a shift in their hearing threshold caused by prolonged or repeated exposure to high sound levels from which an animal does not recover (permanent hair cell or receptor damage). While the loss of hearing sensitivity is usually strongest in the frequency band of the emitted noise, it is not limited to frequency bands where the noise occurs but can affect a broader hearing range.

TTS occurs when an animal's hearing threshold is temporarily increased during and immediately after sound exposure whereas PTS is hearing loss from which an animal does not recover (Richardson et al., 1995). TTS severity is expressed as a magnitude and duration of hearing sensitivity shift relative to pre-exposure sensitivity. The relationship between these two thresholds is complex since PTS can either be induced from a single high-level noise exposure or by chronic (longer term) noise exposure at lower levels (Southall et al., 2007). The threshold for auditory injury is therefore taken as the level at which PTS starts to occur, based on the overall noise dose received over time. Given that PTS cannot be ethically or legally induced in animals to determine the threshold, Southall et al. (2007) proposed for PTS-onset sound criteria should be extrapolated from TTS-onset criteria and the relationship between the relative levels of noise likely to cause TTS and PTS.

It is noted that there are different mechanisms (e.g. anatomical, neurophysiological) associated with TTS versus PTS onset making the relationship between these types of thresholds not completely direct, however the only data available for marine mammals is from TTS studies (NMFS, 2016). This method also provides a conservative estimate of the noise levels likely to induce permanent injury.

TTS data from impulsive airgun sources on cetaceans has been measured in the following studies:

- Finneran et al. (2002) reported behaviourally-measured TTS of 6 and 7 dB in a beluga exposed to single pulses (186 dB re 1µPa^2.s (SEL), 224 dB re 1µPa (PK)); and
- Lucke et al. (2009) reported measured TTS of 7 to 20 dB in a harbour porpoise exposed to single impulses (162 dB re 1µPa^2.s (SEL), 195 dB re 1µPa (PK)).

Several impulsive noise studies have also been conducted without measurable TTS. Finneran et al. (2002) exposed belugas and dolphins to single pulses from an 'explosion simulator" (179 dB re 1µPa^2.s (SEL), 217 dB re 1µPa (PK)); and Finneran et al. (2015; in NOAA, 2016) exposed three dolphins to sequences of 10 impulses from a seismic airgun (193 dB re 1µPa^2.s (SEL), 196-210 dB re 1µPa (PK)) without measurable TTS (NMFS, 2016). These TTS studies observe odontocetes exposed to impulsive sounds, however there is not data for mysticetes as TTS has not been observed.

TTS impacts in cetaceans are thought to have very similar effects to masking: a reduction in foraging efficiency, reproductive potential, social cohesion and ability to detect predators (Weilgart, 2007).

Adopted Impact Thresholds for Injury:

In 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing and propose new noise exposure criteria. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included a peak pressure level threshold (PK) and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of three cetacean species hearing groups: Low-, Mid- and High-Frequency Cetaceans (LFC, MFC, and HFC respectively). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of TTS in belugas by the amount of TTS required to produce PTS in chinchillas.

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LFC and HFC while retaining the filter shapes. Revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HFC of 179 dB re 1 µPa^2·s. Because there was no data available for baleen whales, Wood et al. (2012) based their recommendations for LFC on results obtained from MFC studies. In particular they referenced Finneran et al (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed.

As of 2018, an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for cetacean injury. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature, NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2018). The guidance describes PTS injury criteria with new thresholds and frequency weighting functions for the three cetacean hearing groups described by Finneran and Jenkins (2012).

The recommended PTS thresholds as defined by NFMS (2018) are provided in **Table 7-27** and are adopted as injury assessment criterion in this EP.

The *EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales* determines exclusion zones based on an unweighted per-pulse SEL threshold of 160 dB re 1µPa^2.s (DEWHA, 2008). This threshold minimises the likelihood of hearing impairment (TTS) in mysticete and large odontocetes (DEWHA, 2008). The EPBC Policy Statement 2.1 does not apply to smaller dolphins and porpoises as DEWHA assessed these cetaceans as having peak hearing sensitivities occurring at higher frequency ranges than those that seismic arrays typically produce.

Table 7-27: The SPL, SEL, SEL_{24h} and PK Thresholds for acoustic effects on cetaceans. Injury is measured as permanent thresholds shift (NMFS, 2018)

Hearing Group	DEWHA (2008)	NMFS (2016)	
	Unweighted per-pulse SEL (dB re 1µPa^2.s)	Injury (PTS)	
		Weighted SEL_{24h} (dB re 1µPa^2.s)	PK (dB re 1µPa)
Low Frequency Cetaceans	160	183	219
Mid-Frequency Cetaceans		185	230
High Frequency Cetaceans		155	202

Extent and Duration of Exposure and Identified Potential Impact (Injury):
Based upon the acoustic modelling undertaken for the Dorrigo survey location, the $R_{95\%}$ 160 dB re 1µPa^2.s single pulse SEL ranged from 3.05-3.61 km at the different sites modelled across the survey area (Warner et al, 2018). As this distance exceeds 1 km, the EPBC Policy Statement 2.1 requirement for power-down zones of 2 km is adopted for the Dorrigo survey in accordance with EPBC Policy Statement 2.1.

Table 7-28: Maximum over depth results for weighted SEL_{24hr} PTS thresholds based upon NOAA Technical Guidance (2016) for the entire water column. A dash indicates the threshold was not reached (Warner et al, 2018).

Hearing Group	Weighted SEL_{24h} (dB re 1µPa^2.s)		PTS		TTS	
	PTS	TTS	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
Low-frequency	183	168	2.48	615	78.7	7640
Mid-frequency	185	170	-	-	<0.05	1.05
High-frequency	155	140	<0.05	2.10	0.27	83.4

Table 7-29: Maximum (R_{max}) horizontal distances (km) from the 3260in^3 array to the modelled maximum-over-depth peak pressure level (PK) threshold based on the NOAA Technical guidance (2016) (Warner et al., 2018)

Hearing Group	**PK Threshold (dB re 1µPa)**		**Site 1**		**Site 2**		**Site 3**	
			116 m		**105 m**		**133 m**	
	PTS	**TTS**	**PTS**	**TTS**	**PTS**	**TTS**	**PTS**	**TTS**
Low Frequency	219	213	<0.04	0.06	<0.04	0.06	<0.04	0.06

Mid Frequency	230	224	-	<0.04	-	<0.04	-	<0.04
High Frequency	202	196	0.36	0.66	0.40	0.72	0.38	0.68

Table 7-28 and **Table 7-29** provide acoustic modelling results for cetacean PTS thresholds by cetacean hearing group for locations across the Dorrigo OA for PK and SEL_{24hr} metrics. Modelling predicts:

- For LF cetaceans (i.e. baleen whales):
  - PTS**:** Unmitigated sound exposures exceed PTS thresholds at a maximum horizontal distance of < 40 m (PK) and 2.48 km (SEL_{24hr}) from the operational array. The SEL_{24hr} is a cumulative metric assuming an animal is constantly exposed to 'injury' noise levels at a fixed position relative to the vessel for 24 hrs and represents an unlikely worst-case scenario. More realistically, cetaceans would not stay in the same location or same range for 24 hrs given the constant movement of the survey vessel and individual cetacean movement. Therefore, a reported radius for the SEL_{24hr} does not mean that the marine fauna travelling within this radius will be injured, but rather that an animal could be exposed to a sound level associated with PTS if it remained in that range for 24 hours. The maximum areas receiving the frequency-weighted SEL_{24hr} PTS threshold is 615 km^2 over a 24-hour period which is 1.7% of the Otway bioregion.
  - TTS**:** Unmitigated sound exposures exceed TTS thresholds at a maximum horizontal distance of 60m (PK) and 78.7 km (SEL_{24hr}). The SEL24hr footprint is provided in **Figure 7-12** with the longest range extending into deep waters in a westerly direction. Note that the SEL_{24hr} footprint does not encroach on the SRW connecting corridor BIA present along the King Island coastline, the coastal migration and resting BIA along the Otway coastline (VIC) or the calving BIA located at Logan's Beach (VIC).

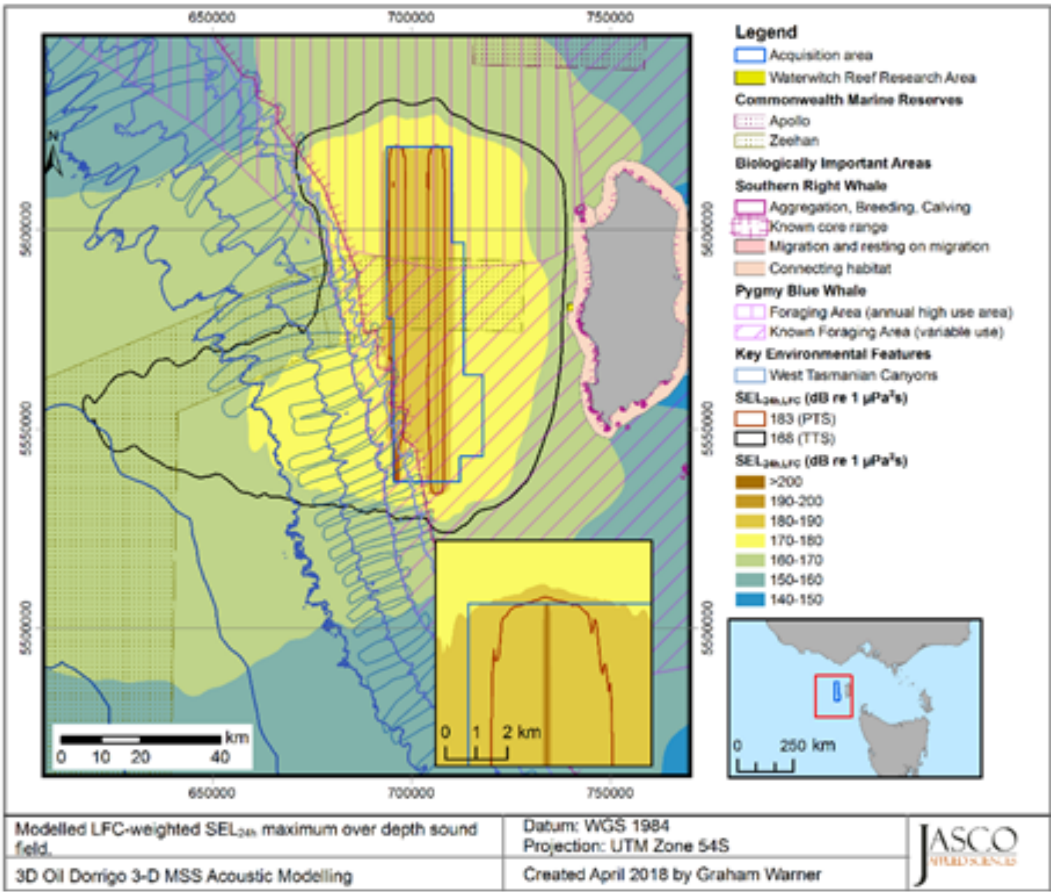
    For migrating LF cetaceans transiting within a radius of 78.7 km of the operational array in deeper waters, individual animals may be exposed to TTS sound levels if the animal remains within that range for 24 hours. No recognised migration pathways or migration BIAs for LF cetaceans lie within this TTS SEL_{24hr} footprint. Given this, and the constant movement of migrating species, TTS impacts over a 24-hr period are very unlikely.
- For MF Cetaceans (i.e. sperm and beaked whales, common dolphin):
  - PTS: Unmitigated sound exposures do not exceed PTS thresholds on a PK or SEL_{24hr} basis; and
  - TTS: Unmitigated sound exposures exceed TTS thresholds at a maximum horizontal distance of <40m (PK) and <50 m (SEL_{24hr}) from the operational array.
- For HF cetaceans (i.e. pygmy and dwarf sperm whale):
  - PTS: Unmitigated sound exposures exceed PTS thresholds at a distance of 400 m (PK) and < 50 m (SEL_{24hr}); and
  - TTS: Unmitigated sound exposures exceed TTS thresholds at a maximum distance of 702 m (PK) and 270m (SEL_{24hr}) from the operational array.

For all cetaceans (LF, MF, HF) injury is possible without mitigation. The Dorrigo MSS will implement a shutdown zone of 500m and a 2000m low-power zone around the operational array to protect cetaceans against PTS and TTS injury, compliant with EPBC Policy Statement Guideline 2.1 requirements. For all cetaceans, injury may occur if the acoustic array is started suddenly with cetaceans nearby. With soft start procedures also implemented, injury to cetaceans is not predicted as individual animals are expected to displace from areas where physical damage might occur. In circumstances where the acoustic array is operational, acoustic source shutdown and low-power zones will protect all cetaceans from injury.

Based upon this analysis, implementation of a low power and shutdown zones will protect LF, MF and HF cetaceans from PTS/TTS injury during Dorrigo acquisition activities.

Overlap with Critical Habitat and Periods of Activity:
The Dorrigo MSS area spatially overlaps the pygmy blue whale foraging BIA (high annual use area; known foraging area) which coincides with high productivity during the Bonney upwelling periods. The Dorrigo MSS has been positioned outside the upwelling timeframe to prevent any disturbance to foraging activities.

Figure 7-12: Sound level contour map showing low-frequency cetacean weighted maximum-over-depth SEL_{24hr} results (Warner et al, 2018).



The Conservation Management Plan for the Blue Whale (DoE, 2015) and EPBC Policy Guidelines require surveys to be undertaken outside BIAs at biologically important times. The temporal placement of the Dorrigo MSS has observed this requirement with the selection of September-October as the survey timeframe. The Conservation Management Plan for the Blue Whale (DoE, 2015) also identifies the risk of physical impact is minimised by the implementation of the practical control measures outlined in the EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. This includes the implementation of a shutdown and low power zones for acoustic array operations, and soft-start procedures prior to full array operation. Control measures for reliably ensuring these shut-down/power-down distances are activated are contained in **Table 7-32**.

The Dorrigo MSS timeframe is coincident with the presence of SRW along the southern coastline of Australia and lies adjacent to a low-use “connecting habitat BIA” present around the Tasmanian coastline in shallow waters including King Island (DoEE, 2018b). Modelling predicts that for SRW species if present within this corridor during the Dorrigo MSS, no PTS/TTS impacts. PTS/TTS sound impacts are not predicted to affect Victorian coastal “migration and resting on migration BIA” areas.

Summary:

Consequence Level (PTS/TTS Injury): Without EPBC Policy Statement 2.1 control measures implemented, individual whales present in proximity to the operating array may be injured leading to disruption to a small portion of the population with temporary effects on critical habitat (based on blue whale BIA) (SIGNIFICANT consequence). After adoption of controls in *EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (Part A)* injury impacts are not expected and effects are expected to be incidental to the species (NEGLIGIBLE consequence).

Behavioural Disturbance

Species Sensitivity:
In considering behavioural responses in cetaceans, Southall et al. (2007) discussed a range of possible cetacean behavioural reactions including orientation or attraction to a sound source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat abandonment and in severe cases, panic and flight. An individual animal's response to a stimulus is influenced by the context in which the animal has received the stimulus and how relevant the stimulus is to the individual. A number of biological and environmental factors can affect the animal's response – behavioural state (e.g. foraging, travelling or socialising); reproductive state (e.g. female with or without calf, or single male), age (juvenile, sub-adult, adult), and motivational state (e.g. hunger, fear of predation, courtship) at the time of exposure as well as perceived proximity, motion, and biological meaning of the sound nature of the sound source. For example, observations indicate the SRW females appears more sensitive to sound disturbance at the start of the calving season. Once they are on calving grounds and give birth, they tend to be more settled (AMMC, 2009).

Animals might temporarily avoid anthropogenic sounds, but could display other behaviours, such as approaching novel sound sources, increasing vigilance, hiding and/or retreating, that might decrease their foraging time (Purser and Radford 2011). Marine mammals have also reduced their vocalisations in response to anthropogenic sounds, sometimes ceasing to call for weeks or months (Weilgart, 2007). Some cetaceans might also compensate for masking, to a limited degree, either by increasing the amplitude of their calls or by changing their spectral or temporal vocalisation properties (Hotchkin and Parks 2013). Whales seem most reactive when the sound level is increasing, which they may perceive as an approaching sound. An animal may exhibit a startle effect at the onset of a sound. Although limited data is available, cetaceans respond less to stationary anthropogenic activities that produce continuous sounds (such as dredging, drilling, and oil-production-related activities) than they do to moving and/or transient sound sources, including seismic surveys and ships (Richardson et al. 1995). Some cetaceans may also partially habituate to continuous sounds (Richardson et al. 1995).

Mysticises
There are limited behavioural studies on seismic sound impacts to mysticetes and more particularly to (southern) right whales, a species with a seasonal presence in the area coincident with the Dorrigo MSS survey timeframe. Most studies relate to northern right whales with respect to ship noise. Nowacek et al (2004) observed no avoidance behaviour in response to simulated ship noise; mild behavioural changes in response to playbacks on con-specific sounds; and avoidance of long-duration, tonal synthetic 'alarm' sounds. Parks et al (2007, 2011) observed an alteration of vocal behaviour in the presence of noise and Rolland et al (2012) identified increased evidence of stress hormones in the species in the presence of ships.

While there are limited behavioural response studies relating to right whales, other mysticete behavioural response studies are considered relevant. These include:

Foraging Behavioural Changes:

- Richardson et al. (1995) observed foraging bowhead whales avoid airguns when received levels reached 152-178 dB re 1µPa (SPL), roughly 10,000 times louder than avoidance levels when the whales are migrating;
- Cummings (2009) in a review of sound impacts to foraging behaviour in whales observed an emerging pattern of (at least occasional) changes in foraging at sound levels of 170 dB re 1µPa (units not specified) or less;
- McCauley et al. (1998b) observed foraging humpback whales showed behavioural responses commencing at levels 150-159 dB re 1µPa (SPL);
- Malme et al., (1985) observed foraging humpback whales responded up to 3 km from a single 100 in^3 airgun at received levels of 150-169 dB re 1 µPa;
- Yazvenko et al., (2006) confirmed no statistically significant effect to foraging gray whale behaviour during a 3D MSS using pre-seismic, post-seismic and during seismic aerial observations. Mitigations used in the survey minimised the number of gray whales exposed to received sound levels of 163 dB re 1µPa (SPL). This exposure threshold was based on avoidance observations for eastern gray whales by Malme et al. (1986) where the data estimated a 10%, 50% and 90% probability of gray whale avoidance reaction at 163, 170 and 180 dB re 1µPa (SPL) respectively (Nowacek et al., 2012). It concluded that the 2001 MSS had no measurable effect on bottom feeding activity of western gray whales off Sakhalin Island. Yazvenko noted high variability in the feeding activity index (*the index used as to equate feeding activity of whales in the area*) and therefore admitted low experimental power in his study.

Migration and resting behavioural changes:

Behavioural studies undertaken into migration and resting behaviour changes include the following:

- McCauley et al. (2000b) observed the following humpback whale behaviour from an operating 2678 in^3 seismic array in ~ 120 m water depths;
  - Stand-off (i.e. closest distance of approach by animals to source) for migrating humpbacks was observed at an approximate distance of 1.8-4.6 km at received sound levels of 157-164 dB re 1µPa (SPL). These results were consistent with sound exposure/distances observed for gray whales of 160 dB re 1µPa SPL (Malme et al., 1985) (*refer below*) and for gray and bowhead whales of 150-180 dB re 1µPa SPL (Richardson et al., 1995);
  - Resting cow-calf pods began avoidance at 9 – 15 km from the operating array and received sound level of 140 dB re 1µPa (SPL) although other cohorts reacted at higher levels (157-164 dB re 1µPa);
  - Resting cow-calf pods began standoff at 7.3-12 km and received sound level of 143 dB re 1µPa (SPL); and
  - A single operational air-gun was tolerated by investigating (probable) male humpbacks at 0.65 – 1.1 km and a received sound level of 179 dB re 1µPa (SPL).

  McCauley et al (2000b) observed that resting cow-calf pods were more sensitive to the approach of air-guns than animals involved in purposeful migratory swimming behaviours. Humpback whale pods on an interception course with the survey vessel, maintained course until 4-5 km from the operational array where bearing and speed adjustment were observed with an avoidance range of approximately 3 km around the operational array. McCauley et al (2000) concluded that 'any risk factor associated with the seismic survey was confined to a comparatively short period and small range displacement' (p177).

- Malme et al (1983;1984) documented behavioural reactions of migrating gray whales to seismic pulses. The study concluded that received levels exceeding 160 dB re 1µPa (SPL) were required to cause migrating gray whales to avoid airgun sounds, although statistically significant reactions that were less profound occurred at much lower received levels. Malme et al (1984) calculated 10, 50 and 90% probabilities of gray whale avoidance reactions in these conditions to 164, 170 and 184 dB re 1µPa respectively;
- Migrating bowhead whales, at received levels from 120-130 dB re 1µPa (SPL), showed strong avoidance reactions to an operating acoustic array (Richardson et al, 1999; Manley et al, 2007), however while feeding remained in the area until sound levels exceed ~ 160 dB re 1µPa (SPL) (Richardson et al, 1986; Ljungblad et al., 1988; Miller et al, 1995);
- Dunlop et al (2017) as part of the BRAHSS Project, observed that humpback whales were more likely to avoid an operational airgun array within 3 km of the source at received noise levels over 140 dB re 1µPa^2.s (SEL) meaning that both the proximity and the received level were important factors and the relationship between dose (received level) and response is not simple. The 'control' in this study was the noise effects of the vessel without the array operating and behaviour assessment was determined in change in movement behaviour (i.e. a decrease of speed of movement and/or an increase in course deviation). When controlling for the received level, humpback groups had a greater response to a smaller source size (which was closer) than to the larger source illustrating that proximity to the source is also important.

  Dunlop et al (2017) noted that the derived values (exposure and distance) for this particular study did not represent a response threshold, but responses were more likely to occur within those bounds than outside them. In addition the response was highly variable, in that some groups did not respond within these values while others responded outside them. That is, not all movement responses translated into an avoidance response; therefore, a change in movement behaviour should not be assumed to be avoidance of the source. Dunlop et al (2017) noted that the study is only applicable to migrating whales approaching a source vessel that is moving directly across their migratory path.

Odontocetes:
Dolphin and other toothed whale species seem to show a variety of reactions to MSS. Stone (2015) in a review of the effects of seismic on marine mammals in UK waters during the period 1994-2010 observed that cetaceans can be disturbed by seismic exploration. These findings included (Stone, 2015):

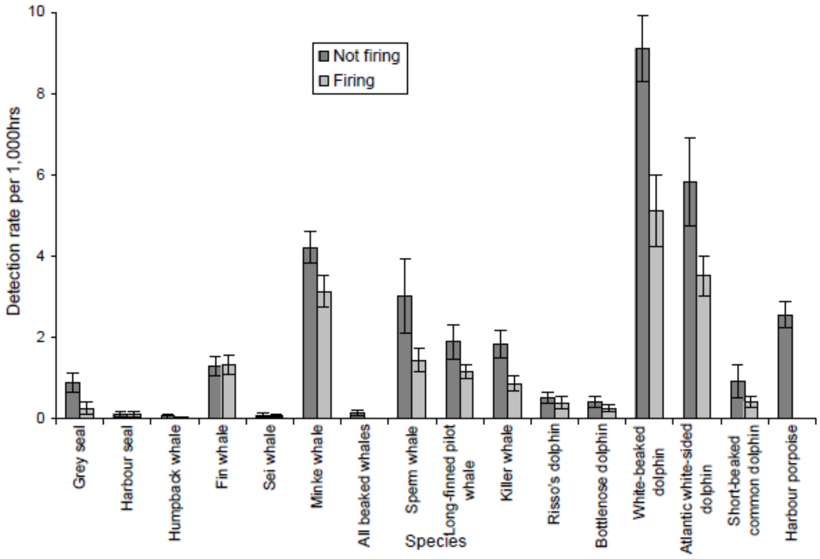
- When 'large arrays' of airguns (>500 in^3) were firing a significant response (lateral displacement, more localised avoidance or a change in behaviour) was evident for all small and medium-sized odontocetes (including beaked whales) where sample sizes permitted testing, except of Risso's dolphin. The minke and fin whales were the only individual species of baleen whale where a significant response to 'large arrays' was found. Lateral displacement, where found, sometimes extended beyond the visual range of the observer. Behavioural responses observed when 'large arrays' were firing included changes in swimming/surfacing behaviour and there were indications that cetaceans remained near the water surface at these times. Cetaceans were recorded as feeding significantly less often when 'large arrays' were active.

- On surveys with 'large arrays', detection rates were significantly higher when the airguns were not firing for the grey seal, minke whale, all beaked whales combined, killer whale, white-beaked dolphin, Atlantic white-sided dolphin and harbour porpoise (refer **Figure 7-13**).
- There was some evidence that the soft start was an effective mitigation measure. Detection rates of cetaceans during the soft start were significantly lower than when the airguns were not firing and on surveys with 'large arrays' more cetaceans were observed avoiding or travelling away from the survey vessel during the soft start than at any other time. These results were found for all species or species groups that were able to be tested.

Goold (1996) studied the effects on common dolphins (*Delphinus delphis*) over a three-month period before, during and after a 2D seismic survey in the southern Irish Sea. The results from this study suggested general avoidance by common dolphins to seismic sound. Monitoring during the period of the survey was restricted to the immediate vicinity (1-2 km) of the seismic vessel; however, observations suggest tolerance to sounds outside a 1 km radius of the operating array. Other studies also document that small odontocetes show some avoidance at distances less than 1 km (Stone 2003; Gordon et al. 2004), however some also approach the seismic vessel and even bow ride (Haley and Koski 2004; Smultea et al. 2004; Holst et al. 2005). Dall's porpoise also shows little avoidance of seismic survey vessels, but the harbour porpoise has been reported moving away from surveys at received levels < 155 dB re 1µPa SPL (Calambokidis and Osmek, 1998; Bain and Williams, 2006).

In contrast, sperm whales show little response to MSSs, but noise may disrupt/delay foraging and swim effort (Mate et al. 1994; Madsen et al. 2002; Stone 2003; Stone and Tasker 2006; Jochens et al. 2008; Miller et al. 2009). Miller et al. (2009) tagged 8 sperm whales, recording sounds and movement while exposing them to operating airgun arrays. For seven of the eight animals observed, they found that gross diving behaviour did not change. They did not change their buzz rates however oscillations in pitch were affected. One whale exhibited the longest resting period observed in any sperm whale (265 min.) and recommenced diving immediately after the final airgun pulse. Data from the seven whales which continued diving were assessed for alterations to foraging behaviour. Pre-exposure conditions were not compared with exposure conditions because of lack of data however full-array exposure and post-exposure control data for the seven whales were included in the analysis. During the operational period, the whales significantly reduced their pitching movements by 11% and all seven sperm whales studied reduced their fluke strokes on foraging dives in the presence of seismic noise. However, the analysis performed "*suggest that the odds favour the conclusion that there is a decrease in foraging attempts at exposure levels ranging from 111 – 147 dB re µPa SPL at ranges of approximately 1.4-12.6 km from the sound source*" (Jochens et al. 2008). Recognising the small sample size of the exposed subjects, definitive statistical significance could not be established for foraging effects. Miller et al. (2009) concluded that sperm whales in the highly exposed Gulf of Mexico habitat did not show any significant avoidance response to airguns but exhibited subtle effects on their foraging behaviour.

Figure 7-13: Mean Detection rates (& standard error) of marine mammals in relation to airgun activity on surveys with large arrays (Stone, 2015)



Weir (2008) studied the overt responses (i.e. not subtle responses) of sperm whales and Atlantic spotted dolphins from a seismic vessel off Angola between August 2004 and May 2005 (10-month survey period) using a dual source airgun array of volume 5085 in^3 or 3147 in^3. During the study, sperm whales showed few overtly observable responses to airgun sound. The following observations were made:

- The encounter rate and mean distance were similar during full array seismic and guns off although it is possible that individuals/groups may have spent longer periods at the surface during full array seismic, perhaps increasing their detection. The behaviour of sperm whales rarely changed during encounters, with animals frequently engaged in socialising bouts and feeding dives without obvious reaction as the active source passed. Over half of the sperm whale encounters consisted of nursery groups of calves, juveniles, and adult females;
- Atlantic spotted dolphin encounters occurred at a significantly greater distance from the airgun array during full power compared with guns off and positive approach behaviour by Atlantic spotted dolphins occurred only during the guns-off period; and
- There was no evidence for prolonged or large-scale displacement of any species from the region during the 10-month survey duration.

Madsen et al. (2002) observed the behaviour of adult sperm whales in polar waters during exposure to pulses from a remote (> 20 km) seismic survey. The estimated sound pressure received by the whales were 146 dB re 1µPa PK-PK (124 dB re 1µPa^2.s) in the frequency range 210-260 Hz. The whale’s exposure to the seismic survey pulses did not:

- Elicit observable avoidance and the whales stayed in the area for at least 13 days of exposure;
- Fall silent or change their normal vocal patterns during feeding dives;
- Cease clicking as reported from previous investigations, but two whales seemed to direct their high power, narrow-beam sonar towards the transmitter

The available literature generally supports that there is little behavioural effect of seismic sound on odontocetes. Some literature identifies, particularly for dolphin species, minor levels of displacement while the acoustic array is operational; and another, possible reduced levels of foraging.

Adopted Thresholds (behaviour):
Southall et al. (2007) extensively reviewed marine mammal behavioural responses to sound and found that most marine mammals exhibited varying behavioural responses between 140 and 180 dB re 1µPa (SPL) although some species in specific behavioural modes (i.e. migrating bowhead whales) respond to lower received sound levels. A lack of convergence of data from the multiple studies prevented the authors from suggesting explicit criteria. The causes for variation between studies included lack of control groups, imprecise measurements, inconsistent metrics, and context dependency of responses which included the animal's activity state.

Foraging: NMFS has historically used a relatively simple sound criterion for potentially disturbing a marine mammal. Currently, for impulsive sounds, the received sound threshold is 160 dB re 1µPa (SPL) for marine mammals (NMFS, 2018). For **foraging** mysticetes (e.g. blue, fin, sei and humpback whales) and odontocetes (e.g. sperm whale) this received sound level is adopted for assessing the onset of foraging disruption based upon the available scientific studies (Richardson et al, 1995; Cummings, 2009; McCauley et al, 1998; Malme et al, 1985; Yazvenko et al, 2006).

Mysticete Migrating and Calving Disturbance: Southall et al (2007) in their review of literature relating to behavioural response of low frequency cetaceans to seismic pulses developed an ordinal ranking of behavioural response 'severity' delineating behaviours which are considered biologically *unimportant* (i.e. relatively minor and/or brief responses including altered orientation behaviours, alert behaviour, minor changes in speed, direction and/or dive profile but not avoidance, moderate changes in respiration, minor cessation or modification in call behaviour) with more biologically significant ('relevant') responses related to avoidance of sound sources, alterations in foraging, reproduction or survival and vital rates. This approach recognises behavioural disturbance is graduated and that some noise induced changes in behaviour are more significant than others.

The Southall et al (2007) review identified onset of more significant behavioural responses from multiple pulses for migrating bowhead whales occurred at received levels around 120 dB re 1µPa (SPL) (Richardson et al, 1999). For all other low-frequency cetaceans (including bowhead whales not engaging in migration), significant behavioural response onset was observed at received levels of 150 – 160 dB re 1µPa (Malme et al, 1983, 1984; Richardson et al, 1986; Ljungblad et al, 1988; Todd et al, 1996; McCauley et al, 1998, 2000) or perhaps higher (Miller et al, 2005). There is essentially no overlap in the received levels associated with the onset of behavioural responses by members of these two groups based on information available. Low frequency cetaceans, other than migrating bowhead whales, appear much more tolerant of exposure to multiple pulses, although data is limited to a few species (primarily humpback and gray whales) (Southall et al, 2007).

Despite the numerous studies on marine mammal behavioural responses to sound exposure there is not yet consensus within the scientific community regarding the appropriate metric or sound levels useful for assessing behavioural reactions. It is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016; Gomez et al, 2016). Because of the complexity and variability of marine mammal behavioural responses to acoustic exposure, the NMFS has not yet released updated technical guidance providing criteria or thresholds for evaluating behavioural disruption (NMFS 2018).

Initially, the probability of inducing behavioural responses at 160 dB re 1 µPa (SPL) was derived from the HESS (1999) report which, in turn, was based on the responses of migrating mysticete whales to airgun sounds (Malme et al. 1983, Malme et al. 1984). The HESS team recognized that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above 140 dB re 1 µPa (SPL). An extensive review of behavioural responses to sound was undertaken by Southall et al. (2007, their Appendix B). Southall et al. (2007) found varying responses for most marine mammals between 140 and 180 dB re 1 µPa (SPL), consistent with the HESS (1999) report. Absence of controls, precise measurements, appropriate metrics, and context dependency of responses (including the activity state of the animal) all contribute to variability.

As a conservative measure, and based upon available scientific literature, biologically important behavioural responses (i.e. disturbance within calving BIAs) adopt an assessment threshold of 140 dB re 1µPa (SPL) within this EP. AMMC (2009) also identify that significant behavioural responses are unlikely if the received sound level was below 140 dB re 1µPa (SPL).

For purposeful migration within oceanic waters and coastal corridors, a threshold of 160 d B re 1µPa (SPL) is adopted for biologically important responses based upon observations of migratory humpbacks involved in purposeful migratory swimming behaviours (McCauley et al, 2000b).

Extent and Duration of Exposure and Identified Potential Impact:
Acoustic modelling performed for the Dorrigo MSS for the 160 dB re 1µPa (SPL) and 140 dB re 1µPa (SPL) has a maximum horizontal distance from the operational array as shown in **Table 7-30**.

Table 7-30: Maximum (R_{max}) horizontal distance (in km) from the 3260 in^3 array to modelled maximum over depth for the 160 dB re 1µPa SPL & 140 dB re 1µPa SPL (Warner et al., 2018)

Topographical Feature	Relevant Water Depth (m)	160dB re 1 µPa (R_{max}) (km)	140dB re 1 µPa (R_{max}) (km)
Continental Shelf	105	9.64	36.98
Continental Shelf	116	9.47	56.56
Shelf Break	133	9.58	141.4*

**Sound level met maximum modelling extent*

Cetaceans foraging within the Dorrigo MSS include the following:

- *Pygmy blue whale BIA* (foraging – high annual use BIA): Threats identified in the Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015) of relevance to the Dorrigo MSS includes sound interference. Specifically, this conservation plan requires that the EPBC Policy Statement 2.1 (*Interaction between offshore seismic exploration and whales*) is applied to all MSS and anthropogenic noise in BIAs will be managed such that any blue whale continues to use the area without injury and is not displaced from a foraging area. The Dorrigo MSS has been temporally positioned to fall outside of the high productivity Bonney upwelling period to ensure there is no overlap with blue whale foraging. With this control adopted no foraging area displacement is predicted within the BIA.

  Other threatened mysticetes may forage within the Dorrigo MSS area including the fin and sei whales although these species have not been sighted in the Otway basin during September/October (Gill et al, 2015) (refer **Section 5.4.5**). Threats identified in conservation advices for these species includes assessing and addressing anthropogenic impacts once the spatial and temporal distribution (including BIAs) are defined (note at this time these areas have not been established). These species are known to forage with pygmy blue whale species during upwelling events. The temporal placement of the Dorrigo survey is expected to prevent any foraging displacement or disruption for these species.

- *Sperm whale (foraging):* There are no foraging BIAs for the sperm whale within the Dorrigo MSS area. Sperm whales are known to forage within the canyon systems of the western Tasmanian canyon system and sperm whale presence has been observed in the Otway Basin during October (Gill et al, 2015) (refer **Section 5.2.5.6**). Modelling predicts that acquisition areas located close to shelf-break may be affected by received sound levels in excess of 160dB re 1µPa (SPL) which may disrupt/delay sperm whale foraging and swim effort (Mate et al. 1994; Madsen et al. 2002; Stone 2003; Stone and Tasker 2006; Jochens et al. 2008; Miller et al. 2009).

  This foraging disruption is expected to be localised and temporary given the following:
    - The Dorrigo MSS acquisition area spatially overlaps the west Tasmanian canyon system by 37 km^2 (0.27% of the West Tasmanian canyon system KEF[55]);
    - At any one time, if coincident spatially with the KEF, the maximum 160dB re 1µPa (SPL) footprint is 292 km^2 (2.2% of the west Tasmanian canyon system);
    - Given the constant movement of the seismic vessel, the timeframe that any one location is affected above 160 dB re 1µPa is 2.4 hrs (i.e. time to travel 19.16 km). As canyon areas affected by these sound thresholds occur in the south-western section of the acquisition area this exposure will be intermittent given acquisition lines lie predominantly on the continental shelf taking approximately 12-14 hours to acquire each line;
    - Sperm whales observed to reduce foraging activity during acquisition immediately resumed foraging once the operational array ceased operation (Miller et al. 2009);
    - No sperm whale displacement has been directly observed as a result of sound has been observed during acquisition activities (Mate et al. 1994; Madsen et al. 2002; Stone 2003; Stone and Tasker 2006; Jochens et al. 2008; Miller et al. 2009); and
    - Sperm whale prey species, such as the cephalopod, are also sound sensitive and may also displace to distances ~ 10km around the operational array (refer **Section 5.2.5**). This may *indirectly* lead to temporary displacement of the sperm whale due to the displacement of prey species however is not expected to lead to reduced foraging opportunities.

  Given the open ocean location of the Dorrigo MSS area, any sperm whale foraging impact is expected to be localised, temporary, intermittent and recoverable (i.e. NEGLIGIBLE consequence).

Migration:

The Dorrigo MSS area lies adjacent to a SRW coastal connecting corridor (BIA) along the western coastline of King Island; a resting during migration corridor (BIA) along the southern Victorian coastline and an aggregation (calving) BIA located 110 km from the nearest Dorrigo MSS boundary

55 Total area of West Tasmanian Canyons is 13,500 km^2 (Parks Australia, 2018)

between Portland and Warrnambool (VIC). **Table 7-31** provides the predicted received sound levels at the boundaries of these BIAs as modelled from the nearest Dorrigo MSS acquisition point.

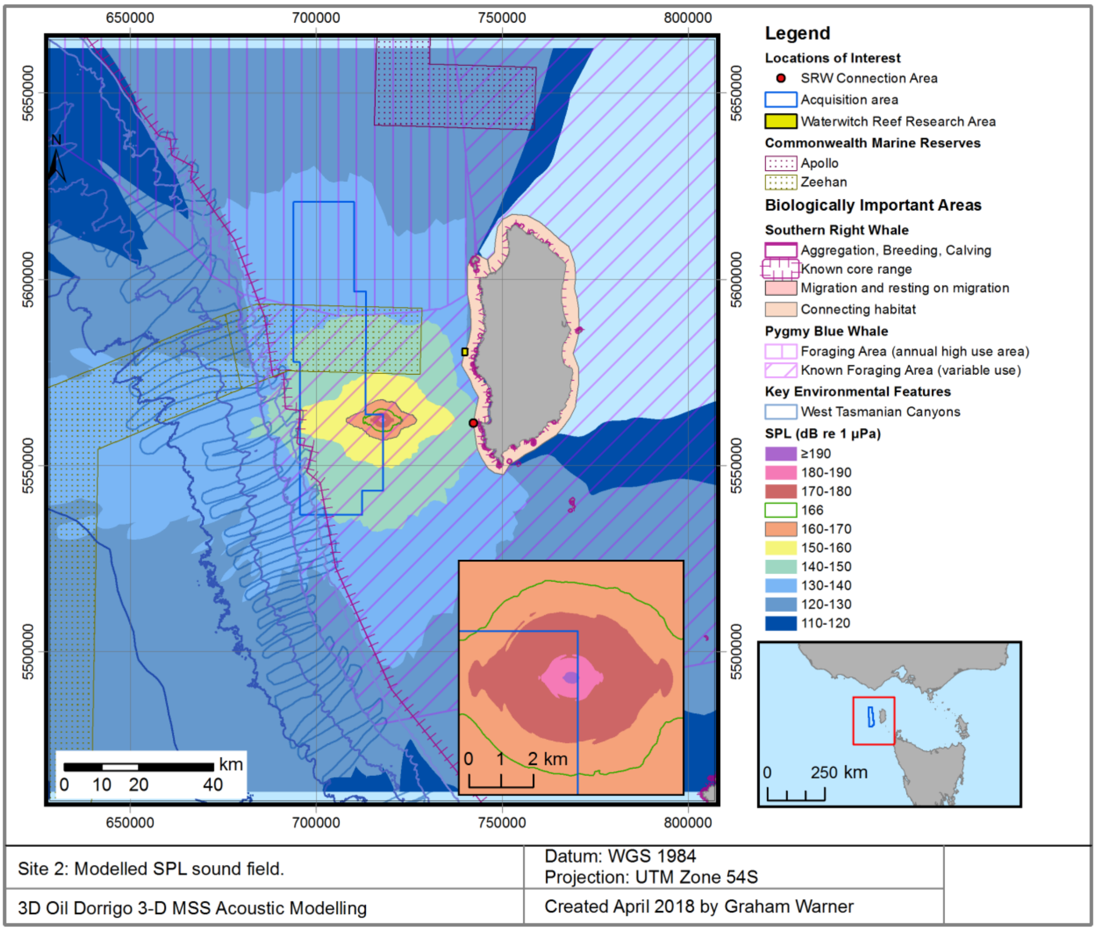
Table 7-31: Maximum over depth per pulse received levels at locations of interest for the 3260 in^3 array at Site 1 (closest Dorrigo MSS point to Victorian coastline) and Site 2 (closest Dorrigo MSS point to King Island) (Warner et al., 2018)

	SRW Calving BIA (from Site 1)	**SRW Resting while Migrating BIA (from Site 1)**	**SRW Connecting Corridor BIA (from Site 2)**
Received Sound Level (dB re 1μPa) (SPL)	116	122	147

Received sound levels at the calving BIA and at the resting during migration BIA along the Victorian coastline fall below 140 dB re 1μPa (SPL) with no significant behavioural impact predicted in these areas to SRW if present.

Received sound levels do not exceed 160 dB re 1μPa (SPL) at the closest point of the Dorrigo MSS to King Island and behavioural impacts to migration are not expected. Received sound levels at the connecting corridor BIA boundary will reduce as the acquisition activities move northwards and further away from the coast (refer **Figure 7-14**).

Figure 7-14: Site 2 (105 m water depth) Sound level contour map showing unweighted maximum over depth SPL results for the 3620 in^3 array towed at 1 m tow depth (Warner et al, 2018)



Based upon available scientific literature, received sound < 140 dB re 1µPa (SPL) is not predicted to cause avoidance within this coastal corridor, if SRW are present (Southall et al, 2007). The presence of SRW in this corridor is extremely unlikely due to the following:

- SRW sighting records identify most SRW sightings are along the east/south-east coast of Tasmania with most whales observed between June and August (AMMC, 2009);
- SRW sightings in King Island waters are low (1.2% of Tasmanian SRW sightings (13/1068 sighting records). Of these sightings, 12 were observed in the more sheltered waters of the east coast of King Island (AMMC, 2018) consistent with the SRW preference for protected, sheltered waters (AMMC, 2012). These waters are also protected from acoustic impacts from the Dorrigo survey area;
- Migratory movement, once SRWs reach southern Australian coastlines (e.g. Warrnambool the closest aggregation area), is generally in a westerly or southerly direction away from aggregation areas (SEWPC, 2012a; Mackay et al, 2015) reflecting observed behaviours in other southern hemisphere regions (Mate et al, 2011; Childerhouse et al, 2010). The Dorrigo MSS is positioned late within the SRW season, so migration away from aggregation areas (i.e. Warrnambool) is not likely to utilise King Island waters; and
- Cow-calf pairs are recorded in low numbers in Tasmania in most years (AMMC, 2012).

While coastal migratory pathways are reasonably well defined for the SRW, offshore migratory routes to/from the Australian coastline are less defined with tagging studies identifying cow/calf pairs migrate directly south as well as west during oceanic migrations (Charlton, 2015). Behavioural studies into MSS sound impacts to migrating mysticetes have observed some deviation as a result of an operational array (Dunlop et al, 2017; McCauley et al, 2000b; Richardson et al, 1999; Manley et al, 2007), however proximity to the operating source array, also appears to be a factor in the level of disruption to migration (Dunlop et al, 2017). With respect to the SRW life stages, females appear to be more sensitive to disturbance at the start of the season. Once they are on calving grounds and give birth, they tend to be more settled (AMMC, 2009). As the Dorrigo MSS is being undertaken in September/October, female SRW sensitivity to sound disturbance during offshore migration is not expected to be as high as migration to the coastline.

SRWs leave the adjacent Victorian coastal aggregation BIA (based on last sighting data) in September (50%) and October (42%) (SWIFFT, 2018). Available offshore migratory information indicates SRWs leave aggregation areas and migrate south or south-west to foraging grounds located at the sub-tropical convergence (SEWPC, 2012a; Mackay et al, 2015; Mate et al, 2011; Childerhouse et al, 2010). Based upon this information, and the distance to the nearest aggregation BIA (Warrnambool ~110 km), SRWs undergoing oceanic migration from this BIA are unlikely to be exposed to received sound levels > 140 dB re 1µPa (SPL) received at a maximum horizontal distance of 10 km from the operating array. Should SRW be present in the Dorrigo MSS migratory deviation to SRW undergoing oceanic migrations may occur. However these impacts, if realised will be temporary (i.e. time for SRW to migrate 10 km is ~ 2.4 hrs) and recoverable. Given SRW south-eastern sub-population levels, estimated to be 600 individuals of a total SRW population of 3500 individuals (Charlton et al, 2017), the number of whales affected by sound levels leading to a behavioural response is low and limited to one or a few individual whales. As the Dorrigo MSS is located in open ocean waters where there are no areas where sound would restrict migration or impede access from aggregation areas, impacts are predicted to be localised and temporary to a small proportion of the species population (MINOR consequence).

Other LF whale species: Other mysticetes identified in **Section 5.2.5** as having a possible presence in the Dorrigo MSS area may also experience behavioural impacts (i.e. avoidance) during migration if present in the survey area during MSS activities. The MSS has been positioned to avoid overlap with the seasonal presence of most mysticetes in the Dorrigo area and within open ocean waters where sound impacts are unlikely to restrict or impede access to other locations. Behavioural impacts to these species will be minor, temporary and limited to a small proportion of the population (MINOR consequence)

Summary:

Consequence Level (Foraging):

- *Baleen whales*: No foraging impacts are predicted for pygmy blue, fin, sei or baleen whale given the lack of temporal overlap with high productivity upwelling periods.
- *Sperm whale:* Foraging impacts to sperm whales, if present, is expected to be localised, affecting only a small proportion of the population, temporary, intermittent and recoverable (i.e. NEGLIGIBLE consequence).

Consequence Level (Migration):

- *Coastal (SRW):* Any received sound within the King Island connecting corridor BIA will be localised, temporary and have negligible effects. Temporal overlap with SRW within this corridor is not predicted based on sighting data (AMMEC, 2018) (Negligible consequence).
- *Oceanic*: Behavioural impacts to these species will be minor, temporary and limited to a small proportion of the population (MINOR consequence).

Acoustic Masking:

Species Sensitivity:

Marine mammals use sound for foraging, orientation, communication, navigation, echo-location and predator avoidance (Richardson et al, 1995).

Acoustic masking occurs when sounds interfere with an animal's ability to perceive biologically relevant sounds. It can be defined as a reduction in communication and listening space (active acoustic space) that an individual might experience due to an increase in background noise (ambient and anthropogenic) in the frequency bands relevant for communicating and listening. For example, acoustic masking can decrease the range over which an animal might communicate with its peers, or detect predators or prey, by decreasing their listening space or total active acoustic space (Clark et al., 2009). Masking can occur naturally from wind, precipitation, wave action, seismic activity, and other natural phenomena. For example, the ranges over which fish-eating killer whales use echolocation clicks to detect chinook salmon can be reduced by more than 50% in moderate rain (Au et al., 2004).

Marine wildlife almost certainly has adapted to naturally occurring signal masking, yet the reduced active acoustic space under noisy natural conditions is a physical constraint that cannot be overcome completely and must be taken into consideration in acoustic impact assessments. The amount of masking an animal experiences is determined by the amplitude, timing, and frequency content of the interfering sounds, as well as how sounds are spatially distributed. Masking may lead to altered communications, potentially increased metabolic costs and may inhibit receipt of biologically important sounds used for finding prey, identify predators, courtship or group cohesion, navigational aid and calls between mothers and calves decreasing the range over which an animal communicates. The context of the exposure plays a critical and complex role in the way an animal might respond (Gomez et al., 2016). As individual animals vary widely in the response type and the degree of response, behavioural responses to masking are difficult to accurately determine (Nowacek et al. 2004) and some mammals have shown some adaption to enable them to minimise masking impacts (e.g. increasing call source level and/or frequencies) (Tyack, 2008).

Predominantly, acoustic masking within the marine environment has focused on interactions between shipping sounds and baleen whales given these whales communicate at similar low-frequencies to shipping. Since the 1960s sound levels in the marine environment at the 20Hz frequency level have increased by 10-12 dB due to increased shipping activity (McDonald et al. 2006; cited in Tyack, 2008). Elevations in ambient noise reduce the minimum detection range of species. Hatch et al. (2012) estimates that calling right whales may have lost on average 63-67% of their communication space due to shipping noise.

Sound from seismic activity contributes to ocean-wide masking (Hildebrand, 2009) particularly for species whose hearing thresholds are close to natural background levels (Nowacek et al. 2015).

Little is known however, about the individual masking effects of seismic sounds alone, other than the aggregated noise from seismic surveys and shipping leads to higher marine sound levels resulting in increased masking (Nowacek et al, 2015).

Detailed below are relevant characteristics of sound signals and noise characteristics (loudness, frequency content and timing) which influence masking:

- *Sound signal amplitude*: The minimum amplitude at which a sound can be heard above the background noise is termed the Critical Ratio (CR). More specifically, the CR is the amplitude difference between the pure tone signal (in dB re 1µPa) and the spectrum level of the background noise at that frequency (in dB re 1 $\mu Pa^2/Hz$) that is needed for the animal to hear the signal. A signal received at a level below the CR in relation to the background noise will be masked. Critical ratios at low frequencies are fairly constant, but at mid frequencies start to increase with frequency. Johnson et al. (1989) found a roughly constant CR for a Beluga whale from 40 to 2,000 Hz (~18 dB), but that the CR increased up to ~40 dB at 100 kHz. Au and Moore (1990) measured CRs in a bottlenose of ~31 dB at 30 kHz and ~45 dB at 140 kHz.
- *Frequency:* The inner ear acts as a bandpass filter in converting the received sound from mechanical to electrical energy. This bandpass filtering is achieved by having different hair cells along the cochlea 'tuned' to different frequencies. However these hair cells are not just sensitive to the frequency they are 'tuned' to, but also to a range of frequencies (a band) around this frequency of highest sensitivity. The width of the frequency band over which hair cells are sensitive is called the Critical Bandwidth (CBW). Noise outside the CBW will have little effect on the detection of a signal in that band, unless the noise is very loud. CBWs tend to be proportional to the frequency of sensitivity, rather than a constant bandwidth. The wider the CBW the more likely broadband noise is to mask a signal. At the upper and lower end of hearing CBWs tend to be wider and may be more susceptible to masking (Richardson et al. 1995)
- *Timing:* The relative timing and length of a signal and noise also impacts the level of masking. The noise must occur at the same time as the signal to produce masking. In addition, repeating a signal, or lengthening it may also reduce the amount of masking. For example, there is some evidence that repetition of signals in seals and odontocetes increases their detectability (Moors and Terhune 2004; Johnson 1991). Likewise, on small time scales, increases in duration of a signal can increase their detectability (Kastelein et al. 2010).

Studies assessing masking effects of anthropogenic noise on marine mammals observe masking impacts by documenting masking compensation strategies (responses the animals use to overcome the masking effects of the noise). For example, in response to anthropogenic noise marine mammals have increased the duration of their calls (humpback whales; Miller et al. 2000), altered the pitch of their calls (right whales; Parks et al. 2007), called more or less often (blue whales; Di lorio and Clark 2009) and called louder (killer whales; Holt et al. 2009). There have also been efforts to quantitatively predict the spatial zones associated with potential masking effects from anthropogenic sounds (e.g., Clark et al. 2009, Hannay et al., 2016). Although masking effects have been documented in a number of species, it is very difficult to quantify the survival or reproductive consequences of this masking on an individual, or masking on the population.

In order to estimate impact of masking through considering the reduction in active acoustic space quantitatively, it is necessary to consider parameters such as call source levels and their adaptive compensation (Lombard response), detection thresholds based on the receiver perception capabilities, signal directivity, band specific (spectral) noise levels, and noise and signal duration.

Instead, a qualitative assessment of masking has been undertaken for this risk assessment, and only species with an overlap between the frequency content of the seismic pulses and their hearing capabilities have been considered. This includes baleen and killer whales.

Extent and Duration of Exposure and Identified Potential Impact:

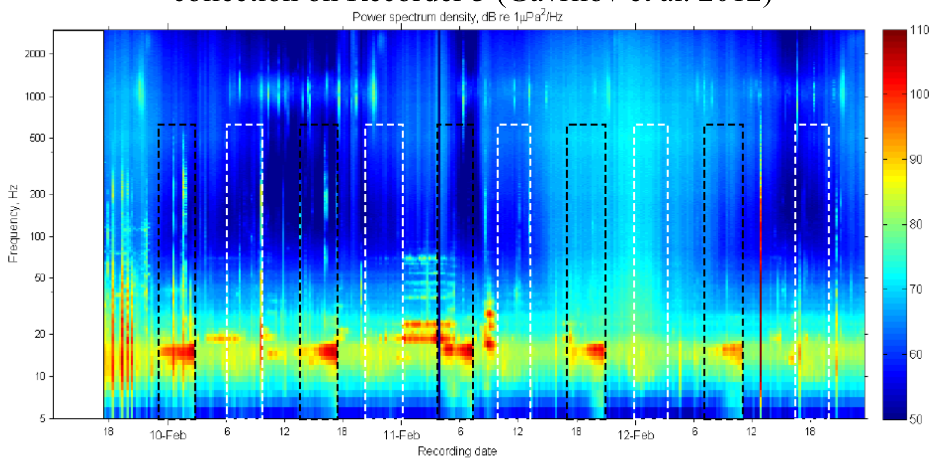
The sound generated by seismic surveys are, by design, brief, repeated every 12.5 to 18.25 s, depending upon the acquisition methodology, impulsive and low frequency (strongest from 10 to 120 Hz), but energy has been measured up to 100 kHz (Richardson et al. 1995; Bain & Williams 2006; Gotz et al. 2009), resulting in overlap with the hearing sensitivities of primarily baleen whales and odontocetes. However, frequencies over 500 Hz typically attenuate at distances beyond 1 km of the array in Australian waters (McCauley et al. 2016).

At close range, airgun direct path pulses are quite short on the order of tens of milliseconds, but the effective source level of full-scale airgun arrays can be quite high (up to ~260 dB (p-p) re 1 µPa @ 1m; Gotz et al. 2009 and for the Dorrigo MSS up to 255.5 dB re 1µPa PK (Warner et al, 2018). At longer ranges however, signal duration is affected by multipath propagation (e.g., reverberation can occur) (Guan et al., 2015). High frequency sound is absorbed readily by seawater and the frequency spectrum of the pulse alters with distance. The extent of this absorption, the resulting propagation modes and the spreading of the pulse in time are highly dependent upon the path between source and receiver, and the environmental parameters such as the sound speed profile and geo-acoustics. Typically, higher frequencies attenuate and pulses spread out in time. Therefore, while the frequency overlap between airgun pulses and baleen whale vocalisations is considerable, at longer ranges only lower frequencies within the impulse are present, and therefore for species with vocalisations over approximately 500 Hz, there is less overlap. Additionally, as the distance from the source increases, the signal has less energy. However, multipath arrivals with short time delays can increase the relative duration of a transmitted pulse, and at low frequencies over long ranges, the seismic impulse begins to approximate characteristics of continuous noise. For example, one measurement program in Greenland demonstrated that long range measured pulses had effective pulse lengths typically in the order of four seconds (Wisniewska et al., 2014). In Australian waters it has been shown that a seismic survey recorded at greater than 160 km away had pulses of lengths 3-4 seconds long, and the noise level did not return to ambient between pulses (McPherson et al., 2016). However, pulses had no energy above 40 Hz, which is similar to the reported attenuation of higher frequency components by Gavrilov et al (2012). Additionally, the work by McPherson et al., (2016) concluded that when discussing the potential influence of seismic impulses on masking, the variability of ambient environment, and contextualisation of the inter-pulse noise levels, is important. This is because when the received pulse levels are low, variations in the local soundscape, including calls from other whales can increase the inter-pulse noise levels.

Clark and Gagnon (2006) documented a cessation of fin whale vocalizations across an area of 10,000 square nautical miles during a seismic survey. Vocalizations resumed after the survey suggesting the whales were not displaced but stopped vocalising which may be an indication that masking was occurring. Further evidence of potential baleen whales masking is suggested by Di Iorio and Clark's (2009) finding that blue whales increased their calling rate during a seismic survey using sparkers (a lower amplitude seismic survey technique). Richardson et al (1995) also identified that distant sources of man-made noise were unlikely to mask short-distance communication between animals. Noise from a distant source, if audible, was likely to be well below the received level of calls by a nearby animal. McDonald et al. (1995) observed that a blue whale stopped vocalising when it was within 10 km of an active seismic vessel. It has been shown that fin whales shortened the duration, decreased the frequency range, and lowered the centre and peak frequencies of their calls in response to shipping and airgun noise (Castellote et al., 2012). Bowhead whale calling rates initially increased alongside seismic sound exposures, but call rates levelled off and peaked as seismic levels increased and then began to decrease when the cumulative SEL 1-minute values increased above 118 dB re 1 μPa^2.s, until they are silent when cumulative SEL 10-min values were above ~160 dB re 1 μPa^2.s (Blackwell et al., 2015).

Recent work on the sound transmission on the continental shelf in western Bass Strait has demonstrated that transmission losses associated with low frequency sound propagation where bottom sediments consist primarily of calcarenite are generally much higher than those observed over other continental shelves (Duncan et al, 2013). Transmission losses remained low only in a few narrow frequency bands. Analysis of the data revealed the spectrum of signals received at recorders contained noticeable energy components only within a few narrow frequency bands (particularly 5 Hz and 15 Hz) and with no energy above approximately 35 Hz (refer **Figure 7-15**). The signal spectrum also revealed frequency dispersion within these bands with the lower frequencies propagating significantly faster than the higher ones. These results show transmission losses are relatively small only within three narrow low-frequency bands at about 5 Hz, 15 Hz and 25 Hz, and very high at frequencies above 40 Hz.

Figure 7-15: Long-term variations in the spectrum level of sea noise obtained from the power spectrum density averaged over each 500 second recording during the first four days of data collection on Recorder 3 (Gavrilov et al. 2012)



This example of impulsive sound propagation across the Australian southern continental shelf in approximately 115 m of water within 40 km of an operating array demonstrated that the geo-acoustic profile of a limestone cap over an elastic seabed eliminated the higher frequency components completely.

Southern right whale: Along the Victorian coastline southern right whales aggregate seasonally between late May and October. SRW 'calls' are an up-sweep at 50-200 Hz for long-distance contact and to bring groups together (Clark, 1983; cited in Richardson et al. 1995). A down call, at a frequency of 100-200 Hz, may be used to maintain acoustic but not physical contact. Source levels have been estimated between 172-187 dB re 1μPa @ 1m (measurement not defined) (Richardson et al. 1995). Other sounds include mixtures of amplitude and frequency modulation all with the major energy at 50 – 1000 Hz (Clark, 1982, 1983; cited in Richardson et al. 1995). Webster and Dawson

(2011) in field studies to understand the vocal repertoire of southern right whales in New Zealand waters established that the majority of calls from the species were up-calls with an average peak frequency of 127 Hz (SD +34.71, range: 61-208 Hz) with an average peak frequency of all calls of 156 Hz (SD+ 168.04, Range: 37 – 1599 Hz). The average call duration was 0.74s (SD = 0.32, range: 0.18-2.15s).

Acoustic modelling from the closest modelling site to the coast predicts sound levels in coastal SRW aggregation areas to be ~ 108 dB re 1µPa (SPL). The impulses propagating across the continental shelf from the survey are expected to only contain low frequency components. As the geo-acoustics will be similar to those reported in Garilov et al. (2012) and Erbe et al. (2016), pulses will contain no frequencies higher than approximately 40 Hz, which is below the typical frequency band of SRWs. If this is compared to the CBW introduced earlier, there will be overlap between the estimated lowest CB's of the SRW and the seismic impulses. However, the low received sound level of the seismic impulses is expected limit the extent of the impact. As the audiogram for the SRW is unknown (Erbe et al. 2016), it is difficult to estimate impacts due to low amplitude and frequencies below the typical vocalisation range of the whale. No significant impacts are expected from airgun impulses at SRW aggregation sites at adjacent coastal areas.

Figure 7-14 and Table 7-31 of the EP show that the south-western part of the SRW BIA on the west coast of King island will likely be exposed to levels of seismic noise up to 147 dB SPL which may have an effect on SRW cow and calf behaviour as outlined in Southall et al. (2007). Figures 6,7, and 8 of Appendix 5 show that some of the southern parts of west coast of King Island could receive seismic noise levels as high as 147 dB SPL (EP Appendix 5), but as the vessel moves to survey the western and northern parts of the survey area, the extent of BIA exposure above 140 dB SPL decreases or is completely eliminated. Therefore, the west coast of King Island BIA will not be ensonified above 140 dB SPL during the entire period of the survey.

In addition to the extent of sound exposure, the impact assessment must also consider the probability of SRW's being exposed to noise levels above 140 dB SPL. The SRW conservation values atlas identifies the BIA around King Island as connecting coastal habitat (Figure 5-19 and Figure 5-19A) that is defined as habitat "which may also serve a migratory function or encompass locations that will emerge as calving habitat as recovery progresses (some locations within connecting habitat are occupied intermittently but do not yet meet criteria for aggregation areas)" (CMP pg 29). To be clear then, the BIA around King Island is not in place because it is a known calving or nursing area – only that it could emerge as one. In conclusion, it is highly unlikely there will be seismic sound exposure of cows calving or cows resting with their calves in the King Island SRW BIA. If present, they are more likely to migrating through the area.

In the highly unlikely event that SRW are resting in the King Island BIA with their calves, their behaviour and the nature of how seismic sound propagates around the island is likely to offer protection from sound levels above 140 dB SPL. The SRW CMP outlines that SRW prefer some degree of protection from prevailing weather conditions given their preference for sheltered waters less than 10m depth when calving and nursing (pg 26 of CMP). Description of this behaviour is also corroborated in the SRW species management profile on the Tasmanian government threatened species link (https://www.threatenedspecieslink.tas.gov.au/Pages/Southern-Right-Whale.aspx). As a logical extension of this observation, SRW aggregations may be expected to be more abundant on the sheltered east coast of King Island given the prevailing westerly winds during their calving season and the west coast being dominated by exposed rocky coastline. Similarly, aggregations on the west coast, if present, are likely to be in the few bays and coves sheltered from the westerly winds. As a result of these aggregation behaviours, seismic acoustic exposure of calving and nursing SRW aggregations would be greatly reduced due to the north and east coasts of King Island laying within a sound shadow of the seismic acoustic pulses (Figure 7-14). Also, shelter from seismic acoustic exposure is also likely in sheltered bays and coves on the west coast of King Island because the seismic sound originating west of King island is likely to be reflected and attenuated by the rocky headlands. It is therefore, in the unlikely event that SRWs are resting with their calves, the actual level of exposure (either as a proportion of the Eastern population or levels of received seismic noise) in the King Island BIA would be very low.

If SRWs are exposed to these or greater levels of noise are more likely to be those migrating to, from and between BIAs. Sound modelling indicates that migrating cows and calves may be exposed to noise levels that exceed 140 dB SPL, but since they are migrating would be capable of avoiding harmful levels of seismic noise.

Other baleen whales: The Dorrigo survey is temporally located in a period which avoids foraging baleen whales. Whales present in deeper waters are more likely to experience masking from the survey with the modelled sound footprints showing greater ensonification levels in deeper waters with no benefits of frequency attenuation from calcarenite seabeds. However, higher ensonification levels occur when the Dorrigo survey is undertaken over shelf-break or continental slope areas (~6% survey duration or 2 days). On this basis, masking for LF whales in deeper waters will be localised intermittent, temporary and recoverable.

For any baleen whales present in the Dorrigo MSS area within ~ 40 km of the operational array on the continental shelf, it is expected that the seismic signal will display distinct pulses which may mask a portion of the sounds emitted/received by the species. As species will be transiting through the area, exposure will have negligible impacts, be temporary, localised and the effects recoverable with no effects on critical habitats (Negligible consequence).

Odontocetes: There is evidence that mid frequency cetaceans continue to utilize calls and echolocation during seismic surveys. Goold and Fish (1998) reported whistles and clicks from common dolphins during a seismic survey although they did not specifically test for masking effects. Miller et al. (2009) also reported a continuation of foraging clicks from sperm whales exposed to airgun noise. There was some evidence (although not significant perhaps due to small sample size) that buzz train rates decreased during seismic exposure. Because of the lower frequency overlap, masking is less likely in MF cetaceans than it is in baleen whales. Likewise, with HF cetaceans, the frequency overlap is even lower. No data is available of vocalizing high frequency cetaceans exposed to seismic airguns; however, data available from pile driving detected echolocation clicks of harbor porpoises before and during construction of an offshore wind farm, although the latency between echolocation bouts was much larger during construction than before (Carstensen et al. 2006). Based on the frequency range of the acoustic pulse and the rapid attenuation of high frequency components in seawater, mid and high frequency cetaceans both at short and long range from the operational acoustic source are not expected to be impacted by significant levels of masking.

Summary:

- Masking of MF and HF cetacean call signs during the Dorrigo MSS, due to the signal pulse and frequency characteristic, is not expected (Negligible consequence).

- Masking in LF cetaceans in proximity to the array when operating on the continental shelf is possible with some obscuring of call signals (Negligible consequence).

Controls Assessment:

Table 7-33 provides an assessment of possible controls to reduce impacts to cetaceans from the Dorrigo MSS activity.

Table 7-32: Assessment of possible controls to reduce impacts to cetaceans

Control Measure	ALARP?	Will it be Implemented?	ALARP Justification
Temporal Control: Acquisition will occur in designated windows to avoid spatial and temporal overlap in BIAs in biologically important periods This includes the BIA (foraging – blue whale) in Otway Basin waters during the Bonney Upwelling (November to April)	Yes	Yes	Preventing temporal overlap with biologically important periods is considered Good Industry Practice and is considered effective, reliable and survivable. However, it is not possible to temporally avoid all cetaceans due to their being cetaceans present during the all the available periods that the seismic survey can be safely conducted. For this survey, selection of the timeframe between 1st September – 30th October avoids the primary period when upwellings may occur at, and adjacent to, the survey area. However, in avoiding the sensitive period described above it will not be possible to also avoid interactions with Southern Right Whales that may be migrating through the survey area or through the coastal connecting habitat BIA on the west coast of King Island. Delaying the survey until after November to avoid SRW use of the King Island BIA would introduce a new risk to Blue whales, also listed as endangered under the EPBC Act, which are known to forage in and adjacent to the survey area from November and through the summer months. With the current proposed timing of the survey in September and October, impacts to foraging Blue whales would be temporally avoided (the winter months are unsafe due to predominant strong westerly winds and so the survey cannot be conducted during this period). The foraging movements and behaviour of Blue whales are detailed in Section 5.4.5 of the EP. It is noted that Blue whales do not just forage at the Bonny Upwelling, but are known to forage on subsurface euphausiid swarms associated with subsurface upwelling along the shelf-break area near the seismic survey area (pg 85 of EP; BWS http://bluewhalestudy.org/our-study-area/). In an environment where their main food source of krill is intrinsically patchy due to its linkage with ephemeral upwelling events, disruption from foraging may have a great energetic and ecological consequences for the individuals disrupted. In addition, by temporally avoiding significant upwelling in the survey area, impacts to foraging baleen whales and all the other marine predators (other cetaceans, birds, pinnipeds and fish) foraging at the upwelling event will be also avoided. Also, the cost to mobilise a dedicated vessel just for this seismic activity several months later would cost an additional several million dollars, a cost that, when combined with the impacts of conducting the survey during upwelling and impacting associated foraging, is grossly disproportionate to the benefit of potentially preventing effects on behaviour of some SRW individuals that are

Control Measure	ALARP?	Will it be Implemented?	ALARP Justification
			unlikely to be using the BIA on the western coast of King Island. Given the potentially very low probability of behavioural effects to SRWs within the King Island BIA (outlined above), the adoption of additional control measures to further reduce this impact (in addition to those already committed to in the EP) is likely to have very little environmental benefit with the costs both financial and environmental being grossly disproportionate to the benefit to SRWs. **Control adopted for 1st September – 30th October survey period.**
Implement EPBC Policy Statement 2.1 (Part A) Standard Management Procedures A1 to A4 including: • Pre-startup observation and use of soft-start procedures (30 mins observation time in whate depths < 200m; 60 minutes observation time for water depths > 200 m); • Adoption of operational buffer zones – 3 km observation zone, 2 km power down zone and 500 m shutdown zone. • Start-up delay Procedures; • Operational Procedures; • Stop work Procedures • Adoption of night time/low visibility procedures • Trained crew observing for cetaceans The following additional controls will be implemented for SRW: If one or more SRW (identified by lack of dorsal fin) and calf are observed within the 3km observation zone, a power-down will be instigated. If the SRW and calf come within 1.5km of the source a shutdown procedure occur until the cow and calf move outside of the 3km observation zone.	Yes	Yes	Good industry practice. Standard practice for industry. Crew will be briefed on environmental matters including information on the EPBC Policy Statement 2.1, whale identification and legal obligations in Australian waters. Adoption of JNCC requirements for longer observation periods in deeper waters is due to the possible presence of sperm whales (JNCC, 2017). Given the potential for sperm whale presence, environmental benefits are considered to outweigh costs. Southall et al. 2007 specifies that 198 dB re: 1 μPa2 -s SEL is the threshold for injury to low frequency cetaceans from multiple pulses (Southall et al. 2007, pg 444). Sound levels attenuate to this level at approximately 1.5km from the source (Figures 3-5 in Warner et al 2018 modelling report). Therefore, the current power-down and shutdown zones will prevent injury to all low frequency hearing SRWs. Although practicable control measures cannot be adopted to manage affects to SRW up to 9.5km from the source, the greatest practicable measure that can be applied is a power-down at 3km – considered the maximum visible extent that SRW could be identified. The adoption of this control measure reduces as far as practicable the effects of the survey on biologically relevant behaviour of SRW. **Control adopted**.
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B1: Use of MFOs (survey vessel).	Yes	Yes	Good Practice – well defined and established procedures. Two MFOs will be present on the survey vessel to observe and initiate shutdown and powerdown procedures if cetaceans are sighted within respective zones. MFOs will be trained in whale identification and behaviour and distance estimation. **Control adopted**.
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B1: Use of MFOs (support/chase vessel).	Yes	Yes	Support/chase vessels will each have one trained and experienced MFO to observe for cetacean presence and behaviour. Crew relieving the MFO will have training in whale observation and distance estimation. **Control adopted**.
Implement EPBC Policy Statement 2.1 (Part B) Additional Management	Feasible	Part A Management	3D Oil will adopt the night-time and low visibility procedures as per the Part A management measures. That

Control Measure	ALARP?	Will it be Implemented?	ALARP Justification
Procedures – B2: Night-time/poor visibility (limiting soft starts to conditions which allow for visual inspection of the precaution zone).		Procedures for poor visibility will be adopted.	is, within a location soft-starts and operations may proceed provided: • There has not been 3 or more whale instigated power-downs or shut-downs during the preceding 24 hours.; or • Startup may also occur if operations have not been underway in the preceeding 24 hours and the vessel (& surveillance craft) have been in the vicinity of the proposed start-up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period and no whales have been sighted. Operations may proceed (as normal) provided there has not been 3 or more whale instigated power-down or shut-down situations during the preceeding 24 hours. If 3 or more whale instigated shutdowns/powerdowns occur (i.e. high numbers of animals): • Soft starts will be undertaken at that particular location if good visibility conditions are present; and • Operations at night or in low visibility will not be undertaken at that particular location. In this instance adaptive management measures will be considered (refer *adaptive management*). In general, limiting soft starts to conditions which allow for visual inspection will increase the survey duration, overall cost and length of survey (with associated impacts). As the survey period has been selected for low encounter rates with cetaceans, this measure is not seen to offer significant environmental benefits. **Control adopted.**
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B2: Poor visibility (Daylight spotter vessels or aircraft).	No	No	The Dorrigo MSS is temporally positioned in a period where there is low encounter with cetaceans, based on extensive survey data. As all control measures to protect whales from sesimic impacts can be implemented from vessel-based platforms (including two support vessels) utilisation of aerial platforms is not considered to add any environmental benefit. **Control not adopted.**
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B2: Night-time/poor visibility (Pre-survey research surveys).	No	No	3D Oil has reveiwed all available cetacean data for the area potentially affected by sound effects. 3D Oil considers that this information, together with the advice from cetacean experts (e.g. blue whale study) have provided sufficient consistent information to assess possible impacts from the survey and reliably develop mitigation controls. Pre-survey research surveys are not considered to add any environmental benefit. **Control not adopted.**
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B3: Spotter Vessels and Aircraft	-	-	Assessed as part of Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B2: Night-time/poor visibility (Daylight spotter vessels or aircraft and pre-survey research survey).
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B4: Increased precaution buffer zones (Foraging – Low power @ 3 km) (Note: increased buffer implemented in previous control for migrating Southern Right Whales)	Possible	No	Precaution zones for migrating cetaceans (excluding dolphins and porpoises) of 3 km observation; 2 km low-power and 500 m shutdown as per EPBC Policy Statement 2.1 Part A requirements. Application of these distances protects all whales (LF, MF, HF) from PTS and TTS impacts. Increasing the low-power zone to a larger distance to prevent foraging impacts offers no benefit to baleen whales in the Dorrigo MSS, due to the timeframe of the survey (Sept/Oct) when no foraging is expected.

Control Measure	ALARP?	Will it be Implemented?	ALARP Justification
			Foraging sperm whales are possible in the canyon systems which spatially overlap the southwest acquistion area and total 0.27% of the West Tasmanian canyon system KEF. Increasing low-power zones to prevent this impact would require monitoring to a distance of 10 km from the operational array. This would add significantly to the amount of time spent by the vessel around the canyon area and lead to increased vessel impacts on other fauna. Given the open ocean location of the Dorrigo MSS area, any sperm whale foraging impact is expected to be localised, temporary, intermittent and recoverable. Any additional benefits associated with non-disturbance of sperm whale foraging does not outweigh the additional vessel impacts/risks associated with increased monitoring. It is possible with cephalopod displacement with sound, the sperm whale will also spatially displace to follow foraging opportunities making additional surveillance redundant within the sound affected zone. **Control not adopted.**
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B4: Increased precaution zones and buffer zones (application of a 60 min pre-watch)	Yes	Yes (in certain conditions)	Pre-watch timeframe for migrating cetaceans (excluding dolphins and porpoises) is 30 minutes as per EPBC Policy Statement 2.1 Part A requirements. Increased pre-watch times are recommended for critical habitats, where longer 'down-times' may be observed, (i.e. the time between surfacing events are longer for species that are feeding, migrating or inhabit deeper depths of the water column for species such as sperm whales). While a sperm whale BIA does not spatially overlap the Dorrigo MSS area, sperm whales are known to inhabit the west Tasmanian canyons. For waters > 200m, 3D Oil will take a precautionary approach and implement an increased pre-watch time of 60 minutes to assist with sperm whale detection. **Control adopted**.
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B5: Passive Acoustic Monitoring (PAM)	No	No	Passive acoustic monitoring is a technique that uses underwater microphones to detect, monitor and in some cases localise marine mammals that are vocalising. PAM is known to be particularly successful when implemented for odontocetes such as sperm whales, dolphins and porpoise known to emit regular distinctive clicks during long dives. PAM has limited application for detecting baleen whales such as blue whales due to the types of vocalisations made by these whales (long wavelength). As such PAM is not considered to provide any environmental benefit to baleen whales. This has been further corroborated by Curtin University (Consultation report: Record 62; April 2018) that details the ineffectiveness of PAM for detecting baleen whales during seismic surveys. PAM could be utilised to detect sperm whales which forage in the West Tasmanian Canyon system. The Dorrigo MSS aquisition area overlaps the canyon system by 37 km^2 (from a total of 13,500 km^2 (or 0.26% spatial overlap)) with 71 km^2 (4.5% of the Dorrigo MSS acquisition area in waters deeper than 200m). In reality, prey displacement with sound (cephalopods) is expected to also displace the sperm whale. Any impacts associated with foraging are localised, temporary and recoverable. Additional costs associated with PAM for the survey is not expected to offer any significant environmental benefit (i.e. PTS/TTS prevention, foraging impact reduction) given the low impacts expected. Survey is not located in a sperm whale BIA. **Control not adopted**.

Control Measure	ALARP?	Will it be Implemented?	ALARP Justification
Implement EPBC Policy Statement 2.1 (Part B) Additional Management Procedures – B6: Adaptive Management (Acquire data on different lines or cease operations)	Yes	Yes	It is inefficient and costly for a proponent to continuously shut down due to the presence of whales. If there are three or more power-downs/shut-down zone due to whale presence in the preceding 24 hours or three OR or three or more sightings of these species within the shut/power-down zones when the acoustic array is non-operational in the preceding 24 hr period, the density of whales in the area will be deemed to be "high" and cause the following measures to be implemented: • Surveillance: A support vessel will travel along the acquisition line to a distance not greater than 10 km from the seismic array. If whales are observed within the distance of observation by the MFO on the support vessel, the survey vessel will implement adaptive management. • Relocation: Survey vessel will relocate to another survey line > 10 km from the last confirmed whale sighting location where the support vessel has confirmed no whale presence. The survey vessel will not return to the original location within 24 hrs; OR • Cessation: If there are no options for the relocation (e.g. no other survey lines to acquire), all night time operations will cease at this location until 24 hours have passed with no whales observed. Based upon industry experience, it is very unlikely for more than three power-downs/shutdowns to occur within 24 hours. It is more likely that one or two power-downs/shut-downs may occur in 24 hours which is usually followed by a gap period of no observations. This would be indicative of low densities of whales transiting through the survey area and not necessarily indicative of increased populations of whales in the surrounding area. The threshold of 3 or more power/shutdowns or three or more sightings within the power-down/shut-down zone when the array is non-operational will be used as the indicator that there is an unexpected higher density of marine fauna and/or foraging animals may be present in the region. The following additional control measures will be implemented for SRW: • Operations may proceed as normal only if a SRW (identified by lack of dorsal fin) and calf have not been observed within the 3km observation zone within the previous 24 hours. If a SRW and calf have been observed within the 3km observation zone in the previous 24 hours, night time and low visibility operations can only proceed if the vessel relocates to at least 10km from the sighting. **Control adopted.**
Mitigation Acoustic Source	Yes	Yes	JNCC's analysis of marine mammal observer data from 1994 – 2010 collated the median closest distance from the acoustic source while the source was active and and not active. This data identified that the likelihood of whales approaching the the injury zone (within 500 m of the operational array) is extremely low. These observations are consistent with the general concensus that whales exhibit aversion to sound levels which may cause injury (DEWHA, 2008).

Control Measure	ALARP?	Will it be Implemented?	ALARP Justification
			Sound may also cause behavioural impacts to cetaceans in foraging areas. Spatial buffers will be applied to foraging whales to prevent displacement effects. However, to eliminate sound contribution to the environment and potentially contributing to masking effects, on line turns the operating array will be shut down other than when testing the guns. **Control adopted.**
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. **Control adopted.**
Acoustic sound source verification	Yes	Yes	3D Oil will ensure that sound source verification (SSV) for the array is confirmed prior to deployment in the Dorrigo MSS area (refer **Section 7.2.1**). Further verification activities are not considered warranted given the low sound levels predicted in sensitive areas compared with their impact threshold. **Control adopted prior to mobilisation. No testing proposed thereafter.**
In addition to whale management, MFOs an inducted crew will monitor for pinnipeds and other marine fauna.	Yes	Yes	Good Industry Practice. MFOs will monitor for species other than whales including dolphins, porpoises, pinnipeds, turtles and seabirds. There is a limitation on the practicability of sighting of some species (e.g. shark, fish) and increasing visual observation to these species may serve to compromise implementation of EPBC 2.1 control provisions for key sensitive species (whales). **Control adopted.**
Use of drones as surveillance tools.	No	No	Drones offer safety benefits over aerial surveillance and can operate in broader weather windows. Although drones have been used for spotting and watching whales, they are untested on an operational seismic survey and as such will not be adopted during the Dorrigo MSS. This has been further corroborated by a personnel communication from a prominent researcher of cetaceans in Southern Australian waters who detailed that use of drones still relies on the initial observation of the MFO to detect the cetacean. **Control not adopted.**
Use of quieter technologies (air guns with bubble curtains, marine vibrators, DTAGS)	No	No	3D Oil has considered the use of quieter technologies (air guns with bubble curtains, marine vibrators. DTAGs) for the Dorrigo survey. Other than eSource (a technolology which reduces the amount of higher frequency components) which costs $4.5M to install for marginal benefit, these emerging technologies are unavailable on a commercial basis and geophysical objectives of the survey may not be met resulting in large gaps of data. Their use may also result in prolonging total survey duration. **Control not adopted.**
EPBC Act Environmental Offsets policy has measures that might compensate for 'residual impacts' that cannot be adequately reduced through avoidance or mitigation where those impacts are also signficant. Offset of potential impacts to Southern Right Whales	No	Potentially	3D Oil has evaluated the cost and the benefit of funding and implementing a research program primarily into Southern Right Whales, but also into other cetacean species, in and more broadly around the seismic survey area to improve available knowledge of cetacean population dynamics. The two independent researchers both advised that an aerial survey would be required to provide sufficient data that would improve the probability collecting meaningful results and that would allow for safe execution of the study. The cost estimates provided were about 200k, which in the context of a very small seismic

Control Measure	ALARP?	Will it be Implemented?	ALARP Justification
			survey (i.e. high cost as a proportion of the cost of the survey) and the low risk to SRW in their connecting coastal habitat, is considered grossly disproportionate to the potential benefit gained. 3D Oil will continue to engage with the research community to explore reasonably practical options and environmental offsets related to the protection of Southern Right Whales eastern population. **Control not adopted.**

7.2.3.8 Water Sports/Tourism/Diving

As identified in **Section 5.7.5.8**, the adjacent King Island coastline supports commercial diving for abalone. The closest abalone diving area to the Dorrigo MSS area is the Waterwitch Reef (abalone) Research Area located 26 km from the nearest acquisition line and 15 km from the nearest Dorrigo MSS operational boundary. Fishery data identifies that blacklip abalone is harvested predominantly between July and December along the west King Island coastline by diving ('wet-ear methods) (Mundy & Jones, 2017). On King Island, abalone is targeted by two divers (KIRDO, 2018).

Receptor Sensitivity:
Humans exposed to high levels of underwater sound can suffer from dizziness, hearing damage or damage to other sensitive organs depending on the frequency and intensity of the sound. Human hearing underwater with a 'wet' ear (i.e. water contact with ear canal) is less sensitive than sound in air and is believed to produce less hearing damage than airborne sound. If the ears are dry (i.e. wearing a helmet) the noise exposure is the same as airborne noise (Anthony et al., 2009). Underwater auditory threshold curves indicate the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz and 1 kHz with a peak at 800 Hz (Parvin et al; cited in Anthony et al., 2009) and these frequencies have the greatest potential for damage. In general, within this frequency band, underwater hearing is 35-40 dB less sensitive than air.

Adopted Thresholds:
Studies undertaken on low frequency (100-600 Hz) underwater sounds to divers by the US Department of Navy identified received sound levels below 160 dB re 1µPa (SPL) was not expected to cause physiological damage to a diver and concluded that received SPLs of 157 dB re 1µPa did not produce physiological damage in humans. An aversion reaction, subjectively reported as "very severe" by 2% of divers, was documented at 148 dB re 1µPa (SPL). On this basis, the threshold was scaled back by 3 dB (a 50% reduction in signal strength) to provide a suitable margin of safety against psychological aversion for divers (US Department of Navy, 2001). Interim conservative and protective guidance for the operation of low frequency sound sources in the presence of recreational or commercial divers is recommended not to exceed a received level of 145 dB re 1µPa (SPL) (US Department of Navy, 2001).

Parvin et al. (2005) also provides recommended guidance on received SPLs to divers for the frequency band 500-2500 Hz of 155 dB re 1µPa.

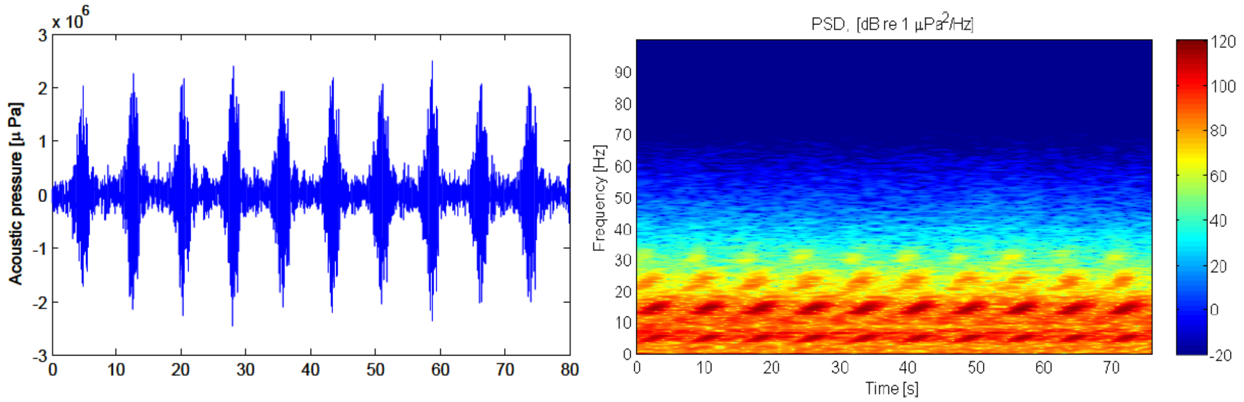
The UK Diving Advisory Committee (DMAC) (2011) issued guidance on the proximity of diving operations from seismic surveying operations. This guidance recommends that where diving and seismic activity occurs within 10 km, a joint risk assessment should be conducted between both parties and a simultaneous operations plan developed.

Based on this information a conservative received level of 145 dB re 1µPa (SPL) is used to assess impacts to commercial abalone diver's present in coastal areas adjacent to the survey operations.

Extent and duration of Exposure and identified Potential Impact:
Dorrigo MSS acoustic modelling predicts the 145 dB re 1µPa (SPL) is reached 29.96 km from Site 2 (the nearest location modelled to shore) (Warner et al, 2018). Sound exposures along the west King Island coastline may therefore be subject to received sound levels marginally higher than 145 dB re 1µPa (SPL) particularly in south-west King Island where the shortest distance to shore is 26 km.

As discussed in **Section 7.2.3.7**, recent studies undertaken on the continental shelf in western Bass Strait identified transmission losses from a MSS remains low only in a few narrow low-frequency bands on calcarenite sediment seabed (refer **Section 3.2.3.7**) (Gavrilov et al., 2012). Within that study, the distance of the acoustic source (volume 3090 in^3) from the receiving hydrophone varied from 38 km to nearly 75 km. The acoustic energy was noticeable only in three relatively narrow frequency bands as shown in **Figure 7-16**. It is therefore likely that any sound exposure to near-shore abalone divers will be in low frequencies less than 100 Hz.

Figure 7-16: Waveform and spectrogram of series of airgun signals received on hydrophones from inshore seismic transect (Gavrilov et al. 2012)



Based upon received sound levels in coastal King Island environments, there is potential for an "aversion reaction" in high-sensitivity commercial abalone divers, particularly along the south-west coastline where the MSS is closest to shore. However, these effects are:

- Possible only on the acquisition lines closest to the King Island coastline. As the survey vessel moves to the west, sound levels at the coastline reduce also reducing the risk of diving aversion;
- Acoustic source start-up is on a graduated scale, or gradually increasing in level when an operating array is approaching, so any sound impacts to abalone divers will not be immediate with the opportunity for divers to return to surface if here are any adverse impacts;
- Intermittent and temporary at any one location on the coast, given the constant movement of the vessel and the survey's racetrack design (i.e. sequential lines spaced 10 km apart reducing sound levels at the coast every 12-14 hrs).

Summary:
High-sensitivity commercial divers may experience "diving aversion" impacts, if present along the west King Island coastline during the Dorrigo MSS. This impact will be localised, temporary and recoverable (Negligible consequence).

Controls Assessment:

Table 7-33 provides an assessment of possible controls to reduce impacts to divers from the Dorrigo MSS activity.

Table 7-33: Assessment of possible controls to reduce impacts to abalone divers

Control Measure	Practicable?	Will it be Implemented?	Justification
Source Reduction: Minimise the sound intensity and exposure time of surveys	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. Control adopted.
Temporal Overlap: Avoid Temporal Overlap of Seismic & Diving Activities:	No	No	According to Abalone Fishery Reports, abalone diving is present along the western King Island coastline throught the year so there is no opportunity to select a period where diving will not be occurring. 3D Oil is limited in its ability to move the timeframe of the Dorrigo MSS given other environmental sensitivities present. No alternate period of the year would eliminate the presence of abalone divers. **Control not adopted.**
Soft Start Process: Implement EPBC Policy Statement 2.1 (Part A) procedures (*soft start procedures*)	YES	YES	Soft-start procedures will assist in alerting divers of the presence of seismic operations. **Control is adopted**.
Regular Communications: Regular contact will be undertaken between the survey vessel and diving vessels during the Dorrigo MSS.	YES	YES	3D Oil will provide awareness of survey operations to abalone divers during the Dorrigo MSS to alter divers of possible noise impacts. 3D Oil will ensure daily contact is undertaken between the seismic and abalone divers so both parties are aware of each other's program for the day. Benefits outweigh cost of control. **Control adopted.**

7.2.3.9 Cumulative Sound Impacts

It is possible that other third party MSSs may simultaneously acquire seismic data in proximity to the Dorrigo MSS area in the same timeframe. 3D Oil is aware through consultation activities and submission of EPs on the NOPSEMA website, of two proposed surveys planned for the Otway Basin in proximity to the Dorrigo MSS:

- The Otway Deep 3D MSS[56] by Spectrum Geo [**Stakeholder No: 35**], scheduled to commence in October 2019 for a period of 4 months. There is no spatial overlap of the Otway Deep full-fold acquisition area with the Dorrigo full-fold area, however the survey operational boundaries overlap in the far south of the Dorrigo MSS area.
- Preliminary verbal advice of the Otway Basin 2-Dimensional (2D) MSS by Schlumberger (SLB) proposed for the December 2018 to May 2019, for a period of 150 days which also overlaps the operational area (only) with the Dorrigo MSS. No temporal overlap is identified at this point in time.

Consultation with the proponents of these MSSs is outlined in **Section 4** of this EP, however 3D Oil is maintaining close liaison with these groups to understand the potential for concurrent operations.

[56] The Otway Deep MSS EP has been submitted and is currently under assessment by\ NOPSEMA.

Spatial/temporal overlap with third party MSS activities could result in cumulative impacts to marine environment including marine fauna. Cumulative impacts from seismic pulses within the marine environment are difficult to quantify given the temporary creation of sound/pressure waves that dissipate and soon disappear when the energy source ceases. Unlike other activities which create contaminants and noxious materials (e.g. drill cuttings), there is no bioaccumulation of sound/pressure within the food chain. Nonetheless, there may be a temporary additive effects if sounds from one activity coincide and overlap spatially and temporally with another concurrent activity. However, this "added sound" will disappear once one survey ceases or travels out of the area of concern.

The Programmatic Environmental Assessment of Arctic Ocean OCS Seismic Surveys (2006) established proactive measures for simultaneous MSSs with a minimum spacing of 24 km (15 nm) between seismic source vessels. More recently, the Bureau of Ocean Energy Management (BOEM) reviewed geological and geophysical survey activities off the mid- and south Atlantic coasts and recommended a spatial separation of 40 km between the acoustic sources of simultaneous MSSs to minimise the impacts to marine life by providing a 'corridor' between vessels below 160 dB re 1µPa SPL (*recognised behavioural limit for impulsive sound and significantly below thresholds which may cause injury to species*) to allow passage by marine fauna. The BOEM review recommended a 10 km corridor between MSSs which has a received level of < 160 dB re 1µPa (SPL) (BOEM, 2014).

In conjunction with Spectrum, 3D Oil engaged JASCO Applied Sciences to quantify the combined SPL from the Otway Deep MSS 3475 in^3 array and the Dorrigo MSS 3260 in^3 array at the closest point between the two MSS areas (i.e. a spatial separation of 35 km) (refer **Appendix 5** for full report). **Table 7-34** provides the results of the cumulative sound from both surveys on regional sensitivities. **Figure 7-17** provides the 'worst-case' where each survey's acoustic pulse temporally overlaps. Given that both surveys will be conducted without intended temporal synchronisation between operations, and the short duration of the airgun pulses, acoustic pulse overlap is not very likely (Warner et al, 2018b).

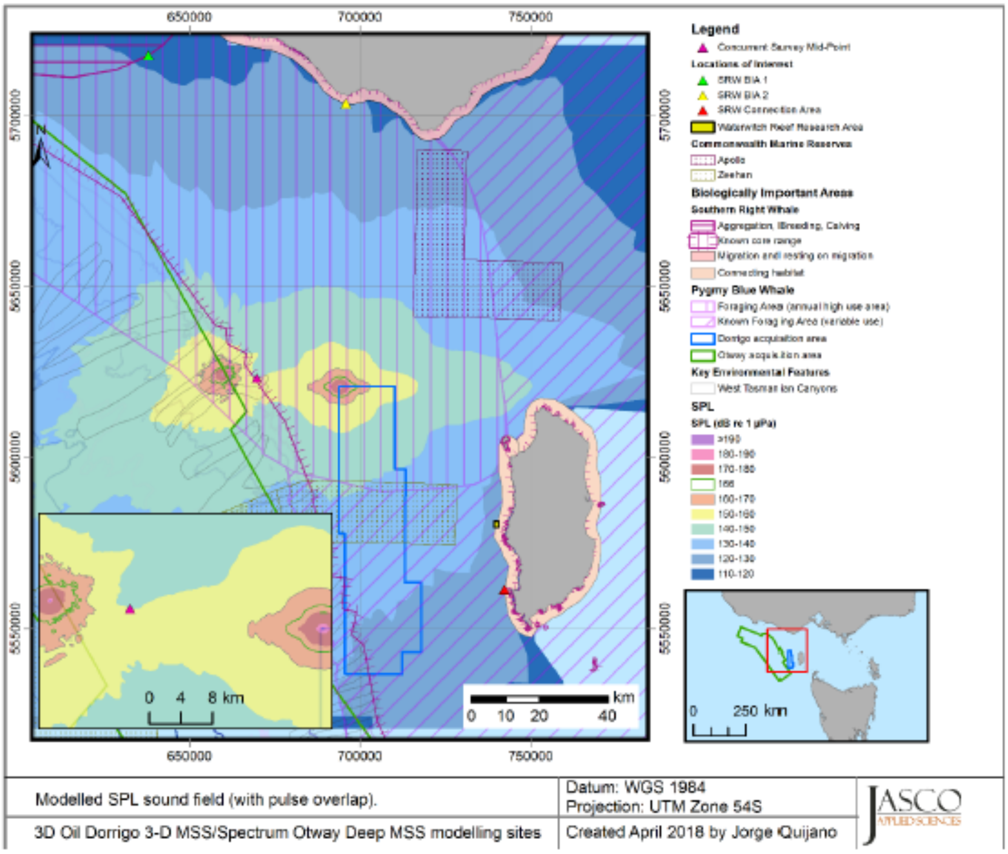
Table 7-34: Unweighted maximum-over-depth per pulse received SPL (dB re 1µPa) at locations of regional interest for the combined effect of the 3260in^3 (Dorrigo MSS) and 3475 in^3 (Otway Deep MSS) Arrays (Warner et al, 2018b)

Assumption	SRW (Warrnambool Calving) BIA	SRW (Migration Corridor and Resting on Migration) BIA	SRW (Coastal Connecting Corridor) BIA	Concurrent Survey mid-point
No pulse overlap	116.3	121.9	121.4	147.7
Pulse overlap	118.8	122.5	121.9	150.2

These results identify that received sound in all BIAs do not exceed the 'behavioural disturbance' threshold set for these sensitive SRW BIAs (i.e. 140 dB re 1µPa (SPL)) and no biologically significant disturbance (i.e. avoidance) is expected. The maximum cumulative SPL predicted at the midpoint between the two active sources, separated by 35 km, is 150 dB re 1µPa (SPL). Spatial separation of 40 km between active sources will therefore retain a 10 km corridor whereby sound levels are below 160 dB re 1µPa (SPL) and biologically relevant behavioural disturbance might occur.

3D Oil will continue to consult with Spectrum Geo and other third parties with temporal overlap with the Dorrigo MSS. For third-party surveys which temporally overlap the Dorrigo MSS, 3D Oil will prepare at least one month prior to the planned survey commencement, simultaneous operations procedures when operating within 40 km of a third-party vessel. No cumulative impacts to the marine environment from concurrent surveys are predicted from concurrent surveys on this basis.

Figure 7-17: Sound level contour plot showing unweighted maximum over depth SPL results for the 3260 in^3 array towed at 8m (Dorrigo MSS) and the 3475 in^3 array towed at 6 m depth (Otway Deep MSS) (Warner et al, 2018b)



Summary:
Without controls, marine fauna may experience localised and temporary barriers to migration Minor consequence). With spatial controls adopted to prevent cumulative impacts from creating migratory barriers thereby limiting the movement of marine mammals/fauna, any impacts are localised, temporary and of negligible consequence to marine receptors (Negligible consequence).

Controls Assessment:
Table 7-35 provides an assessment of controls to reduce impacts of cumulative impacts from MSSs which temporally overlap with the Dorrigo MSS activity.

Table 7-35: Assessment of controls to reduce cumulative impacts from temporally coincident MSSs

Control Measure	Practicable?	Will it be Implemented?	Justification
Source Reduction: Minimise the sound intensity and exposure time of surveys.	YES	YES	3D Oil has assessed the minimum size source required to fulfil survey data objectives. The maximum size array 3D Oil will utilise is 3260 in^3. The Dorrigo survey design (north-south) has also considered the timeframe to acquire seismic data minimising the acquisition time (& exposures) in the field. Control adopted.
Spatial Separation of Survey Activity: Adopt spatial buffer of 40 km between two active sources to prevent migratory barriers.	YES	YES	Modelling performed by JASCO has shown received levels at the mid-points between the closest two locations of the Dorrigo and Otway Deep MSSs falls below significant disturbance (i.e. avoidance) thresholds for marine receptors. A minimum distance of 40 km between MSS sources ensures that migratory barriers are prevented. This will be achieved through agreed SIMOPS procedures. **Control Adopted -** Environmental benefit outweighs the cost of implementation.
Sharing cetacean observations: Regular contact between survey vessels to inform on cetacean presence.	YES	YES	3D Oil considers information sharing on cetacean activity with other survey vessels in the region to offer benefit to both parties. The intention is to gather as much information on cetacean distribution as practicable to assist with operational decision making on a daily basis. **Control Adopted -** Environmental benefit outweighs the cost of implementation.

7.2.3.10 Impacts to KEFS

The Dorrigo MSS and acoustic footprint of the Dorrigo MSS spatially overlap KEFs within the region (refer **Section 5.5.7**). KEFs are of regional importance for either a region's biodiversity or its ecosystem function and integrity. While KEFs have no legal status, they are considered part of the Commonwealth marine environment which is a matter of NES under the EPBC Act 1999. In accordance with the Significant Impact Guidelines 1.1 (Matters of NES) (DoE, 2013), relevant criterion to assess whether impacts are significant with respect to acoustic impacts are:

- *The action will not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such than an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results; and*
- *Have a substantial adverse effect on a population of marine species or cetacean including its lifecycle (for example breeding, feeding, migration behaviour, life expectance) and spatial distribution.*

Table 7-36 provides an assessment of the Dorrigo MSS activity with respect to NES criteria.

7.2.3.11 Impacts to Commonwealth and State Marine Reserves

Commonwealth Marine Parks:
Commonwealth marine parks within the south-east marine region are managed under the South-East Commonwealth Marine Reserves Network Management Plan 2013-23 (DNP, 2013). An assessment of activities which are permissible under the zones within these CMPs is provided in **Section 3**.

The Dorrigo MSS acquisition area spatially overlaps 37% of the Commonwealth Zeehan CMP Multiple use Zone (IUCN VI) and lies adjacent (~16 km) to the Zeehan CMP Special Use zone (IUCN VI). Residual sound from the survey activities is also predicted to travel into the Commonwealth Apollo CMP (IUCN VI – Multiple Use Zone) which lies ~22 km north-east of the Dorrigo full-fold acquisition area. The conservation values present in these CMPs are described in **Section 5.5.1** and the potential impact of underwater sound to those values and IUCN principles are assessed in **Table 7-37**.

State Marine Parks:
No Tasmanian or Victorian marine reserves are predicted to be impacted by residual sound levels from the Dorrigo MSS activities (refer **Section 5.5.2**).

Table 7-36: Dorrigo MSS - Acoustic Impact Assessment of affected KEFs

KEF	Ecosystem Sensitivity/ Values	Actions having a risk of significant impact on the Commonwealth Marine Environment	Description of Impact
West Tasmania Canyons	These canyons can influence currents, act as sinks for rich organic sediments and debris, and can trap waters or create upwellings that result in productivity and biodiversity hotspots. For example, plumes of sediment and nutrient-rich water can be seen at or near the heads of canyons. Sponges are concentrated near the canyon heads, with the greatest diversity between 200 m and 350 m depth. Sponges are associated with abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts.	Actions that have a real chance or possibility to modify, destroy, fragment, isolate or disturb an important/substantial area of habitat to cause an adverse impact on marine ecosystem functioning; or have a substantial adverse effect on populations of marine species or cetacean including lifecycle and spatial distribution.	The Dorrigo MSS acquisition area has a 0.3% spatial overlap with the West Tasmania Canyons KEF. The Dorrigo MSS does not: • Physically interact with the seabed so does not modify, destroy or disturb the physical topography or structure of the KEF; • Interfere with the environmental parameters such as ocean circulation and temperatures affecting productivity and diversity hotspots. An assessment of ecosystem sensitivities within the KEF which might be affected by the Dorrigo MSS and affect ecosystem functioning has been undertaken in this EP. This includes: • Impacts to sessile invertebrates such as sponges, bryozoans and ascidians from acoustic sound sources used not expected based upon available scientific literature and review of acoustic impacts to other sessile feeders such as corals. Ecological integrity of sponge and benthic habitats are not expected to be affected (refer **Section 7.2.3.2**). • Mortality and recoverable injury impacts to fish within the Dorrigo MSS is very unlikely based upon the available scientific literature with behavioural impacts predicted to be localised, temporary and recoverable. Impacts are not predicted to have a significant adverse effect on the population's lifecycle or spatial distribution (refer **Section 7.2.3.3**). *On this basis, ecological integrity of these habitats and its functioning is not expected to be significantly affected by seismic operations as defined by the EPBC significant impact criteria.*
Shelf rocky reefs and hard substrates	The shallowest depth at which the rocky reefs occur in Commonwealth waters is approximately 50 m. On the continental shelf, rocky reefs and hard grounds provide attachment sites for macroalgae and sessile invertebrates, increasing the structural diversity of shelf ecosystems. The reefs provide habitat and shelter for fish and are important for aggregations of biodiversity and enhanced productivity.	Actions that have a real chance or possibility to modify, destroy, fragment, isolate or disturb an important/substantial area of habitat to cause an adverse impact on marine ecosystem functioning; or have a substantial adverse effect on populations of marine species or cetacean including lifecycle and spatial distribution.	The Dorrigo MSS area has a 0.42% spatial overlap with the non-spatially defined Shelf rocky reef and hard substrates KEF.[57] As per the West Tasmania Canyons KEF, the Dorrigo MSS does not physically interact with the seabed to modify, destroy or disturb the physical topography or structure of the KEF. An assessment of ecosystem sensitivities within the KEF which might be affected by the Dorrigo MSS and affect ecosystem functioning has been undertaken in this EP. This includes: • Impacts to plankton/fish larvae from MSS operations are predicted to be within the natural mortality rates (refer **Section 7.2.3.1**). • Impacts to sessile invertebrates such as sponges, bryozoans and ascidians and other invertebrates (e.g. lobsters, crab) from acoustic sound sources not expected based upon available scientific literature and review of acoustic impacts to invertebrates. Ecological integrity of sponge and benthic habitats are not expected to be affected (refer **Section 7.2.3.2)** • Mortality and recoverable injury impacts to fish within the Dorrigo MSS is very unlikely based upon the available scientific literature with behavioural impacts predicted to be localised, temporary and recoverable (refer **Section 7.2.3.3**). *On this basis, ecological integrity of these habitats and its functioning is not expected to be significantly affected by seismic operations as defined by the EPBC significant impact criteria.*

[57] KEF is estimated based on the bioregion area for the continental shelf in the South-East Marine Bioregion of 501,500 km^2 adopting 75% of this area as KEF based upon continental shelf depth range (0-200m) (DoE, 2015).

Table 7-37: Dorrigo MSS – CMP Conservation Values and Management Principles Impact Assessment

<table>
<tr><th>CMP</th><th>Zone</th><th>SPL (dB re 1µPa) at Boundary</th><th>Distance to Nearest Acquisition Line (km)</th><th>Purpose of Zoning</th><th>South-East Commonwealth Marine Reserves Network Management Plan 2013-23 – IUCN Management Objectives/Principles</th><th>Conservation Values (DNP, 2013)</th><th>Principle Attainment</th></tr>
<tr><td>Zeehan CMP</td><td>Multiple Use Zone (IUCN VI) (933 km^3)

Dorrigo MSS spatial Overlap (350 km^2)</td><td>-</td><td>Within Survey Area</td><td>Provide for the ecologically sustainable use and the conservation of ecosystems, habitats and native species.</td><td rowspan="2">Applicable to both Multiple Use and Special Purpose Zones:
Zone should be managed for the sustainable use of natural ecosystems based upon the following principles:
• Biological diversity and other natural values should be protected and maintained in the long-term;
• Management practices applied to ensure the ecological sustainable use of the reserve or zone;
• Management of the reserve or zone should contribute to regional and national development to the extent it is consistent with these principles.</td><td rowspan="2"><u>Environmental/ecosystem values</u>:
Important migration area for:
• Blue and humpback whales (refer Section 7.2.3.7)
Important foraging area for:
• Black-browed, wandering and shy albatross; and great-winged and cape petrels (refer Section 7.2.3.6)
Ecosystems, habitats and communities of:
• Tasmania Province, West Tasmania Transition and Western Bass Strait Shelf Transition (refer Section 7.2.3.2)

<u>Cultural Values</u>: None listed

<u>Heritage Values</u>: None listed

<u>Social & Economic Values</u>: None Listed</td><td rowspan="2">This impact assessment demonstrated the Dorrigo MSS, with control measures adopted, will protect the biological diversity of the CMP. All impacts assessed for the listed conservation values have been assessed as minor or negligible with impacts localised, temporary and fully recoverable. On this basis the management practices applied during the Dorrigo MSS ensures the protection of these conservation values.
Sound residuals present in the Zeehan CMP (Special Purpose Zone) are below biologically significant behavioural levels for marine mammals, invertebrates, plankton, turtles and avifauna. Negligible impacts are predicted for this CMP Zoning.
An assessment of the Dorrigo MSS activity on the ecological integrity of ecosystems (KEFs) present in the Dorrigo MSS area has been undertaken in Table 7-36. The Dorrigo MSS will not modify, destroy, fragment, isolate or disturb important/substantial areas of habitat adversely impacting on the Commonwealth marine area ecosystem functioning; or have a substantial adverse effect on marine species.
On this basis the biological diversity and other natural values of the CMP is protected, ecological sustainability of the area maintained and the CMP will continue to contribute to national development.
IUCN Management Principles/Objectives are not compromised by undertaking this activity.</td></tr>
<tr><td>Zeehan CMP</td><td>Special Purpose Zone (IUCN VI) (18,967 km^3)

Dorrigo MSS spatial Overlap (nil)</td><td>< 150 dB re 1µPa</td><td>~ 16 km</td><td>Provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species, while applying special purpose management arrangements for specific activities.</td></tr>
</table>

CMP	Zone	SPL (dB re 1µPa) at Boundary	Distance to Nearest Acquisition Line (km)	Purpose of Zoning	South-East Commonwealth Marine Reserves Network Management Plan 2013-23 – IUCN Management Objectives/Principles	Conservation Values (DNP, 2013)	Principle Attainment
Apollo CMP	Multiple Use Zone (1184 km^3) Dorrigo MSS spatial Overlap (nil)	< 150 dB re 1µPa	~ 22 km	Provide for the ecologically sustainable use and the conservation of ecosystems, habitats and native species.	Zone should be managed for the sustainable use of natural ecosystems based upon the following principles: • Biological diversity and other natural values should be protected and maintained in the long-term; • Management practices applied to ensure the ecological sustainable use of the reserve or zone; • Management of the reserve or zone should contribute to regional and national development to the extent it is consistent with these principles	Environmental/ecosystem values: Important migration area for: • Blue, fin, sei and humpback whales (refer **Section 7.2.3.7**) Important foraging area for: • Black-browed and shy albatross; Australasian gannet; Short-tailed shearwater; and Crested tern (refer **Section 7.2.3.6**) Ecosystems, habitats and communities of: • Western Bass Strait Shelf Transition and Bass Strait Shelf Province (refer **Section 7.2.3.2**) Cultural Values: MV City of Rayville shipwreck (1940) Heritage Values: None listed Social & Economic Values: None Listed	The assessment of principle attainment within the Apollo CMP is as per the Zeehan CMP (Multiple Use Zone). Sound residuals present in the Apollo CMP (Multiple Use Zone) are below biologically significant behavioural levels for marine mammals, invertebrates, plankton, turtles and avifauna. Negligible impacts are predicted for this CMP Zoning. *IUCN Management Principles/Objectives are not compromised by undertaking this activity.*

7.2.3.12 Impacts from Helicopter and Vessel Sound

Hazard:
Noise emissions subsea will occur form:
- Vessel engines, propellors and thrusters;
- Helicopter rotors.

Known and Potential Impacts:
The known and potential environmental impacts of vessel and helicopter noise is:
- Behavioural change
- Localised avoidance of area.

Area of Affected Impact: All vessels emit underwater noise via machinery transmitting sound through the hull and from propeller cavitation which is the loudest source. Kent et al. (2016) details that propeller cavitation noise is broadband due to the range of bubble sizes involved, from a few Hz to tens of kHz. The sound levels and frequency characteristics of underwater noise produced by vessels are related to ship size and speed. Typically, marine vessels produce low frequency sound (i.e. below 1 kHz) from the operation of machinery on-board; from hydrodynamic flow noise around the hull; from engine transmitted through the hull and from propeller cavitation, which is typically the dominant source of sound (Ross, 1987; 1993 in Skjoldal et al. 2009). Most vessel sounds are broadband (i.e. contain a broad range of frequencies), though, tones are generally associated with the harmonics of the propeller blades (Ross, 1987; 1993 in Skjoldal et al. 2009)

Survey vessels in the absence of an operating acoustic source have been measured to have a broadband source level (SLbb) of 180–191 dB re 1 µPa @ 1 m (Hannay et al. 2004; Wyatt 2008 in Kent et al. 2016). This is similar to fishing vessels that have been measured to have a broadband source level (SLbb) of 174–195 dB re 1 µPa @ 1 m (Kent et. al. 2016).

Studies of the radiating underwater sound generated from the thrusters and propellers of support vessels when holding position indicate highest measured levels of up to 182 dB re 1Pa with levels of 120 dB re 1 µPa SPL RMS measured at 3–4 km (McCauley 1998).

Helicopter operation produces strong underwater sounds for brief periods when the helicopter is directly overhead (Richardson et al. 1995). The received sound level underwater depends on the helicopter source altitude and lateral distance, the receiver depth and water depth. Sound emitted from helicopter operations is typically below 500 Hz and sound pressure is greatest at surface in the water directly below a helicopter, but this diminishes quickly with depth. Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. Richardson et al. (1995) reports figures for a Bell 214 helicopter (stated to be one of the noisiest) being audible in air for four minutes before it passed over underwater hydrophones but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. Noise from helicopter activities would therefore be localised.

Possible environmental receptors affected by impact: Based upon receptors identified for acoustic noise, those species known to be sensitive to vessel and/or helicopter underwater sound include:
- Fish (including sharks)
- Pinnipeds
- Cetaceans
- Turtles

Evaluation of Environmental Impacts:

Receptor Sensitivity:
Vessel Noise: Hearing damage in marine mammals from shipping noise has not been widely reported (OSPAR, 2009). Observed marine mammal behaviour to vessel sound includes the following:

- Sea lions (an otariid pinniped similar to fur seals) in water tolerate close and frequent approaches by vessels and sometimes congregate around fishing vessels. However, the amount of evidence is slender, and it is not known whether these animals are affected or are stressed by these encounters (Peterson and Bartholomew, 1967; cited in Richardson et al, 1995);
- Dolphins tolerate or even approach vessels but sometimes show avoidance. Reactions appear to be dependent on the dolphin's activity at the time - resting dolphins tend to avoid boats, foraging dolphins ignore and socialising dolphins may approach vessels (B. Wursig, pers.obs; cited in Richardson et al, 1995). Dolphins also reduce the energy costs of travel by riding the bow and stern waves of vessels (Williams et al, 1982; cited in Richardson et al, 1995);
- Baleen whales seem to ignore weak vessel sounds and move away in response to strong or rapidly changing vessel noise. Avoidance is particularly strong when vessels approached directly (Watkins, 1986; cited in Richardson et al, 1995). Vessels operating in gray whale breeding lagoons caused short term escape reactions in the species particularly when the vessels are moving fast and erratically, however there is little response to slow-moving or anchored vessels (Reeves 1977; Swartz and Cummings, 1978; Swartz and Jones, 1978, 1981; cited in Richardson et al. 1995). Some whales are attracted to noise from idling outboard motors and are not seriously disturbed by small vessels however calling behaviour may change to reduce masking by boat noise. During migration, gray whales were observed to change course at 200-300 m in order to move around a vessel in their path (Wyrick, 1954; cited in Richardson et al, 1995);
- There is no direct evidence of mortality or potential mortality to fish or sea turtles from ship sound (Popper are al., 2014). Popper et al. (2014) identifies that TTS impacts in turtles is moderate near the sound source (tens of meters) and masking risk is high at near and intermediate distances (hundreds of meters) from the sound source; and
- Popper et al (2014) using a relative risk assessment process for continuous shipping sounds identifies that there is a low risk of mortality, potential mortality or recoverable injury for fish without swim bladders or fish with a swim bladder (not involved in hearing) exposed to continuous shipping sound.

Aviation Noise: The behavioural reaction of cetaceans to circling aircraft (fixed wing or helicopter) has been observed. Reactions are sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS, 2001; cited in Santos, 2004). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animal. The effects on whales seem transient, and occasional over-flights probably have no long-term consequences (NMFS, 2001; cited in Santos, 2004).

Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150 m. Leatherwood et al. (1982) observed that minke whales responded to helicopters at an altitude of 230 m by changing course or slowly diving.

Extent and duration of Exposure and Potential Impact:

For most of the Dorrigo MSS the acoustic array will be the dominant noise source. For periods where the array is not operating or for support vessels, underwater sound generated by the presence of these vessels may result in changes in behaviour of marine fauna such as behavioural disturbance, localised avoidance or attraction. However, underwater sound from the survey vessels is transient and typical of other underwater noise emitted by commercial shipping or fishing vessels which operate in the area.

The Dorrigo MSS area does not contain any special features where marine species aggregate. BIAs present in the Dorrigo MSS are seabird foraging BIAs (not affected by vessel noise), a distribution BIA for the white shark and a forgaging BIA for the blue whale (with active foraging during the Bonney upwelling period). All other species present (cetaceans, pinnipeds, sharks, fish, turtles) transit through the area, and impacts from vessels would be limited to localised avoidance around the sound source. Given survey vessels are in constant movement, noise impacts in any one area is leads to temporary avoidance of species present. Given the noise footprint of the vessel travels for kilometres, impacts in species present may be short-term.

Helicopter noise is likely to be heard underwater during crew change or medivac. This sound source impacting upon the sea surface occurs for an extremely short duration to a very localised area. Impacts to any species present would be localised and temporary.

Summary:

Vessel Impacts: Disturbance to marine fauna will be localised and short term (Minor consequence); Helicopter Impacts: Disturbance to marine fauna will be very localised and temporary (Negligible consequence).

Controls Assessment:

Table 7-38 provides an assessment of controls to reduce impacts from vessel and helicopter noise during the Dorrigo MSS activity.

Table 7-38: Assessment of controls to reduce vessel and helicopter noise during the Dorrigo MSS

Control Measure	Practicable?	Will it be Implemented?	Justification
Spatial separation: Minimise the sound intensity and exposure by adopting spatial buffers between vessel/helicopters and sensitive fauna.	YES	YES	EPBC Regulations Part 8 (Division 8.1) provides details of interacting with cetaceans during vessel and helicopter movements. This includes applying caution zones, vessel speed restrictions and height restrictions. Control adopted.
Vessel engine and propulsion equipment is maintained: Ensure equipment is properly maintained to reduce sound impacts.	YES	YES	Good industry practice. Ensures reliability of equipment. **Control Adopted -** Environmental benefit outweighs the cost of implementation.
Prevent temporal overlap with foraging activities in the blue whale BIA.	YES	YES	The Dorrigo MSS will be undertaken between September 1 and October 31, 2019 which avoids the Bonney upwelling. **Control Adopted -** Environmental benefit outweighs the cost of implementation.

7.2.4 Environmental Impact Assessment

Table 7-39 provides the impact assessment for acoustic sound disturbance from the MSS activity.

Table 7-39: Acoustic sound disturbance from seismic survey EIA

Aspect	Seismic array acoustic disturbance in the marine environment. Helicopter and vessel noise impact in the marine environment	
Impact Summary	Possible physiological or behavioural impacts to sound-sensitive species.	
Extent of Impact	**Seismic Array:** High levels of sound localised around the moving operating array, with lower-level residual sound impacts on a regional basis. **Helicopter/Vessel Noise:** Non-lethal levels of sound localised aound vessels, with lower-level residual sound impacts in the area surrounding vessel operation.	
Duration of Impact	Temporary (duration of survey)	
Level of Certainty of Impact	MEDIUM. Impact of acoustic sound on species has been extensively studied for a number of species (e.g. whales, fish) with lesser studies on other species. 3D Oil considers that there is sufficient literature available to assess impacts to species present and adjacent to the Dorrigo MSS area.	
Values potentially affected within the survey environment	Whales (protected and listed), turtles (protected), pinnipeds (protected and listed), fish (pelagic, commercial), sharks (protected), marine invertebrates (lobster, deep sea crab, sponges, bryozoans, ascidians), plankton, commercial fishing, tourism	
Impact decision framework.	**Decision Context B** 3D MSS are commonly undertaken in Australian waters. There have been numerous studies on the effects of sound on marine receptors with a range of effects to no effects identified. MSS activities in Australian are well regulated and guidance is available for managing potential impacts to sound sensitive marine fauna. Sound sensitive fauna have been identified as having the potential to transit through the area (whales, turtles, sharks, fish, pinnipeds, cephalopods, plankton) or reside in the area (benthic fauna, crustaceans). The MSS area is a BIA for a number of foraging seabirds and foraging whales particularly during upwelling seasons (November to April). The MSS area also overlaps the Zeehan CMP where conservation values must be retained with no significant impact to benthic environments. The MSS area also overlaps Commonwealth commercial fisheries (CTS, GHaT); Victorian commercial fisheries (SRL and giant crab); and Tasmanian commercial fisheries (SRL and giant crab). During consultation with Commonwealth, Victorian and Tasmanian fishing industry bodies/fishers, concerns were raised in regard to the impacts of MSS to commercial fish and invertebrate species, their larvae and broader ecosystem impacts. On this basis, 3D Oil considers that Study Context B is applied to this environmental hazard.	
POTENTIAL IMPACT	INHERENT CONSEQUENCE	RESIDUAL CONSEQUENCE
Acoustic Array Sound Impact Assessment: *Note Assessment of sound to species has been undertaken in **Section 7.2** sub-sections with this table providing a summary. Note also that an assessment of controls has also been undertaken in each of the subsections and are not repeated here.*		
Plankton (mortality)	NEGLIGIBLE	NEGLIGIBLE
Sessile filter feeders (mortality/behavioural)	NEGLIGIBLE	NEGLIGIBLE
Crustaceans (No mortality, sub-lethal impacts only)	MINOR	MINOR
Crustaceans (Catchability/Abundance)	NEGLIGIBLE	NEGLIGIBLE
Gastropods (Physiological)	NEGLIGIBLE	NEGLIGIBLE
Cephalopods (Behavioural Impact)	MINOR	NEGLIGIBLE
Sharks/Pelagic Fish (Recoverable Injury)	NEGLIGIBLE	NEGLIGIBLE
Demersal Fish (Recoverable Injury)	MINOR	MINOR

Sharks/Fish (TTS)	NEGLIGIBLE	NEGLIGIBLE
Sharks/Fish (Behavioural including masking)	NEGLIGIBLE	NEGLIGIBLE
Fish (Catch abundance/ catchability)	NEGLIGIBLE	NEGLIGIBLE
Pinniped (Mortality/Recoverable Injury)	MINOR	NEGLIGIBLE
Pinnipeds (Behavioural)	MINOR	NEGLIGIBLE
Turtles (Mortality/Recoverable Injury)	MINOR	NEGLIGIBLE
Turtles (Behavioural)	MINOR	NEGLIGIBLE
Birds/Seabirds (Injury/foraging)	MINOR	NEGLIGIBLE
Penguin (foraging)	MINOR	MINOR
Cetaceans (Mortality/Recoverable Injury)	SIGNIFICANT	NEGLIGIBLE
Cetaceans (Baleen Foraging)	SIGNIFICANT	NEGLIGIBLE
Cetaceans (Odontocetes Foraging)	NEGLIGIBLE	NEGLIGIBLE
Cetaceans (Baleen –Migration)	MINOR	MINOR
Cetaceans (SRW – Breeding BIA)	NEGLIGIBLE	NEGLIGIBLE
Cetaceans (masking)	NEGLIGIBLE	NEGLIGIBLE
Water Sports/Tourism/Diving	NEGLIGIBLE	NEGLIGIBLE
Vessel and Helicopter Sound Impacts		
Vessel Impacts to Marine Fauna	MINOR	MINOR
Helicopter Impacts to Marine Fauna	NEGLIGIBLE	NEGLIGIBLE

Environmental Controls and Performance Measurement		
EPO	**EPS**	**Measurement Criteria**

The MSS is conducted in a manner that prevents physical injury (PTS/TTS) to marine fauna (whales, turtles, pinnipeds, cephalopods) and minimises effects on behaviour of Southern Right Wales with calves from underwater sound.	*EPBC Policy Statement 2.1 (Part A) control measure implementation):*
	MSS operations conducted in accordance with all requirements of the EPBC Act Policy Statement 2.1 – Part A Standard Management Procedure which includes:
	• A.3.1: Pre-startup visual observation;
	• A.3.2: Soft-start procedures;
	• A.3.3: Start-up delay procedures;
	• A.3.4: Operational procedures (shut-down on line turns);
	• A.3.5: Stop work procedures;
	• A.3.6: Night-time and low visibility procedures.
	The following zones will be implemented for whales (excluding dolphins) for all acquisition activities:
	• Observation Zone: 3km +
	• Low-power Zone: 2 km
	• Shutdown Zone: 500 m
	The following additional controls will be implemented for SRW:
	• If one or more SRW (identified by lack of dorsal fin) and calf are observed within the 3km observation zone, a power-down will be instigated. If the SRW and calf come within 1.5km of the source a shutdown procedure occurs until the cow and calf move outside of the 3km observation zone.
	The following *additional control modifications* are also adopted:
	• To protect deep-diving whale species present in the MSS area, pre-startup visual observation will include:
	  ○ For water depths <200m – 30 mins;
	  ○ For water depths > 200m – 60 mins;
	• For pinnipeds – if during pre-start observations a MFO detects a pinniped within 200m of the source, startup will be delayed until:
	  ○ The MFO confirms the pinniped has moved to a location > 200m from the sources; or
	  ○ Despite continuous observation, 10 minutes have passed since the last detection of a pinniped within 200m of the source and the mitigation zone remains clear.
	• For Turtles – If during prestart observations, an MFO detects a turtle within 500 m of the source, startup will be delayed until:
	  ○ The MFO confirms the turtle has moved to a point > 500 m from the source: or
	  ○ Despite continuous observation, 30 minutes have passed since the last detection of a turtle within 500m of the source and the mitigation zone remains clear.
	• For Turtles (Shutdown):
	  ○ If during survey operations turtles are detected within 500m, shutdown will occur.
		MFO reports show marine fauna interaction protocols are followed during survey including all required soft-start, shutdown and power-down activities.
		<u>Responsibility</u>: MFO
		Records of marine fauna sightings including pinnipeds and turtles are recorded on MFO's and support vessel crew's marine fauna record sheets.
		<u>Responsibility</u>: MFO
		Vessel logs with records of all soft starts, shut down procedures and timing of acquisition.
		<u>Responsibility</u>: Vessel master

The MSS is conducted in a manner that prevents physical injury (PTS/TTS) to marine fauna (whales, turtles, pinnipeds, cephalopods) and minimises effects on behaviour of Southern Right Wales with calves from underwater sound (*Con't*)	*Additional Management Requirements (EPBC 2.1 – Part B1 (BFOs)* The following MFOs will be present during the survey: • Two dedicated trained and experienced MFOs will be available on the survey vessel to observe for marine fauna; • At least one MFO is on observation effort during daylight hours to advise on whale presence and shutdown/power down requirements; • An additional MFO will be present on each of the support vessels to assist with marine fauna identification/observation and implementation of adaptive management measures if 'high' whale densities are triggered within the survey period. All MFOs will be trained and experienced in whale identification and behaviour, distance estimation and capable of making accurate observations of whales in Australian waters.	MFO training and experience resumes are assessed and on file prior to engagement. Responsibility: 3D Oil Project Manager (or delegate) MFO shifts recorded in the MFO Report. Responsibility: MFOs
	Crew induction into EPBC Policy Statement 2.1 Requirements (Part A2): The MFOs will induct survey and support vessel crews to ensure they are aware of the EPBC Policy Guideline 2.1 requirements and methodologies to undertake visual assessment for marine fauna species	Induction records verify key crew members have participated in the induction Responsibility: 3D Oil Offshore Representative
	EPBC Policy Statement 2.1 Requirements (Part A3 – Low Visibility Requirements): Within a location soft-starts and operations may proceed provided: • There has not been 3 or more whale instigated power-downs or shut-downs during the preceding 24 hours; or • Startup may also occur if operations have not been underway in the preceeding 24 hours and the vessel (or surveillance craft) have been in the vicinity of the proposed start-up position for at least 2 hours (under good visibility conditions) within the preceding 24-hour period and no whales have been sighted. Operations may proceed (as normal) provided there has not been 3 or more whale instigated power-downs or shutdown situations during the preceeding 24-hour period. If 3 or more whale instigated power-down or shut-down situations occur (i.e. high numbers of animals): • Soft starts will be undertaken at that particular location is good visibility conditions are present; and • Operations at night or in low visibility conditions will not be undertaken at that particular location. In this instance adaptive management measures will be considered (*refer adaptive management*).	MFO reports show marine fauna interaction protocols are followed during survey including all required soft-start, shutdown and power-down activities. Responsibility: MFO

The MSS is conducted in a manner that prevents physical injury (PTS/TTS) to marine fauna (whales, turtles, pinnipeds, cephalopods) and minimises effects on behaviour of Southern Right Wales with calves from underwater sound (*Con't*)	*EPBC Policy Statement 2.1 Requirements (Part B6 – Adaptive Management):* If there are 3 or more shut-down/power-downs due to whale presence in the preceding 24 hours; OR if there are three or more sightings of whales within the shut-down/power-down zones when the acoustic array is not operational in the preceding 24 hr period; the density of whales is deemed to be high and will cause the following measures to be implemented: • Surveillance: A support vessel will travel along the acquisition line to a distance or at least 10 km from the seismic array. If whales are observed within the distance of observation by the MFO on the support vessel, the survey vessel will undertake adaptive management (below) • Relocation: Survey vessel will relocate to another survey line > 10 km from the last confirmed whale sighting location where the support vessel has confirmed no whale presence. The survey vessel will not return to the original location within 24 hrs; OR • Cessation: If there are no options for the relocation (e.g. no other survey lines to acquire), all night time operations will cease at this location until 24 hours have passed with no whales observed. **The following additional control measures will be implemented for SRW**: Operations may proceed as normal only if a SRW (identified by lack of dorsal fin) and calf have not been observed within the 3km observation zone within the previous 24 hours. If a SRW and calf have been observed within the 3km observation zone in the previous 24 hours, night time and low visibility operations can only proceed if the vessel relocates to at least 10km from the sighting.	MFO reports show marine fauna interaction protocols are followed during survey including all required soft-start, shutdown and power-down activities to inform the activity. Responsibility: MFO
	Array Volume and Source Level An array volume of no greater than 3260 in^3 volume operating at 2000psi will be used to meet the objectives of the Dorrigo MSS. The airgun will have the following equivalent PK source pressure levels: • <255.5 dB re $1 \mu Pa^2 m^2$ (vertical plane) • <249.3 dB re $1 \mu Pa^2 m^2$ (broadside plane) • <246.1 dB re $1 \mu Pa^2 m^2$ (endfire plane)	Record of airgun configuration testing. Responsibility: 3D Oil Project Manager (or delegate)
	Area of Operation: There will be no discharge of the acoustic source outside the Dorrigo MSS operational area.	Record of survey line acquisition. Responsibility: 3D Oil Offshore Representative.
	Acoustic Source Operation on Line Turns: During line turns the acoustic source will be shut-down.	MFO report verifies shutdown on line turn. Responsibility: MFO

The Dorrigo MSS is undertaken in a manner which prevents: • Disruption to ecological processes through reduced plankton availability; • Prevents behavioural impacts to foraging blue (and other baleen) whales or displacement from blue whale foraging BIAs.	*Dorrigo MSS Survey Design* Timeframe: The Dorrigo MSS will be undertaken during the period 1 September to 31 October 2019 to prevent temporal overlap with upwelling periods (November to April) and blue whale presence. Orientation: Survey orientation is in a north-south direction (cross-current) which reduces impacts to plankton and minimises the timeframe required to acquire seismic data. Line-turns: During line turns the acoustic source will be shut-down.	MFO Report verifies period of operation. Responsibility: 3D Oil Offshore Representative
The Dorrigo MSS is undertaken in a manner which prevents: • Disruption to ecological processes through reduced plankton availability; Prevents behavioural impacts to foraging blue (and other baleen) whales or displacement from blue whale foraging BIAs (*Con't)*	*Array Volume and Source Level* An array volume of no greater than 3260 in^3 volume operating at 2000psi will be used to meet the objectives of the Dorrigo MSS. The airgun will have the following equivalent PK source pressure levels: • <255.5 dB re $1 \mu Pa^2 m^2$ (vertical plane) • <249.3 dB re $1 \mu Pa^2 m^2$ (broadside plane) • <246.1 dB re $1 \mu Pa^2 m^2$ (endfire plane)	Record of airgun configuration testing. Responsibility: 3D Oil Project Manager (or delegate)
The Dorrigo MSS is undertaken in a manner which prevents injury to invertebrates and fish such that the impacts as result of the survey are localised, temporary and recoverable.	*Array Volume and Source Level* An array volume of no greater than 3260 in^3 volume operating at 2000psi will be used to meet the objectives of the Dorrigo MSS. The airgun will have the following equivalent PK source pressure levels: • <255.5 dB re $1 \mu Pa^2 m^2$ (vertical plane) • <249.3 dB re $1 \mu Pa^2 m^2$ (broadside plane) • <246.1 dB re $1 \mu Pa^2 m^2$ (endfire plane)	Record of airgun configuration testing. Responsibility: 3D Oil Project Manager (or delegate)
	Area of Operation: There will be no discharge of the acoustic source outside the Dorrigo MSS operational area.	Record of survey line acquisition. Responsibility: 3D Oil Offshore Representative.
	Acoustic Source Operation on Line Turns: During line turns the acoustic source will be shut-down.	MFO report verifies shutdown on line turn. Responsibility: MFO
	Sort-start Procedures: Soft start procedures will be conducted in accordance with Part A of the EPBC Policy Statement 2.1 requirements to alert sound sensitive species and allow for displacement.	MFO reports show marine fauna interaction protocols are followed during survey including all required soft-start procedures. Responsibility: MFO
	Dorrigo MSS Design Survey is undertaken between 1 September to 31 October 2019 which does not temporally overlap the Victorian SRL or giant crab fishing season or the Commonwealth squid jig fishing season.	MFO Report verifies period of operation. Responsibility: 3D Oil Offshore Representative

The Dorrigo MSS is undertaken in a manner which does not significantly impact on seabird foraging within BIAs.	*Dorrigo MSS Survey Design* Timeframe: The Dorrigo MSS will be undertaken during the period 1 September to 31 October 2019 which prevent temporal overlap with upwellings and chick-raising periods (Penguins: November to April; Shearwaters: November to January). Line-turns: During line turns the acoustic source will be shut-down.	MFO Report verifies period of operation. Responsibility: 3D Oil Offshore Representative
	Array Volume and Source Level An array volume of no greater than 3260 in^3 volume operating at 2000psi will be used to meet the objectives of the Dorrigo MSS. The airgun will have the following equivalent PK source pressure levels: • <255.5 dB re $1 \mu Pa^2 m^2$ (vertical plane) • <249.3 dB re $1 \mu Pa^2 m^2$ (broadside plane) • <246.1 dB re $1 \mu Pa^2 m^2$ (endfire plane)	Record of airgun configuration testing. Responsibility: 3D Oil Project Manager (or delegate)
The Dorrigo MSS is undertaken in a manner which does not significantly impact on seabird foraging within BIAs *(Con't)*	*Area of Operation:* There will be no discharge of the acoustic source outside the Dorrigo MSS operational area.	Record of survey line acquisition. Responsibility: 3D Oil Offshore Representative.
The Dorrigo MSS is undertaken in a manner which does not damage benthic filter-feeders within the Dorrigo MSS.	*Array Volume and Source Level* An array volume of no greater than 3260 in^3 volume operating at 2000psi will be used to meet the objectives of the Dorrigo MSS. The airgun will have the following equivalent PK source pressure levels: • <255.5 dB re $1 \mu Pa^2 m^2$ (vertical plane) • <249.3 dB re $1 \mu Pa^2 m^2$ (broadside plane) • <246.1 dB re $1 \mu Pa^2 m^2$ (endfire plane)	Record of airgun configuration testing. Responsibility: 3D Oil Project Manager (or delegate)
The Dorrigo MSS is undertaken in a manner which does not cause health impacts to abalone divers present on the west King island Coastline.	*Array Volume and Source Level* An array volume of no greater than 3260 in^3 volume operating at 2000psi will be used to meet the objectives of the Dorrigo MSS. The airgun will have the following equivalent PK source pressure levels: • <255.5 dB re $1 \mu Pa^2 m^2$ (vertical plane) • <249.3 dB re $1 \mu Pa^2 m^2$ (broadside plane) • <246.1 dB re $1 \mu Pa^2 m^2$ (endfire plane)	Record of airgun configuration testing. Responsibility: 3D Oil Project Manager (or delegate)
	Daily Consultation with Abalone Divers during MSS Daily contact is made with abalone divers to advise of survey progress and acoustic operations within the Dorrigo MSS area	Consultation records. Responsibility: 3D Oil Project Manager (or delegate)
	Sort-start Procedures: Soft start procedures will be conducted in accordance with Part A of the EPBC Policy Statement 2.1 requirements to alert sound sensitive species and allow for displacement.	MFO reports show marine fauna interaction protocols are followed during survey including all required soft-start procedures. Responsibility: MFO

The Dorrigo MSS is undertaken in a manner that prevents migratory barriers to baleen whales during simultaneous surveys by 3D Oil and other third parties.	*Survey Planning/Acoustic Array Separation* SIMOPs procedures will be developed between 3D Oil and other third-party seismic operators to ensure that a minimum 40 km separation is maintained between operating acoustic arrays.	Records verify that: • Communications between 3D Oil and other seismic operators have been undertaken. • SIMOPS Procedure is in place. • Vessel track plots indicate distances from vessels comply with separation distances. Responsibility: Vessel Master/ MFO
	Simultaneous Survey Monitoring 3D Oil will monitor the NOPSEMA website for potential simultaneous surveys within proximity to the Dorrigo MSS and consult with relevant titleholders on potential spatial and temporal overlaps and measures to prevent possible cumulative impacts.	Records verify surveillance of the NOPSEMA website and communication with relevant titleholders (as required). Responsibility: 3D Oil Project Manager
The Dorrigo MSS is undertaken in a manner that prevents impacts to fishers' gear	Notification to Fishers of Commencement of Survey and Ongoing weekly Updates on Survey Duration and Completion	Record of notification to fishers Responsibility: 3D Oil offshore representative
The Dorrigo MSS is undertaken in a manner that prevents migratory barriers to baleen whales during simultaneous surveys by 3D Oil and other third parties (Con't)	*Sharing cetacean observations*: 3D Oil will promote with other MSS operators regular contact between survey vessels to share cetacean sightings to assist with informing both surveys.	MFO records verify requirements met. Responsibility: MFO
Vessels and helicopters are operated to prevent noise disturbance ro marine fauna during MSS activities.	*Spatial separation between vessels and marine mammals* Vessels will meet the requirements of Part 8 of the EPBC Regulations specifically: • Travel at less than 6 knots when in the caution zone of a cetacean (150 m radius for dolphins and pinnipeds and 300 m for whales) • Do not approach closer than the caution zones for dolphins and whales. Dolphin caution zone adopted for pinnipeds. • If cetacean or pinniped shows signs of disturbance move away at a constant speed of less than 6 knots.	MFO records verify requirements met. Responsibility: MFO
	Spatial separation between helicopters and marine mammals Helicopters will meet the requirements of Part 8 of the EPBC Regulations specifically (unless in an emergency): • Must not operate at a height lower than 1650 ft within a horizontal radius of 500m from a cetacean or pinniped.	MFO records verify requirements met. Responsibility: MFO
	Vessel maintenance (engines and propulsion equipment) Noise radiates from vessels is reduced to as low as reasonably practicable by ensuring engines and propulsion systems are maintained in accordance with manufacturers specifications.	Records verify that engines and propulsion system maintenance meet this standard. Responsibility: Chief Engineer
Demonstration of ALARP - PLANKTON		

<table>
<tr><td>Hazard Consequence Criteria</td><td>A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.</td></tr>
<tr><td>ALARP Statement</td><td>An assessment of controls to prevent impacts to plankton has been provided in Table 7.8. The controls identified by Richardson et al (2017) together with other control which reduce the level of acoustic noise have been assessed. These controls have been adopted where practicable and where the cost is not grossly disproportionate to the environmental benefit gained. The key control is undertaking the Dorrigo MSS outside of the Bonney Upwelling period.

On the basis of this assessment 3D Oil has determined that No reasonably practical, alternate and/or improved control measures exist. .</td></tr>
<tr><td colspan="2">Demonstration of Acceptability - PLANKTON</td></tr>
<tr><td colspan="2">Plankton Impact Summary (NEGLIGIBLE Impacts):

Zooplankton impacts, based upon peer-reviewed science, is predicted to affect ~0.2% of plankton within the Dorrigo MSS area per day which is inconsequential compared with the natural mortality rates for fish eggs/larvae (~21.3% population per day) (Houde & Zastrow, 1993; Saetre & Ona, 1996; Richardson et al, 2017). As a 'worst-case sensitivity, theoretical biomass depletion studies undertaken based upon recent scientific literature identified that relative biomass depletion predicted within the MSS area over the entire survey period, was equivalent to the relative biomass depletion of fish eggs on a daily basis, thereby validating that the impacts are localised, and recoverable within days of survey completion. Based upon this 'worst-case' area, the area affected would be 10% of the Otway bioregion.

In addition, the Dorrigo MSS is being undertaken at a time whereby fish/invertebrate spawning periods are avoided except for ocean perch, pilchard/sardines and the berried female/larval dispersal for SRL and giant crab species. These species are widely distributed along the southern margins of Australia and given the small predicted impacts on fish eggs compared with natural egg mortality, and the reliance of SRL/giant crab eggs/larvae to acoutci noise, any impacts will be incidental to the species populations.</td></tr>
<tr><td>Internal Context: 3D Oil Policy compliance</td><td>The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.</td></tr>
<tr><td>Internal Context: 3D Oil Management System</td><td>Section 8 detaild the relevant management system processes adopted to implement and manage hazards to ALARP:
Contactor and Supplier Management (Section 8.7); and
Maintaining Environmental and Legislative Knowledge (Section 8.10); and
Environmental Performance Monitoring and Reporting (Section 8.12).</td></tr>
<tr><td>External Context: Natural Environment</td><td><u>Environmental Significance</u>: As identified in Section 7.2.3.1, plankton impacts are localised, temporary and rapidly recoverable within the MSS area. No significance criteria is triggered for protected species (threatened or migratory); there is no disruption to normal ecological processes within the Commonwealth marine neviornment or key conservation values in the Zeehan CMR and no significant impacts to foraging seabirds or baleen whales.

<u>Key Ecological Features</u>: KEFs (West Tasmanian Canyons and Shelf Rocky Reef and Hard Substrate) impacts have been assessed in Section 7.2.3.1. Given the small spatial overlap of the Dorrigo MSS with these KEF areas, and the temporal positioning of the survey outside upwelling periods, any impacts to the KEFs from zooplankton depletion would be localised and rapidly recoverable (i.e. not significant to KEF functioning).

<u>Species Recovery Plans</u>: Plankton is not covered by a recovery plan (not threatened or endangered). The Dorrigo MSS area does spatially overlap a foraging BIA for the blue whale, however the presence of the species is tied to the availability of krill which occurs in the Bonney upwelling (active between November and April). The Dorrigo MSS period has been positioned outside this period to avoid impacts to plankton during these productive periods and the possible impacts to blue whales. No indirect impacts to foraging blue whales or displacement from foraging areas are predicted on this basis.</td></tr>
</table>

External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). Fishery-related stakeholders expressed the following concerns associated with 'ecosystem impacts' to the environment as a result of the Dorrigo MSS. • [redacted] (Victorian SRL and giant crab Licensee) expressed concern about the effects of seismic on larvae and the non-lethal injury to invertebrates. • TSIC (**Stakeholder No: 2**) indicated that seismic was becoming a larger issue for their members with a general concern for the health of the wider marine environment, not just specifically lobster and giant crab. There was recognition of work such as Day et al (2016) but also recognition that it is difficult to apply results of any one study to another area and the key issue is how seismic will affect the health of the fishery in the future. Potential mortality in larvae was also raised. • [redacted] (Victorian giant crab, lobster and GHaT fisherman) (**Stakeholder No: 38**) and [redacted] (Tasmanian giant crab fisherman) (**Stakeholder No 39**) confirmed he fishes for crab and lobster in and around the survey area and is concerned that the survey will affect catch and might affect plankton/larvae and spawning for crab. • SIV (**Stakeholder No: 3**) expressed concerns about maintaining a healthy marine environment and not just their target species and requires the EP to address the broader ecosystem and not just target species. • SETFIA (**Stakeholder No: 12**) confirmed that the Dorrigo MSS area is not a significant spawing area. • SSF (**Stakeholder No: 13**) expressed concerns around wider ecosystem impacts from seismic. • TRLFA (**Stakeholder No 9**), [redacted] (**Stakeholder No 42**), [redacted] (**Stakeholder No 58**) expressed concerns around the wider ecosystem with respect to impacts from seismic. 3D Oil has assessed impacts to plankton and broader environment as localised, temporary and recoverable compared with scientific literature and assuming worst case criteria from recent Australian plankton studies. Where the stakeholder has been receptive to information receipt, this assessment material has been provided to act as the basis of further discussion. *No further feedback has been received from these parties to date. This will form part of the ongoing consultation associated with the EP post submission.*

External Context: Legislation and Conventions	There are no specific statutes which specify legal requirements to manage impacts to plankton. However on an ecosystem impact basis, the following legislation/legislative guidelines are relevant:
	<u>Acts/Statutes</u>:
	• EPBC Act 1999 & EPBC Policy Statement 1.1 for Matters of National Environmental Significance (*Action does not significantly impact upon matters of NES*)
	• EPBC Act 1999 & EPBC Regulations 2000 (IUCN Management Principles for CMPs)
	<u>International Conventions</u>: None identified.
	<u>SE Marine Reserves Management Plan:</u>
	• MSS activities are permissible in the 'multiuse zone' of the Zeehan CMP in accordance with the class approval (refer Management Plan Section 5.1);
	• The management plan does not specifically reference plankton impacts as a threat however activities must not have an:
	  ○ Unacceptable impact on the conservation values of the CMP (migrating blue and humpback whales/ foraging albatross and petrel species) [*plankton impacts are localised, temporary and recoverable*] & ;
	  ○ Must be consistent with IUCN Principles, namely:
	    ▪ The biological diversity and other natural values of the reserve or zone are protected and maintained in the long-term;
	    ▪ Management practices should be applied to ensure ecologically sustainable use of the reserve or zone; and
	    ▪ Management of the reserve or zone should contribute to the regional and national development to the extent that it is consistent with these principles.
	  Against all IUCN criteria – as plankton impacts are localised, temporary and recoverable and predicted to be inconsequential compared with natural mortality rates of fish eggs/larvae which are very high (i.e. mean mortality rates for marine fish larvae was M=0.24, a rate equivalent to a loss of 21.3% per day (Houde & Zastrow, 1993). Biological diversity and natural values are maintained in the long-term and are ecologically sustainable.
	<u>Recovery Plans/Conservation Advices</u>: Plankton is not covered by a recovery plan. The Conservation Management Plan for the Blue Whales is considered given the in*direct impact* on foraging BIAs in the MSS area. The positioning of the Dorrigo MSS prevents overlap with Bonney upwelling and the potential for foraging blue whales in the MSS area to be displaced as a result of krill impacts. Conservation plan conditions are met.
	<u>Threat Abatement Plans</u>: Not triggered by this aspect.

<table>
<tr><td>Good Industry Practice:</td><td>No specific industry guidance is available, however measures detailed in Richardson et al (2017) to limit zooplankton impacts have been adopted as controls where practicable.
Other guidelines relate to assessment processes which have been observed in this assessment (i.e.):
• APPEA Code of Environmental Practice (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating:
  ○ The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
  ○ Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts.
• IAGC: Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).</td></tr>
<tr><td>ESD principles</td><td>There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with plankton impacts from acoustic noise.
The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adoptd the principles of ESD via all government frameworks (refer Section 2.2).</td></tr>
<tr><td>Acceptability statement:</td><td>Impacts to plankton, with controls adopted, are acceptable based upon the following criteria:
• Impacts to plankton (fish/invertebrate eggs/larvae) resulting from seismic noise emissions are expected to be inconsequential compared with natural mortality rates which are very high (exceeding 50% per day in some species and commonly exceeding 10% per day). Houde and Zastro (1993) established a mean mortality rate for fish larvae was M=0.24, a rate equivalent to a loss of 21.3% per day. Saetre & Ona (1996) calculated that under a ‘worst case scenario’, the number of larvae killed was 0.45% of the total larvae population for a MSS (> 10 days in duration);
• Plankton has rapid recovery rates (~days) (Huntley & Lopez,1992; Richardson et al, 2017);
• Based upon the localised and temporary impacts, there is no disruption to ecological processes (compared with natural mortality rates) which support conservation values (migrating whales and foraging seabirds) within the Zeehan CMP;
• The impact does not result in a significant impact to benthic habitats (SE Marine Reserves Network Plan);
• There is no overlap of the Dorrigo MSS area with key fish spawning areas (SETFIA, 2018). All species spawning at the time of the Dorrigo MSS are widespread with some species (SRL/giant crab) resilient to seismic exposure (Day et al, 2016; Payne et al, 2008; Christian et al, 2003; DFO, 2004; Perason et al, 1994); and
• Temporal placement of the Dorrigo MSS outside the Bonney upwelling period ensures there is no impact to plankton biomass that would affect foraging blue whales in within foraging BIAs.
Impacts is acceptable based upon criteria in the SE Marine Reserves Network Management Plan, Conservation Plan for blue whales, EPBC significance criteria for matters of NES.</td></tr>
<tr><td colspan="2">INVERTEBRATES</td></tr>
<tr><td colspan="2">DEMONSTRATION OF ALARP</td></tr>
<tr><td>Hazard Consequence Criteria</td><td>The following species were assessed as having a NEGLIGIBLE impact with controls adopted with respect to noise exposure:
• Sessile filter feeders (mortality/behavioural impacts);
• Crustaceans (catchability/abundance impacts);
• Gastropods (physiological impacts);
• Cephalopods (behavioural impacts).
A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
Sub-lethal impacts to crustaceans (specifically SRL) on the basis of the Day et al (2016) studies have been assessed as MINOR
A MINOR consequence needs reduction measures implemented. The ranking is generally acceptable whether further risk reduction is shown not to be practicable.</td></tr>
</table>

ALARP Statement	An assessment of controls to prevent impacts to filter feeders is provided in **Table 7.9;** for crustaceans in **Table 7.12**; for gastropods in **Table 7.13** and for cephalopods in **Table 7-14**. The mitigation controls identified by VFA (2018) for SRL/crab have been considered in the assessment of controls. These controls have been adopted where practicable and where the cost is not grossly disproportionate to the environmental benefit gained. On the basis of this assessment 3D Oil has determined that *No reasonably practical, alternate and/or improved control measures exist*. .
Demonstration of Acceptability	
Sessile Filter Feeder Impact Summary: Studies have not identified any impacts to sessile filter feeders below 214-220 dB re 1µPa (SPL) (Salgado-Kent et al, 2016; cited in Sants 2018). Dorrigo MSS modelling does not predict these sound levels are reached in the Dorrigo MSS. As there is no physical contact with the seabed which could damage benthic communities, any impacts are expected to be localised, incidental and recoverable (NEGLIGIBLE). *Crustacean Impact Summary:* Mortality/Sublethal Impacts: Exposure is not expected to result in mortalities to adult SRL (day et al, 2016; Payne et al, 2007) or crabs (Christian et al, 2004; DFO, 2004; Payne et al, 2008). No physiological or stress-related changes are expected in crab species (Christian et al, 2003; 2004) however close proximity sound exposure may lead to increased stress and neurological impairment in SRL (Day et al, 2016). The authors concluded that impacts to staticyst morpohology, behavioural reflexes and immune response was relatively minor but depended on the fitness of the exposed animal (Day et al, 2016). It is not known what impacts reduce mobility and immunity may have on SRL survival, however SRL populations where statocyst damage is known to exist have high survival rates (Kordjazi et al, 2015). For study where sub-lethal impacts were observed, the acoustic source was at close range which is not similar to conditions present in the Dorrigo MSS (Day et al, 2016). SRL and crab stock affected across the Dorrigo MSS area is small (0.73% SRL TACC and 6.4% giant crab TACC) (MINOR Consequence) Catchability/abundance Impacts: Research has not identified any change to invertebrate catch rates from seismic surveys (Carroll et al, 2017; Morris et al, 2017; Parry & Gason, 2006; Christian et al, 2003; La Bella et al, 1996). The proportion of fishery effected is 0.7% SRL catch and 6.4% giant crab based on TACC (NEGLIGIBLE consequence) *Gastropod Impact Summary*: Abalone are not present within the Dorrigo MSS area. Most studies have found no response with respect to mortality impacts in bi-vale molluscs (Carroll et al, 2017; Harrington et al, 2010; Parry et al, 2002). Mortality impacts which have been observed for bivalves directly exposed to MSS noise lie within natural mortality rates (Day et al, 2016) and are unlikely to have long term population effects. Injury and mortality have been reported in studies where the MSS is at close range to the study species with particle motion rather than spond pressure an important factor (Ellers, 1995; Frings, 1964; cited in McCauley & Kent, 2008; Whethey and Woodein, 2005). As the Dorrigo MSS is spatially separated from abalone reefs, mortality or physiological impacts are not predicted and impacts would be incidental, localised and recoverable (NEGLIGIBLE consequence); *Cephalopod Impact Summary:* Cephalopods are sound sensitive and will displace from areas of high sound intensity (Fewtrell & McCauley, 2012; McCauley et al, 2000). Immediate mass mortalities have not been observed. On a per-shot basis, the behavioural isopleth of 160 dB re 1µPa (SPL) as any one time represents a spatial overlap of 0.7% of the Otway bioregion. Based on observed catch for cephalopods pre and post MSS activities, it is likely the species will move back into the area once the acoustic array has passed (La Belle et al, 1996; Przeslawski et al, 2016). The Dorrigo MSS spatially overlaps seabird foraging BIAs, foraging on multiple species with a widespread distribution. Cephalopod displacement may result in the displacement of these birds however this impact is localised, temporary and recoverable in any one location with no net foraging opportunity reduction. Impacts are localised temporary and recoverable (NEGLIGIBLE consequence). Note also the squid jig fishery is active in proximity to the Dorrigo MSS area between January and June. Based on the studies pre and post MSS activity identifies no impact to catch data (La Belle et al, 1996; Przeslawski et al, 2016). Commercial squid fishing should not be affected.	
Internal Context: 3D Oil Policy compliance	The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** detaild the relevant management system processes adopted to implement and manage hazards to ALARP: • Consulttaion (**Section 4**); • Contactor and Supplier Management (**Section 8.7**); and • Maintaining Environmental and Legislative Knowledge (**Section 8.10**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).

External Context: Natural Environment	Environmental Significance: No listed invertebrate species or critical habitat for invertebrates are identified in, or in close proximity to the Dorrigo MSS area. As identified in **Section 7.2.3.2**, invertebrate impacts are no-effect (crabs, sessile filter feeders, gastropod), sub-lethal (SRL) or behavioural (cephalopod) with only localised and temporary impacts to small number of invertebrate species within or adjacent to the MSS area. No significance criteria is triggered for protected species (threatened or migratory); there is no disruption to normal ecological processes within the Commonwealth marine environment or key conservation values in the Zeehan CMR and no significant impacts to foraging seabirds or baleen whales. Key Ecological Features: KEFs (West Tasmanian Canyons and Shelf Rocky Reef and Hard Substrate) impacts have been assessed in **Section 7.2.3.10**. Given the small spatial overlap of the Dorrigo MSS with these KEF areas (0.3% west Tasmanian KEF and 0.42% Shelf Rocky Reef and Hard Substrate KEF), the MSS does not physically contact the seabed, benthic species have no-effect impacts (crabs, sessile filter feeders) or sub-lethal impacts (SRL) with only a very small proportion of the stock affected (sessile filter feeders – 4.2% Otway bioregion; SRL 0.7% catch based on TACC; and crab 6.4% catch based on TACC), impacts to KEF functioning are incidental and temporary and not expected to disrupt ecological processes. Species Recovery Plans: Invertebrates are not covered by a recovery plan (not threatened or endangered). The Dorrigo MSS area does spatially overlap a foraging BIA for seabirds (petrels, albatross and shearwaters). Most seabirds forage on multiple species, however indirect impacts to seabird foraging may occur as a result of cephalopod displacement from sound sources. Given the displacement is temporary and recoverable, and given the seabirds are wide-ranging, not net reduction in foraging opportunity is expected. Commercial Fishing Species (SRL/Crab/Squid): An assessment of spatial overlap of fishing grounds and SRL/crab stock affected by seismic noise was undertaken in **Section 7.2.3.2** (Commercial Fisheries). The assessment identified that the affected stock together with the catch 'taken' from the fishery did not exceed TACC levels. The sustainability of the fishery will not be affected by the small proportion of the fishery affected. No impact to the squid jig fishery are expected (no temporal overlap with cephalopod species rapidly recoverable form sound impacts).
External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). Fishery-related stakeholders expressed the following concerns associated with SRL or giant crab impacts to the environment as a result of the Dorrigo MSS. • [redacted] (Victorian SRL and giant crab Licensee) expressed concern about the effects of seismic on larvae and the non-lethal injury to invertebrates. He confirmed that probably only 5 vessels were active in the Dorrigo MSS area with only 1-2 giant crab fishermen affected. • TSIC (**Stakeholder No: 2**) indicated that seismic was becoming a larger issue for their members with a general concern for the health of the wider marine environment, not just specifically lobster and giant crab. There was recognition of work such as Day et al (2016) but also recognition that it is difficult to apply results of any one study to another area and the key issue is how seismic will affect the health of the fishery in the future. • [redacted] (Victorian giant crab, lobster and GHaT fisherman) (**Stakeholder No: 38**) and [redacted] (Tasmanian giant crab fisherman) (**Stakeholder No 39**) confirmed they fish for crab and lobster in and around the survey area and is concerned that the survey will affect catch and might affect stock. • SIV (**Stakeholder No: 3**) expressed concerns about maintaining a healthy marine environment and not just their target species and requires the EP to address the broader ecosystem and not just target species. • TRLFA (**Stakeholder No 9**) expressed concerns around SRL and the application of the Day et al (2016) work to the Dorrigo MSS area. 3D Oil has assessed impacts to invertebrates as localised, temporary and recoverable based on scientific literature (Australian and International) which is considered applicable to the Dorrigo MSS area. Where the stakeholder has been receptive to information receipt, this assessment material has been provided to act as the basis of further discussion. [redacted] (Stakeholder No: 38) does not consider the data to be relevant to the Dorrigo area which is not 3D Oil's position. *No further feedback has been received from other parties to date. This will form part of the ongoing consultation associated with the EP post submission.* *No stakeholder feedback has been provided regarding concern for sessile filter feeders, cephalopods or gastropods (abalone).*

External Context: Legislation and Conventions	There are no specific statutes which specify legal requirements to manage impacts to invertebrates. However on an ecosystem impact basis, the following legislation/legislative guidelines are relevant: Acts/Statutes: • EPBC Act 1999 & EPBC Policy Statement 1.1 for Matters of National Environmental Significance (*Action does not significantly impact upon matters of NES*) • EPBC Act 1999 & EPBC Regulations 2000 (IUCN Management Principles for CMPs) • Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights International Conventions: None identified. SE Marine Reserves Management Plan: • MSS activities are permissible in the 'multiuse zone' of the Zeehan CMP in accordance with the class approval (refer Management Plan Section 5.1); • The management plan does not specifically reference invertebrate impacts as a threat however activities must not have an: o Unacceptable impact on the conservation values of the CMP (migrating blue and humpback whales/ foraging albatross and petrel species) [*cephalopod displacement impacts are localised, temporary and recoverable not reducing net feeding opportunities of seabirds*] & ; o Must be consistent with IUCN Principles, namely: ▪ The biological diversity and other natural values of the reserve or zone are protected and maintained in the long-term; ▪ Management practices should be applied to ensure ecologically sustainable use of the reserve or zone; and ▪ Management of the reserve or zone should contribute to the regional and national development to the extent that it is consistent with these principles. *Against all IUCN criteria – as invertebrate impacts are sub-lethal, localised, temporary and affecting only a small proportion of the total species present in the bioregion, and there is no physical impact on benthic habitats from MSS activities, biological diversity and conservation values are maintained in the long-term and are ecologically sustainable.* Recovery Plans/Conservation Advices: Invertebrates are not covered by a recovery plan. While the recovery plan for threatened albatross and giant petrels (2011-2016) (SEWPC, 2011c) does not specifically list foraging displacement as a threat, cephalopod displacement may have in*direct impact* on seabirds foraging in BIAs in the MSS area. Displacement is temporary and does not result in any net foraging opportunity reduction. Threat Abatement Plans: Not triggered by this aspect.
Good Industry Practice:	No specific industry guidance is available, however measures detailed by VFA (2017) to limit SRL/giant crab impacts have been adopted as controls where practicable. Other guidelines relate to assessment processes which have been observed in this assessment (i.e.): • **EPBC Policy Statement 2.**1 Guidelines (Soft-start procedures for sound sensitive invertebrates). • **APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating: o The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and o Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts. • **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with invertebrate impacts from acoustic noise. The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adoptd the principles of ESD via all government frameworks (refer **Section 2.2**).

Acceptability statement:	Impacts to invertebrates, with controls adopted, are acceptable based upon the following: • Impacts to invertebrates are localised, temporary and affect a small proportion of the species within the bioregion. Impacts range from no-effects to sub-lethal effects (with sound source at short-range) (Day et al, 2016). *No disruption to ecological processes supporting conservation values in the Zeehan CMP.* • The activity will not affect the sustainability of the SRL or giant crab fishery based upon the estimated catch affected by the Dorrido MSS and the TACC levels (refer **Section 7.2.3.2**) (i.*e. no impact to the crustacean biomass within the MSS area which affects the sustainability of the fishery*); • No catchability/abundance impacts in the SRL/crab fishery are predicted (Carroll et al, 2017; Morris et al, 2017; Parry & Gason, 2006; Christian et al, 2003; La Bella et al, 1996). The proportion of fishery effected is 0.7% SRL catch and 6.4% giant crab based on TACC (i.*e. any fishery impacts are incidental, localised and short-term*); • No predicted impacts to sessile filter feeders (Slagado-Kent et al, 2016; cited in Santos, 2018) from acoustic sound or physical impacts from MSS operations (i.*e. no significant impact to benthic habitats*). • No injury to cephalopods due to sound displacement on soft-start (Fewtrell & McCauley, 2012; McCauley et al, 2000) with displacement localised and temporary until the source has passed (La Belle et al, 1996; Przeslawski et al, 2016). *Impact is acceptable based upon criteria outlined in the SE Marine Reserves Network Management Plan and EPBC significance criteria for matters of NES.*
FISH/SHARKS	
DEMONSTRATION OF ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice. Recoverable injury impacts to demersal fish species on the basis of the McCauley et al, 2003b; Woodside, 2012b studies have been assessed as MINOR A MINOR consequence needs reduction measures implemented. The ranking is generally acceptable whether further risk reduction is shown not to be practicable.
ALARP Statement	An assessment of controls to prevent impacts to fish/sharks is provided in **Table 7.19.** These controls have been adopted where practicable and where the cost is not grossly disproportionate to the environmental benefit gained. On the basis of this assessment 3D Oil has determined that *All known control measures have been adopted.*
Demonstration of Acceptability	

Shark/Fish Impact Summary:

Mortality/Recoverable injury impacts: Exposure is not expected to result in mortalities to fish/sharks (DFO, 2004b; Carrol et al, 217; Popper et al, 2014; Popper et al, 2016). Area affected by sound sufficient to cause mortality or recoverable injury is localised on a bioregional basis (Sharks (1.8% Otway Bioregion); Type 2/3 Fish (4.3% Otway Bioregion)).

- Injury in sharks is considered remote given their lack of swim bladder and observed response to near-field particle motion (Myrberg, 2001; Klimley & Myrberg, 1979, Casper et al, 2010). Distribution of sharksis widespread within the Dorigo MSS and general Otway bioregion (NEGLIGIBLE consequence).
- Pelagic fish are wide-ranging and likely to move from areas of high sound (Slotte et al, 2004; Carroll et al, 2017). There was a lack of significant impact observed in site-attcahed species in reef habitats (Woodside, 2012b; Boeger et al, 2006; Wardle et al, 2001) supports that pelagic fish displacing from sound disturbance are unlikely to be at risk of mortal/recoverable injury. (NEGLIGIBLE consequence).
- Demersal species may be less included to move away from high levels of sound and damage to hearing hair cells (McCauley et al, 2003b; Woodside, 2012b) or short-term biochemical stress responses (Santtulli et al, 1999) might occur. In this context sensory hair cells are constantly added in fish (Popper & Hoxter, 1984; Lombarte and Popper, 1994) and replaced when damaged (Lombate et al, 1993; Schuck & Smith, 2009). Therefore impacts are expected to be temporary, recoverable and short-term (MINOR consequence).
- Commercial fish impacts based upon the catch exposed by Dorrigo MSS activities and fishery catch 'take' does not exceed TACC for fishery species. On this bais impacts to fish/shark stock from Dorrigo MSS activities is not expected to affect stock sustainability.

<u>TTS Impacts (NEGLIGIBLE Consequence)</u>: Fish/shark species are wide-ranging across the Dorrigo MSS area. Pelagic species may displace from areas of high sound limiting TTS potential (Slotte et al, 2004; Carroll et al, 2017). Given the constant movement of the vessel and small area affected in a 24-hr period (4% Otway bioregion), TTS in pelagic species is very unlikely. Demersal species are generally less mobile than pelagic species and may experience TTS if the fish stays within 3.58 km of the array for 24hrs (Warner et al, 2018). Realistically, given the vessel movement, demersal species do not stay in this range for 24hrs but could be exposed to a sound level associated with injury if within that range for 24 hrs (Warner et al, 2018). Fish with TTS recovered to normal hearing levels in 18-24 hrs (Popper et al, 2005, Popper et al, 2014). TTS impacts in fish are localised and temporary with full recovery expected.

<u>Behavioural Impacts (NEGLIGIBLE Consequence)</u>: Fish/shark species are wide-ranging across the Dorrigo MSS area. With the proportion of fish affected by behavioural impacts 4.2% of the Otway bioregion.

- Behavioural responses in sharks are predicted only in close proximity to the operational array (Popper et al, 2014) consistent with shark bites on hydrophone cables in proximity to the source array (McCauley et al, 1994) and responses to sudden sound increases close to the sound source (Myrberg, 2001). Behaviours are expected to be localised and temporary in any one location;
- Behavioural impacts in pelagic fish have also been shown to be short-term (Slotte et al, 2004; Woodside 2012b) and localised (Pena et al, 2013; Woodside 2008b).
- Behavioural impacts in demersal species has been shown to be localised and temporary (Chapman & Hawkins, 1969; Przeslawski et al, 2016a; Wardle et al, 2001) and in site attached species during MSS activity (Millar and Cripps, 2013; Woodside, 2012b) or experience habituation to the sound after a short period of exposure (Chapman & Hawkins, 1969; Fewtrell & McCauley, 2012)

<u>Commercial Fishing Catch & Abundance (NEGLIGIBLE Consequence)</u>:

- <u>CTS</u>: Catchability in Dorrigo MSS appears to depend on species.Przeslawski et al (2016a) identified that for CTS target species (based on Danish Seine) John Dory and Morwong did not show any significant decrease in catch. Tiger flathead significantly increased. Available information on target species within the Dorrigo MSS would expect the catch rate to remain unchanged or increase. Catch effects are expected to be transitory based on demersal fish studies (Pearson et al, 1992; Przeslawski et al, 2016a) and the proportion of catch taken in the Dorrigo MSS is [redacted]% CTS Catch (2017-18) (SETFIA/ Fishwell Consulting, 2018).
- <u>GHaT (shark):</u> Catchability for demersal gillnet/hook varies by fishing gear type. Gillnet catch has been observed to increase after MSS activities (Lokkeborg et al, 2012) and Przeslawski et al (2016a) identified that the gummy shark showed no change in catch. Fishery in Dorrigo MSS area is predominantly gillnet although closer to the King Island coastline. Catch effects are expected to be transitory based on demersal fish studies (Pearson et al, 1992; Przeslawski et al, 2016a) and the proportion of catch taken in the Dorrigo MSS is [redacted]% GHaT (shark) Catch (2017-18) (SETFIA/ Fishwell Consulting, 2018). The Dorrigo MSS spatially overlaps 0.3% of the GHaT Fishery area actively fished in 2017-18.
- <u>GHaT (scalefish):</u> Catability of demersal hook spcies may decrease based on the studies of Lokkeborg et al (2012) but are expected to be transitory based on demersal fish studies (Pearson et al, 1992; Przeslawski et al, 2016a). The Dorrigo MSS spatially overlaps 0.28% of the GHaT (scalefish) area actively fished in 2017-18.

For all fisheries, catch and abundance impacts are expected to be incidental, localised, short-term and recoverable (NEGLIGIBLE consequence).

Internal Context: 3D Oil Policy compliance	The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** detailed the relevant management system processes adopted to implement and manage hazards to ALARP: • Consultation (**Section 4**); • Contactor and Supplier Management (**Section 8.7**); • Maintaining Environmental and Legislative Knowledge (**Section 8.10**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	<u>Environmental Significance</u>: No fish/shark species have listed critical habitat identified in, or in close proximity to the Dorrigo MSS area with the exception of the white shark who has a distribution BIA which spatially overlays the Dorrigo MSS. The white shark is generally seen between the coast and 100m (water depth) (Bruce et al, 2006) with frequent encounter around seal colonies particularly when juveniles are present (November to January) (EA, 2002) (Reid Rock is located at least 45 km from the MSS). The area affected by sound whereby recoverable injury impacts might occur is 647 km^2. As the white shark BIA is distributed over the continental shelf area of the SE marine region (i.e. 501,500 km^2), the area of impact represents 0.13% of the species distribution BIA. The white shark is expected to have a low presence within the Dorrigo MSS area and any impacts to the species (as above) are localised, temporary and recoverable. The Dorrigo MSS is not located in proximity to breeding or nursing areas for the species (DoEE, 2018b). No significant impacts are expected to the white shark as a result of Dorrigo MSS activities.

External Context: Natural Environment	As identified in **Section 7.2.3.3**, mortality impacts to fish/shark have not been observed (DFO, 2004b; Carroll et al, 2017, Popper et al, 2014; Popper et al, 2016). Recoverable injury impacts have been observed in demersal/site-attached species, however impacts are temporary and while recoverable it is unclear whether they are more susceptible to predation or other stressors. All species are wide-ranging and the area affected by sound levels which may cause recoverable injuries is 4.3% Otway Bioregion (over the 35-day period). All other fish/shark behavioural and catch/abundance impacts are localised, temporary and recoverable. No significance criteria is triggered for protected species (threatened or migratory). Given the small area affected by recoverable injury impacts over the period of the survey, no disruption to ecological processes within the Commonwealth marine environment is predicted or impacts to key conservation values in the Zeehan CMR (foraging seabirds or baleen whales) are expected. <u>Key Ecological Features</u>: KEFs (West Tasmanian Canyons and Shelf Rocky Reef and Hard Substrate) impacts have been assessed in **Section 7.2.3.10**. Given there is only a small spatial overlap of the Dorrigo MSS with these KEF areas (0.3% west Tasmanian KEF and 0.42% Shelf Rocky Reef and Hard Substrate KEF) and as the MSS does not physically contact the seabed only a very small proportion of the fish associated with these KEFs might be impacted by recoverable injury impacts. On this basis, impacts to KEF functioning are incidental and temporary and not expected to disrupt ecological processes. <u>Species Recovery Plans</u>: A recovery plan is in place for the white shark. Noise impacts are not identified as a threat to the species and the species does not have a significant presence in the Dorrigo MSS. Impacts to the species are assessed as localised, temporary and recoverable. No impacts to species recovery are predicted. <u>Commercial Fishing Species (CTS/GHaT):</u> An assessment of spatial overlap of fishing grounds and fish/shark stock affected by seismic noise was undertaken in **Section 7.2.3.3** (Fish/Sharks). The assessment identified that the affected stock together with the catch 'taken' from the fishery did not exceed TACC levels. The sustainability of the fishery will not be affected by Dorrigo MSS activity. Catchability/ abundance impacts within the Dorrigo MSS are expected to vary by gear type however based on available scientific literature *catch and abundance impacts are expected to be incidental, localised, short-term and recoverable* (refer impact assessment summary)
External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). Fishery-related stakeholders expressed the following concerns associated with 'fishing impacts' to the environment as a result of the Dorrigo MSS. SETFIA (**Stakeholder No: 12**) expressed about the impact to the wider marine ecosystem with a slow return of fish stock in and around the acquisition area, particularly in shallow water (fishers generally avoid acquisition areas for some time). There was also concern about the long-term effects of seismic on the environment, with a significant effect on bottom-dwellers, particularly flathead. This concern appears to conflict with available studies on fish species, and available impact information for flathead species obtained from MSS activities in the Gippsland Basin (SETFIA primary fishing grounds were coincident with this study area) (Przeslawski et al., 2016a; Bruce et al, 2018). This information has been provided to SETFIA. SETFIA also requested that 3D Oil reassess survey lines in the south-west continental slope section of the survey area to eliminate if possible. 3D Oil provided data to SETFIA which identified the targets which were being assessed as part of the Dorrigo MSS explaining that if the targets were not assessed as part of the current MSS program, there would be justification for a second MSS to be undertaken (with any associated impacts/disruption). SETFIA agreed that acquisition of data over the south-west corner of the MSS area was less disruptive if undertaken in one MSS event. One survey which covers the area is acceptable. SSF (**Stakeholder No: 13**), representing gillnet fishermen within the GHaT fishery, identified that GHAT fishing activity usually does not occur in the full-fold area and is located closer to King Island. The main concern was impact of seismic on the wider marine ecosystem. Fishermen expressed concern about: • Reduced catches within or around the survey area which manifest 12 months after acquisition. Available literature (Przeslawski et al, 2016a; Bruce et al, 2018) has been provided to SSF which identified that gillnet target species catch increased up to 6 months after MSS activities or remained unchanged within the Gippsland Basin (coincident with GHaT fishery). Anecdotal information would appear to contradict available information in recent scientific studies performed in the Gippsland Basin. • School shark migratory pathway interruption, which based upon the widespread nature of the species and the localised nature of any sound impacts on sharks from seismic is not expected to be significant. • Impacts to food-chain such as crayfish, shellfish and other food sources (**Section 7.2.3.1** & **Section 7.2.3.2** has been provided to SSF to establish negligible impacts to the food-chain are predicted from the Dorrigo MSS activity). Assessment information has been provided to SSF as part of ongoing consultation. No further feedback has been provided by SSF to date.

	[redacted] (**Stakeholder #61**) has also expressed concerns associated with the reaction of fish-stock with seismic surveys. [redacted] fishes in the area 'ocasionally' but is predominantly located along the west coast. 3D Oil has provided information to the stakeholder requesting feedback from his observations as a result of seismic. *No response has been provided to date, but any feedback will form part of the ongoing consultation after submission of the EP.*

External Context: Legislation and Conventions	There are no specific statutes which specify legal requirements to manage impacts to fish and sharks. However on an ecosystem impact basis, the following legislation/legislative guidelines are relevant:
	
	Acts/Statutes:
	• EPBC Act 1999 & EPBC Policy Statement 1.1 for Matters of National Environmental Significance (*Action does not significantly impact upon matters of NES*)
	• EPBC Act 1999 & EPBC Regulations 2000 (IUCN Management Principles for CMPs)
	• Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights
	International Conventions: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)
	SE Marine Reserves Management Plan:
	• MSS activities are permissible in the 'multiuse zone' of the Zeehan CMP in accordance with the class approval (refer Management Plan Section 5.1);
	• The management plan does not specifically reference management measures relating to fish/sharks however activities must not have an:
	  ○ Unacceptable impact on the conservation values of the CMP (migrating blue and humpback whales/ foraging albatross and petrel species) [*fish displacement impacts are localised, temporary and recoverable and will not reduce the net foraging opportunities*] & ;
	  ○ Must be consistent with IUCN Principles, namely:
	    ▪ The biological diversity and other natural values of the reserve or zone are protected and maintained in the long-term;
	    ▪ Management practices should be applied to ensure ecologically sustainable use of the reserve or zone; and
	    ▪ Management of the reserve or zone should contribute to the regional and national development to the extent that it is consistent with these principles.
	  Against all IUCN criteria – as fish/shark impacts are sub-lethal, localised, temporary and affecting only a small proportion of the total species present in the bioregion, and there is no physical impact on benthic habitats from MSS activities, biological diversity and conservation values are maintained in the long-term and are ecologically sustainable.
	Recovery Plans/Conservation Advices: The whale shark is covered by a recovery plan (as above). The recovery plan does not identify noise as a threat to the species and no management actions have been documented. The Dorrigo MSS activity does not conflict with any management measures within this plan.
	Threat Abatement Plans: Not triggered by this aspect.

Good Industry Practice:	No specific industry guidance on reducing impacts to fish/sharks is available.
	Other guidelines relate to assessment processes which have been observed in this assessment (i.e.):
	• **APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating:
	  ○ The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
	  ○ Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts.
	• **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
	• **EPBC Policy Statement 2.**1 Guidelines (Soft-start procedures for fish/sharks).

ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with temporary, localised and recoverable impacts to fish from acoustic noise. The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adoptd the principles of ESD via all government frameworks (refer **Section 2.2**).

Acceptability statement:	Impacts to fish, with controls adopted, are acceptable based upon the following: • Mortality of fish (both immediate and delayed) is considered highly unlikely. No mortality impacts have been observed in fish exposed to airgun sounds (Popper et al, 2014; 2016; Carroll et al, 2016; McCauley et al, 2003, Boeger et al, 2006; Wardle et al, 2001; Popper et al, 2005; Song et al, 2008; Santulli et al, 1999; Woodside, 2008) however some temporary physiological (TTS, hearing hair cell damage, serum stress analytes) (Song et al, 2008; Woodside, 2008; Santulli et al, 1999; Popper et al, 2005) and behavioural impacts (e.g. vertical/lateral displacement, schooling behaviour, startle behaviour) (Woodside, 2008; Przeslawski et al. 2016; Slotte et al, 2004) have been observed. All physiological and behavioural impacts are localised, temporary and recoverable; • Injury impacts in sharks are considered remote given their biology (i.e. no swim bladder) and their observed response to sound intensity increases close to sound sources (Myrberg et al, 2001; Casper et al, 2010; Klimley and Myrberg, 1979). There are no documented cases of mortality in the more 'sound-sensitive fish' types (i.e. with swim bladders) from seismic exposure under experimental or field conditions (Carroll et al, 2017) which supports this conclusion. Mortality and recoverable injury impacts to the white shark is remote; • Acquisition is expected to have temporary and localised impacts to commercial fish abundance within the MSS area (Skalski et al. 1992; Przeslawski et al. 2016; Woodside, 2008; Pena et al, 2013, **Stakeholder Record 12 & 13**] with catchability impacts to target species within the MSS area localised, short-term and recoverable; • No fish/shark stock mortality impacts (indirect from physiological impacts) which affects the sustainability of fish/shark resources in the Dorrigo MSS from survey activities (SETFIA/Fishwell Consulting, 2018; Patterson et al, 2018); • Localised, temporary and recoverable impacts to fish/shark species in the Dorrigo MSS do not disrupt ecological processes supporting conservation values in the Zeehan CMP (foraging albatross/petrels, migrating humpback/blue whales). *Impact is acceptable based upon criteria in the SE Marine Reserves Network Management Plan, EPBC significance criteria for matters of NES and Recovery Plan for the Great White Shark (SEWPC, 2013).*
TURTLES	
DEMONSTRATION OF ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
ALARP Statement	An assessment of controls to prevent impacts to turtles is provided in **Table 7.24.** These controls have been adopted where practicable and where the cost is not grossly disproportionate to the environmental benefit gained. On the basis of this assessment 3D Oil has determined that *All known control measures have been adopted.*
Demonstration of Acceptability	
Turtle Impact Summary: Mortality/Recoverable injury impacts: Turtles are sensitive to sound and airgun exposure may damage turtles that are at very close range to the source (Popper et al, 2014). Based upon available exposure guidelines, it is possible for mortality level thresholds to occur within 191 m of an operational array (Warner et al, 2018). The area of ensonification is 74.3 km^2 per day (0.2% Otway bioregion per day) and over the 35-day period is ~1625 km^2 (4.4% of the Otway bioregion). The MSS area does not represent important habitat for the species most likely to be present, the leatherback turtle. Leatherback turtles forage mainly on pelagic, soft-bodies jellyfish which occur in the greatest concentrations at surface in areas of upwelling over the continental shelf (DoEE, 2018ag). The temporal positioning of the MSS is outside upwelling periods so encounter is possible but low. Disturbance: Behavioural disturbance (i.e. increased swimming, avoidance) may occur within 5.44 km of the operational array. At any point in time, the ensoniifed area (93km^2) represents 0.25% of the Otway Bioregion. Over the 35-day period an area of ~3500 km^2 or 9.4% of the Otway bioregion may be ensonified.	
Internal Context: 3D Oil Policy compliance	The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contactor and Supplier Management (**Section 8.7**); • Maintaining Environmental and Legislative Knowledge (**Section 8.10**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).

External Context: Natural Environment	<u>Environmental Significance</u>: No turtle species has listed critical habitat (BIA) within or adjacent to the Dorrigo MSS area. The leatherback turtle presence in the survey area is linked to upwellings, which the Dorrigo MSS timeframe avoids. There are no breeding locations for the species in or around the Dorrigo MSS area and turtles are not nominated as a conservation value of the Zeehan CMP. As identified in **Section 7.2.3.5**, available literature identifies that turtle species can detect sound between 50-1000Hz (Piniak et al, 2012) and are therefore receptive to to seismic sound. It is possible, without controls adopted that seismic exposure may impact on turtles transiting through the MSS area. Given the non-critical nature of the Dorrigo MSS, and the limited area ensonified at any one time (0.2% Otway bioregion), it is very unlikely that significant number of turtles will be exposed to damaging sound and significance criteria under the EPBC Act is not triggered. Given the small number of turtles affected by seismic sound over the survey period, no disruption to ecological processes within the Commonwealth marine environment is predicted. <u>Key Ecological Features</u>: KEFs (West Tasmanian Canyons and Shelf Rocky Reef and Hard Substrate) impacts have been assessed in **Section 7.2.3.10**. Turtle species do not contribute significantly to KEF functioning in the Dorrigo MSS area. This, together with the small spatial overlap of the Dorrigo MSS with KEF areas (0.3% west Tasmanian KEF and 0.42% Shelf Rocky Reef and Hard Substrate KEF), impacts to KEF functioning are predicted to be incidental and temporary and not expected to disrupt ecological processes. <u>Species Recovery Plans</u>: The recovery plan for marine turtles in Australia (2017-2017) (DoEE, 2017) identifies noise interference as a threat to turtles in Australian watsre and requires all MSS operations to undertake soft-starts during surveys irrespective of the location and time of year. These requirements are adopted within this EP, together with provision for MFO observation for the species, startup delays and shutdowns. With these controls adopted, injury to turtles is not expected.
External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with sound impacts to turtles. As such, 3D oil considers that there is broad acceptability of the impacts associated with this exposure.

External Context: Legislation and Conventions	Turtles are listed under the EPBC Act as threatened and migratory and are considered at matter of NES. The following legislation/legislative guidelines are relevant:
	
	<u>Acts/Statutes</u>:
	• EPBC Act 1999 & EPBC Policy Statement 1.1 for Matters of National Environmental Significance (*Action does not significantly impact upon turtles, their BIAs and therefore matters of NES*)
	• EPBC Act 1999 & EPBC Regulations 2000 (IUCN Management Principles for CMPs)
	<u>International Conventions</u>: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)
	<u>SE Marine Reserves Management Plan:</u>
	• MSS activities are permissible in the 'multiuse zone' of the Zeehan CMP in accordance with the class approval (refer Management Plan Section 5.1);
	• The management plan does not specifically reference management measures relating to turtles however activities must not have an:
	  o Unacceptable impact on the conservation values of the CMP (migrating blue and humpback whales/ foraging albatross and petrel species) [*turtle displacement does not impact on these conservation values*] & ;
	  o Must be consistent with IUCN Principles, namely:
	    ▪ The biological diversity and other natural values of the reserve or zone are protected and maintained in the long-term;
	    ▪ Management practices should be applied to ensure ecologically sustainable use of the reserve or zone; and
	    ▪ Management of the reserve or zone should contribute to the regional and national development to the extent that it is consistent with these principles.
	Against all IUCN criteria – Turtle impacts, with controls implemented, are behavioural, temporary and affecting only a small proportion of the total species present in the bioregion. On this basis, biological diversity and conservation values are maintained in the long-term and are ecologically sustainable.
	<u>Recovery Plans/Conservation Advices</u>: The recovery plan for marine turtles in Australia (2017-2027) (DoEE, 2017) (as above) identifies controls to prevent injury and impacts to turtles as a result of noise exposure.
	<u>Threat Abatement Plans</u>: Not triggered by this aspect.

<table>
<tr><td>Good Industry Practice:</td><td>No specific industry guidance on reducing impacts to turtles is available.
Other guidelines relate to assessment processes which have been observed in this assessment (i.e.):
APPEA Code of Environmental Practice (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating:
The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts.
IAGC: Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
EPBC Policy Statement 2.1 Guidelines (Soft-start, start-up delay and shutdown procedures for turtles, dolphins, and fur seals).</td></tr>
<tr><td>ESD principles</td><td>There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with noise exposure to marine turtles during transit in non-biologically important areas.

The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adoptd the principles of ESD via all government frameworks (refer Section 2.2).</td></tr>
<tr><td>Acceptability statement:</td><td>Impacts to turtles, with controls adopted, are acceptable based upon the following:
No injury to marine turtles is predicted based upon implemented controls for soft-starts, MFO monitoring for turtles, startup delay and shutdown in accordance with EPBC Policy Statement 2.1 requirements. This conforms to the requirements for protected matters under the EPBC Act 1999 (Part 3 – Offences) requirements and the Recovery Plan for Marine Turtles in Australia 2017-2027 (DoEE, 2017).
Impact is acceptable based upon criteria in the SE Marine Reserves Network Management Plan, EPBC significance criteria for matters of NES and Recovery Plan for Marine Turtles in Australia (DoEE, 2017).</td></tr>
<tr><th colspan="2">AVIFAUNA (SEABIRDS)</th></tr>
<tr><th colspan="2">DEMONSTRATION OF ALARP</th></tr>
<tr><td>Hazard Consequence Criteria</td><td>A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.</td></tr>
<tr><td>ALARP Statement</td><td>An assessment of controls to prevent impacts to seabirds is provided in Table 7.25. These controls have been adopted where practicable and where the cost is not grossly disproportionate to the environmental benefit gained.

On the basis of this assessment 3D Oil has determined that No reasonably practical additiona, alternative and/or improved control measures exist.</td></tr>
<tr><th colspan="2">Demonstration of Acceptability</th></tr>
<tr><td colspan="2">Seabird Impact Summary:

<u>Mortality Impacts</u>: Seabird foraging in the south-east marine region is wide-ranging targeting pelagic species (fish, cephalopods). Injury impacts are thought to be possible during plunge diving in close proximity to an operational array. Pelagic prey species are likely to displace from the area immediately surrounding the operational array (Fewtrell & McCauley, 2012; McCauley et al, 2000; Slotte et al, 2004; Woodside 2012b), so bird species are also likely to displace to areas of prey availability. A small number of birds may be exposed to high sound levels during diving/plunge feeding in close proximity to an operational array, however this will be into shallow surface waters where acoustic signals destructively interfere resulting in much lower sound exposures. Injury impacts are considered unlikely (NEGLIGIBLE Impact).

Note, a Little Penguin colony is present at Christmas Island Nature Reserve, approximately 18 km from the Dorrigo MSS survey boundary and 32 km from the nearest acquisition line. Penguins generally forage within 20 km of their colony (non-breeding) and 15km (breeding). A foraging BIA for this species extends 10 km radially from Christmas Island Nature Reserve. On this basis, encounter with the penguin in the acquisition area is considered unlikely.

<u>Behavioural Disturbance (Foraging)</u>: Indirect impacts from pelagic prey displacement may also displace seabirds. This effect is temporary and recoverable in any one location with no reduction in net foraging opportunities for seabirds (NEGLIGIBLE Impact).</td></tr>
</table>

Behavioural (foraging) disturbances in penguins (altered direction of foraging, distance travelled during seismic activity) have been observed as a result of seismic noise to a distance of ~100 km (Pichegru et al, 2017). Penguins quickly revereted to normal foraging after the cessation of seismic activities (Pichegru et al, 2017). Behavioural impacts to the Christmas Island population (6-11% Tasmanian Population; 2.5% Australian/NZ population) is positioned in the interbreeding/egg-laying cycle period of the reproductive cycle, which is not considered as critical as the 'chick-provisioning' period which has higher foraging demands. Impacts are temporary and recoverable at the cessation of seismic (MINOR consequence)	
Internal Context: 3D Oil Policy compliance	The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contactor and Supplier Management (**Section 8.7**); • Maintaining Environmental and Legislative Knowledge (**Section 8.10**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	Environmental Significance: Protected bird species (albatross/petrels/shearwaters) have foraging BIAs which are spatially coincident with the Dorrigo MSS. The recovery plan for threatened albatross and giant petrels (2011-2016) and conservation advices for these species do not list marine noise as a threat to the species. Any impacts from MSS activity to these wide-ranging species (prey displacement) will be localised, temporary and recoverable and will not result in any net foraging opportunities. This in-turn protects the seabird foraging conservation values within the Zeehan CMR and given the localised, temporary displacement of species (Fewtrell & McCauley, 2012; McCauley et al, 2000; Slotte et al, 2004; Woodside 2012b) and their rapid recovery (La Bella et al, 1996), no disruption to ecological processes within the Commonwealth marine environment is predicted. The little penguin is a lited marine species and contributes to the Commonwealth marine environment. Its foraging behavours may be impacted by acoustic noise, on an intermittent basis during the Dorrigo MSS activity. Scientiifc literature identified foraging was undertaken at further distances (i.e. 77km vs 65km) from the colony during seismic operations (Pichegru et al, 2017), however returned to normal foraging after MSS completion. This impact may affect 11,900 breeding pairs which is 6-11% of the Tasmanian population (2.5% of the Australian/NZ population) during the inter-breeding/egg-laying portion of the reproductive cycle when bird condition is high (Salton et al, 2015) and is not predicted to impact during chick provisioning (November-December) timeframes which is a higher demand foraging period. Accordingly, the MSS will not have substantial advers effect on a population of marine species during its lifecycle (breeding/feeding) or spatial distribution (i.e not significant against Commonwealth marine environment significant impact criteria). Key Ecological Features: KEFs (West Tasmanian Canyons and Shelf Rocky Reef and Hard Substrate) impacts have been assessed in **Section 7.2.3.10**. As subsea habitats, bird species do not contribute to KEF functioning in the Dorrigo MSS area. Impact is not relevant to KEF. Species Recovery Plans: The recovery plan for for threatened albatross and giant petrels (2011-2016) and conservation advices for these species do not list marine noise as a threat to the species. The Dorrigo MSS does not conflict with the management provisions in this plan.
External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with sound impacts to turtles. As such, 3D oil considers that there is broad acceptability of the impacts associated with this exposure.

<table>
<tr><td>External Context: Legislation and Conventions</td><td>Albatross/petrel & shearwater seabirds are listed under the EPBC Act as threatened and/or migratory and are considered at matter of NES. The following legislation/legislative guidelines are relevant:

<u>Acts/Statutes</u>:
• EPBC Act 1999 & EPBC Policy Statement 1.1 for Matters of National Environmental Significance (Action does not significantly impact upon seabirds, their BIAs and therefore matters of NES)
• EPBC Act 1999 & EPBC Regulations 2000 (IUCN Management Principles for CMPs)
<u>International Conventions</u>: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)
<u>SE Marine Reserves Management Plan:</u>
• MSS activities are permissible in the 'multiuse zone' of the Zeehan CMP in accordance with the class approval (refer Management Plan Section 5.1);
• The management plan does not specifically reference management measures relating to turtles however activities must not have an:
o Unacceptable impact on the conservation values of the CMP (migrating blue and humpback whales/ foraging albatross and petrel species) [seabird foraging displacement is localised, temporary and recoverable and does not result in a net reduction in foraging opportunities. Conservation values are not impacted within the CMP] & ;
o Must be consistent with IUCN Principles, namely:
▪ The biological diversity and other natural values of the reserve or zone are protected and maintained in the long-term;
▪ Management practices should be applied to ensure ecologically sustainable use of the reserve or zone; and
▪ Management of the reserve or zone should contribute to the regional and national development to the extent that it is consistent with these principles.
Against all IUCN criteria – seabird impacts respond to pry availability withinthe marine environment. Localised, temporary and recoverable prey displacement is possible during the MSS affecting only a small proportion of the total species present and wide-spread in the bioregion. Biological diversity and conservation values are maintained in the long-term and are ecologically sustainable.
<u>Recovery Plans/Conservation Advices</u>: The recovery plan for for threatened albatross and giant petrels (2011-2016) and conservation advices for these species do not list controls fo r he protection of seabird against marine noise impacts. No conflict in controls adopted.
<u>Threat Abatement Plans</u>: Not triggered by this aspect.</td></tr>
<tr><td>Good Industry Practice:</td><td>No specific industry guidance on reducing impacts to seabirds is available.
Other guidelines relate to assessment processes which have been observed in this assessment (i.e.):
• APPEA Code of Environmental Practice (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating:
o The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
o Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts.
• IAGC: Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
• EPBC Policy Statement 2.1 Guidelines (Soft-start, start-up delay and shutdown procedures for turtles).</td></tr>
<tr><td>ESD principles</td><td>There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with noise exposure to seabirda in BIAs.

The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adoptd the principles of ESD via all government frameworks (refer Section 2.2).</td></tr>
</table>

Acceptability statement:	Impacts to seabirds, with controls adopted, are acceptable based upon the following: • No reduced foraging opportunities as a result of the Dorrigo MSS. Prey displacement is expected to be localised and temporary (Fewtrell & McCauley, 2012; McCauley et al, 2000; Slotte et al, 2004; Woodside 2012b) with rapid recovery (La Bella et al, 1996). • There is no disruption to ecological processes within the Commonwealth marine environment is predicted; or disruption to ecological processes supporting conservation values in the Zeehan CMP (foraging seabirds). • Foraging impacts to penguins during the MSS are localised and temporary (Pichegru et al, 2017) during the inter-breeding/egg-laying period (Salton et al, 2015). The MSS will not have a significant adverse effect on the little penguin population during this part of its lifecycle (breeding/feeding) or spatial distribution (i.e not significant against Commonwealth marine environment significant impact criteria) *Impact is acceptable based upon criteria in the SE Marine Reserves Network Management Plan, EPBC and significance criteria for matters of NES (SEWPC, 2013).*
MARINE MAMMALS (CETACEANS/PINNIPEDS)	
DEMONSTRATION OF ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
ALARP Statement	An assessment of controls to prevent impacts to marine mammals is provided in **Table 7.32** (Cetaceans) and **Table 7.22** (Pinnipeds). These controls have been adopted where practicable and where the cost is not grossly disproportionate to the environmental benefit gained. On the basis of this assessment 3D Oil has determined that *No additional, alternative and improved control measure would provide further environmental benefit.*
Demonstration of Acceptability	

Pinniped Impact Summary:

There are no pinniped colonies present within the Dorrigo MSS area with the nearest colony ~45 km wast at Reid Rocks. Pinniped presence is expected to be transitory through the MSS area for foraging activity. No BIAs for the species is present (DoEE, 2018b).

PTS/TTS Impacts: Accoustic modelling predicted no PTS impacts to pinniped species (Warner et al, 2018) On a SEL_{24hr} basis, TTS impacts are possible within 50m of the operating array. The areas ensonified over the 24hr period, 4.78 km^2, is 0.01% of the Otway bioregion.

Behavioural Impacts: Behavioural impacts on foraging may be experienced to 9.62 km from the operational array or at any time ensonify 292 km^2 (0.8% Otway bioregion). No behavioural impacts are predicted at the nearest fur-seal colonies. The Australian/NZ Fur Seal target cephalopods and fish as prey species. These species are also sound sensitive and may also displace from areas of high sound (Fewtrell & McCauley, 2012; McCauley et al 2000; Woodside, 2008b). This may lead to localised and temporary foraging displacement, however no net reduction in foraging opportunity is expected.

Cetacean Impact Summary:

The Dorrigo MSS is patially coincident with a foraging BIA for the blue whale. Blue whale foraging is observed in this BIA during the Bonney upwelling which is seasonally present from November to April (Nieblas et al, 2009). Blue whales have been encountered north of the Dorrigo MSS in November and at Cape Nelson in October (BWS, 2018).

The Dorrigo MSS is also in proximity to the SRW calving aggregation BIA at Warrnambool (~125 km northwest); a coastal migration and resting on migration BIA along the Victorian coastline, and a coastal connecting BIA in Tasmanian State waters. The SRW is present from May to November.

PTS Impacts: Without mitigation, LF cetaceans may experience PTS at a maximum distance of 40 m (PK metric) and 2.48 km (SEL_{24hr} metric) and HF cetaceans may experience PTS at a maximum distance of 400m (PK metric) and 50m (SEL_{24hr} metric). No PTS impacts are predicted for MF cetaceans.

TTS Impacts: Without mitigation, LF cetaceans may experience TTS at a maximum distance of 60 m (PK metric) and 78.7 km (SEL_{24hr} metric); for MF cetaceans at a maximum distance of 40m (PK metric) and 50m (SEL_{24hr}); and for HF cetaceans at a maximum distance of 702m (PK metric) and 270m (SEL_{24hr} metric).

Behavioural Disturbance (Foraging): For the adopted behavioural disturbance threshold of 160 dB re 1µPa (SPL) for both mysticete and odontocete whales, the maximum distance where behavioural disturbance might occur is 9.64 km (shelf) and 9.58km (shelfbreak) from the operational array. Blue whale foraging impact is not predicted due to the selected MSS timeframe. Sperm whale foraging occurs in canyon systems. Maximum spatial overlap of the 160 dB re 1µPa (SPL) footprint is 2.2% of the KEF system. Given the intermittent overlap of this canyon system with MSS activities, timeframes for foraging impact in these systems is ~2.4 hrs. Impact is temporary, intermittent and recoverable (NEGLIGIBLE impact). Behavioural Disturbance (Calving): For the adopted behavioural disturbance threshold of 140 dB re 1µPa (SPL) for SRW calving, maximum predicted received levels at the calving BIA is 116 dB re 1µPa (SPL). No significant disturbance impacts predicted. Behavioural Disturbance (Migrating): For the adopted behavioural disturbance threshold of 160 dB re 1µPa (SPL) for migratory disturbance, maximum predicted received levels in the Tasmanian coastal connecting BIA is 147 dB re 1µPa (SPL) and for the Victorian migration and resting on migration BIA is 122 dB re 1µPa (SPL). No significant disturbance to migration in these areas are predicted. For oceanic migration, behavioural impacts may be experienced within 9.58 km of the vessel, should SRW be present in the Dorrigo MSS, noting that the southeastern population is small compared with the total SRW population. Behavioural studies into MSS sound impacts to migrating mysticetes have observed some deviation as the result of the operational array (Dunlop et al, 2017; McCauley et al, 2000; Richardson et al, 1999; Manley et al, 2007) however prioximity to the array also appears to tbe a factor in the level of distruprion to migration (Dunlop et al, 2017). Minor deviations from the oceanic migration pathway, however impacts will be temporary and recoverable (MINOR Impact)	
Internal Context: 3D Oil Policy compliance	The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** detaild the relevant management system processes adopted to implement and manage hazards to ALARP: • Contactor and Supplier Management (**Section 8.7**); • Maintaining Environmental and Legislative Knowledge (**Section 8.10**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	Environmental Significance: The Dorrigo MSS area is influenced by the Bonney upwelling which operates from November to April. This is a high productivity period in the Otway Basin with a number of environmental sensitivities present. The Zeehan CMP identifies migrating humpback and blue whales as key conservation value: • The blue whale is seasonally present in the region and the Dorrigo MSS overlaps a foraging BIA for the species. Season presence is tied to Bonney upwelling. Dorrigo MSS is temporally positioned outside the upwelling timeframe to avoid spatial impact with blue whales and potential for foraging displacement. No impacts to this species (or other foraging baleen whales) are expected based on the survey timeframe. • The humpback whale is seasonally in the area between September and May (Gill et al, 2015) during its migration to calving ground in tropical environments. The period September-October is a period of lower encounter. EPBC Policy Statement 2.1 controls will be adopted to ensure that impacts to migrating whales are managed and no injury occurs. Note that ther Dorrigo MSS is not locate din a calving, resting, foraging or confined migratory pathway for the species. • A migratory coastal corridor (Victoria & Tasmania) BIA is present between late April and early November for the SRW. The Dorrigo MSS is not spatially coincident with these BIAs but sound impacts have been modelled to understand behavioural impacts on aggregation areas (in accordance with the Conservation Management Plan for the SRW). No biologically significant behavioural disturbances are predicted in these areas. • Pinnipeds, an EPBC listed species, are wide-spread though Bass Strait and will transit through the survey area foraging. The nearest colony is at Reid Rocks ~45 km from the Dorrigo MSS area. Given the assessment and mitigation controls adopted for the Dorrigo MSS, conservation values are protected with any impacts localised and temporary. Key Ecological Features: KEFs (West Tasmanian Canyons and Shelf Rocky Reef and Hard Substrate) impacts have been assessed in **Section 7.2.3.10**. As subsea habitats, cetacean and pinniped species do not significantly contribute to KEF functioning in the Dorrigo MSS area. As all impacts to marine mammals are localised and temporary, together with the small spatial overlap of the Dorrigo MSS with KEF areas (0.3% west Tasmanian canyon KEF and 0.42% Shelf Rocky Reef and Hard Substrate KEF), impacts to KEF functioning are predicted to be incidental and temporary with no disruption to ecological processes.

	Species Recovery Plans: The Blue whale Conservation Management Plan (DoE, 2015) requires anthropogenic noise in BIAs to be managed so that the blue whale continues to use the area without injury and ins not displaced from a foraging area. EPBC Policy Statement 2.1 guidelines are to be applied to all seismic surveys. These objectives are achieved by positioning the survey in September-October and adopting EPBC Policy 2.1 requirements. The Conservation Management plan for the SRW requires the implementation of the EPBC Policy Statement 2.1 requirements requiring that MSSs are undertaken outside of BIAs at biologically important times. In addition, given that it is unknown at what distance from a seismic source behavioural impacts may occur, a MSS has the potential to have a behavioural impact on many individuals at a time should the survey have behavioural effects in calving or aggregation areas. The impact of the Dorrigo MSS has assessed impacts to the calving BIA located at Warrnambool and found thet received sound levels are below those adopted for behavioural impacts at these sensitive environments. Other species conservation advices (Sei & Fin) whales relate to assessing anthropogenic noise to the species and Humpback Conservation Advice requires all MSS activities consistent with EPBC Policy Statement 2.1. These requirements are observed.
External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). The following stakeholders have provided feedback: **DPIPWE (Conservation Assessment)** (**Stakeholder No 17**) recommended that EPBC Policy Statement 2.1 Guidelines are followed when undertaking the Dorrigo MSS. This recommendation has been adopted. **BWS** (**Stakeholder No: 25**) expressed concern that the Dorrigo MSS was planned to proceed in the timeframe of the Bonny Upwelling (November to April). 3D Oil subsequently revised plans to consider the period outside the upwelling period (September-October). This information has been provided to BWS and no further feedback has been received. 3D oil considers that BWS is in broad agreement with the survey timeframe. No stakeholder concerns have been raised to date associated with sound impacts to cetaceans. As such, 3D oil considers that there is broad acceptability of the impacts associated with this exposure.

External Context: Legislation and Conventions	Some marine mammals are listed under the EPBC Act as threatened and/or migratory and are considered at matter of NES. The following legislation/legislative guidelines are relevant:
	
	<u>Acts/Statutes</u>:
	• EPBC Act 1999 & EPBC Policy Statement 1.1 for Matters of National Environmental Significance (*Action does not significantly impact upon seabirds, their BIAs and therefore matters of NES*)
	• EPBC Act 1999 & EPBC Regulations 2000 (IUCN Management Principles for CMPs)
	<u>International Conventions</u>: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)
	<u>SE Marine Reserves Management Plan:</u>
	• MSS activities are permissible in the 'multiuse zone' of the Zeehan CMP in accordance with the class approval (refer Management Plan Section 5.1);
	• The management plan does not specifically reference management measures relating to turtles however activities must not have an:
	  o Unacceptable impact on the conservation values of the CMP (migrating blue and humpback whales/ foraging albatross and petrel species) [*with controls adopted, any impacts to cetaceans will be localised and temporary, not significantly impacting upon the species and the conservation values of the Zeehan CMR*] & ;
	  o Must be consistent with IUCN Principles, namely:
	    ▪ The biological diversity and other natural values of the reserve or zone are protected and maintained in the long-term;
	    ▪ Management practices should be applied to ensure ecologically sustainable use of the reserve or zone; and
	    ▪ Management of the reserve or zone should contribute to the regional and national development to the extent that it is consistent with these principles.
	  Against all IUCN criteria – Marine mammals are protected from injury with only localised, temporary and recoverable behavioural impacts possible during the MSS. The timeframe selected for the MSS does not correspond with upwelling conditions so it is considered that only a small proportion of marine mammals maybe encountered during the survey. Biological diversity and conservation values are maintained in the long-term and are ecologically sustainable.
	<u>Recovery Plans/Conservation Advices</u>: As above the conservation plans for the blue and SRW, together with the conservationadvices for the humpback, se and fin whales have been addressed in this assessment. There is no conflict with the management measures detailed in those documents and the controls adopted.
	
	The impact to SRW are considered acceptable because:
	
	• The effects to SRW and their calves using the Connecting Coastal Habitat BIA at King Island and those migrating through the survey area have been reduced to ALARP by using temporal control measures (survey timing), additional power-down/shutdown, and poor visibility procedures.
	
	• It has been demonstrated that the survey will be conducted in a manner that is not inconsistent with the SRW CMP Action Area A.2. The demonstration of ALARP (Table 7-32) assesses the practicability of EPBC Act Policy Statement 2.1 Interaction between offshore seismic exploration and whales 2008 (Seismic Guidelines) and EPBC Act Environmental Offsets policy. Also, in accordance with Action Area A.2 (c) mitigations for noise impacts have been adopted to prevent PTS injuries to migrating cows and calves, and further controls have been applied to reduce as far as practicable the effects on biologically relevant behaviour. As a result of the control measures adopted for SRWs the survey is consistent with the recovery objective of the SRW CMP which is to minimise anthropogenic threats to allow the conservation status of the SRW to improve so that it can be removed from the threatened species list.
	
	• The acceptability of the effects to SRW using the Connecting Coastal Habitat at King Island must also consider the low probability that cows and calves will be present in the BIA during the survey, and if present, they are likely to be migrating through the BIA (since it is not known as a calving or resting ground), and finally they are unlikely to be using the western side of the island because it provides little calm protected waters that are selected by SRW's.
	
	<u>Threat Abatement Plans</u>: Not triggered by this aspect.

Good Industry Practice:	The following industry guidelines have been utilised in this assessment:
	• JNCC Guidelines for minimising the risk of injury to marine mammals from geophysical surveys (August 2017) &
	• NZ Code of Conduct for minimising acoustic disturbance to marine mammals from seismic survey operations in New Zealand Waters (DOC, 2013) .
	Other guidelines relate to assessment processes which have been observed in this assessment (i.e.):
	• **APPEA Code of Environmental Practice** (2008) objectives met for offshore geophysical surveys with respect to reducing the impacts to marine life to a level which is ALARP and acceptable by demonstrating:
	  o The adoption of appropriate management measures for the survey in accordance with legislative requirements/guidelines; and
	  o Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the acoustic array will operate and assess potential impacts.
	• **IAGC:** Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.2 Planning & Section 8.7 Aquatic Life).
	• **EPBC Policy Statement 2.**1 Guidelines (Soft-start, start-up delay and shutdown procedures for turtles).

ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with noise exposure to marine mammals within the Dorrigo MSS area. The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adopted the principles of ESD via all government frameworks (refer **Section 2.2**).
Acceptability statement:	Impacts to marine mammals , with controls adopted, are acceptable based upon the following: • With EPBC Policy Statement 2.1 controls implemented, no injuries to whales or pinnipeds are predicted (Warner et al, 2018; DPIPWE (**Stakeholder No 17**)); • Survey activities are located at a distance whereby sound impacts are not predicted to cause behavioural impacts to breeding pinniped colonies (NFMS, 2016; Warner et al, 2018). Ensonified areas, where behavioural impacts may occur are localised in the context of the Otway bioregion (0.8% Otway bioregion affected at any time) (Warner et al, 2018); • Survey activities are located at a distance whereby sound impacts are not predicted to cause behavioural impacts to whales present in coastal calving SRW BIAs (NFMS, 2016; Warner et al, 2018); • MSS activity is undertaken during September-Octber which avoids the Bonney upwelling period, the potential for spatial overlap with foraging baleen (blue, fin, sei) whales and displacement potential from foraging BIAs (BWS (**Stakeholder No 25**)); • Predicted impacts to marine mammals during the Dorrigo MSS are behavioural (localised, temporary and recoverable). Conservation values within the Zeehan CMR are conserved and IUCN management principles met. (South-east Commonwealth marine Reserve Network Management Plan (DoE, 2013). The Dorrigo MSS, with the adoption of controls in EPBC Policy Statement 2.1 and this EP, will not injure whales or pinnipeds, displace foraging whales within foraging BIAs, disturb aggregation or calving activities within adjacent Victorian coastal waters or disturb breeding pinniped colonies (NFMS, 2016; Warner et al, 2018).
ABALONE DIVERS	
DEMONSTRATION OF ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
ALARP Statement	An assessment of controls to prevent impacts to divers is provided in **Table 7.33**. These controls have been adopted where practicable. On the basis of this assessment 3D Oil has determined that *All known control measures have been adopted.*
Demonstration of Acceptability	
Sound Impact Summary: Received Sound at King Island Coastline: Accoustic modelling predicts that sound impacts along the King Island coastline may be subject to received sound levels marginally higher than 145 dB re 1µPa (SPL), the nominated guidance issued by the US Department of Navy to protect commercial and recreational divers (US Department of Navy, 2001). High sensitivity abalone divers diving on the western side of the island may experience 'diver adversion' impacts. This impact is localised, temporary amd recoverable (NEGLIGIBLE impact)	

Internal Context: 3D Oil Policy compliance	The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** detaild the relevant management system processes adopted to implement and manage hazards to ALARP: • Consultation (**Section 4**); • Contactor and Supplier Management (**Section 8.7**); • Maintaining Environmental and Legislative Knowledge (**Section 8.10**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	Environmental Significance: Abalone harvesting is present along the West King Island coastline with fishery reports identifying that harvesting may occur at the same time as the Dorrigo MSS. Key Ecological Features: Not relevant to the aspects being assessed. Species Recovery Plans: Not relevant to the aspect being assessed.
External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). While the Tasmanian Abalone Council (**Stakeholder No 11**) has not expressed concern regarding g the activity, consultation is still underway to confirm the controls in place to alert abalone divers of the activity. Consultation from this point is considered 'ongoing consultation'.
External Context: Legislation and Conventions	The following legislation/legislative guidelines are relevant: Acts/Statutes: • Offshore Petroleum and Greenhouse Gas Storage Act 2006 (S280) – Interference with Other Rights International Conventions: Not Relevant SE Marine Reserves Management Plan: Not Relevant – activity is not in CMR Recovery Plans/Conservation Advices: Not Relevant – Abalone is not threatened species. Threat Abatement Plans: Not triggered by this aspect.
Good Industry Practice:	There is no specific legal and other industry best practice guidance to manage impacts to abalone divers and recreational water users. The following industry guidelines are available: • DMAC – Safe Diving Distance from Seismic Surveying Operations, DMAC 12 Rev 1 July 2011
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with noise exposure to marine mammals within the Dorrigo MSS area. The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adoptd the principles of ESD via all government frameworks (refer **Section 2.2**).
Acceptability statement:	Impacts to divers, with controls adopted, are acceptable based upon the following: • Divers will not suffer from health impacts as a result of survey activities.
VESSEL AND HELICOPTER NOISE	
DEMONSTRATION OF ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice. Vessel noise in the marine environment has been assessed as MINOR A MINOR consequence needs reduction measures implemented. The ranking is generally acceptable whether further risk reduction is shown not to be practicable.
ALARP Statement	An assessment of controls to prevent impacts to seabirds is provided in **Table 7.38**. These controls have been adopted where practicable. On the basis of this assessment 3D Oil has determined that *No reasonably practical additional, alternate and/or improved control measures exist.*
Demonstration of Acceptability	

Sound Impact Summary: Vessel noise discharges: Scientific literature identifies that the sound emitted by vessels is not sufficiently high to cause mortality/PTS impacts. Impacts therefore fall into a behavioural response (avoidance, etc). Sound impacts will affect all marine species present (except seabirds). Given the foot-print of vessel sound (~kms) and the constant movement of the vessel, impacts will be localised and short-term (Minor Consequence). Helicopter noise discharges: Scientific literature identifies that the sound emitted by helicopters is extremely localised and temporary. Noise is not sufficiently high to cause mortality/PTS impacts. Impacts therefore fall into a behavioural response (avoidance, etc). Helicopter noise will have a small footprint of impact and its temporary (Negligible consequence).	
Internal Context: 3D Oil Policy compliance	The impact management strategy for acoustic impact disturbance reflects 3D Oil's HSE Policy of proactively identifying hazards, eliminating impacts where possible and where this is not possible, managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** detaild the relevant management system processes adopted to implement and manage hazards to ALARP: • Contactor and Supplier Management (**Section 8.7**); • Maintaining Environmental and Legislative Knowledge (**Section 8.10**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	Environmental Significance: Vessel noise footprint is retained within the Dorrigo MSS operational area. Species present in that area, outside of upwelling periods, are wide-spread throughout the Otway bioregion. Migratory species (whales) may be encountered however the Dorrigo MSS does not overlay any BIAs except for blue whale foraging (not active during Sept/Oct) and foraging seabirds (not relevant to impact assessment). Any displacement effects will be localised, short-term and recoverable. Given these low-level effects (behavioural only), there will be no disruption to ecological processes which support the conservation values of the Zeehan CMR. Key Ecological Features: Key ecological features are on the seabed and unlikely to be impacted by vessel and helicopter noise. Species Recovery Plans: Not relevant to the aspect being assessed.
External Context: Stakeholder Consultation	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with vessel or helicopter noise impacts. As such, 3D oil considers that there is broad acceptability of the impacts associated with this exposure.
External Context: Legislation and Conventions	The following legislation/legislative guidelines are relevant: Acts/Statutes: • EPBC Act 1999 & EPBC Regulations 2000 International Conventions: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) SE Marine Reserves Management Plan: Given these low-level effects (behavioural only), there will be no disruption to ecological processes which support the conservation values of the Zeehan CMR and provides for the ecologically sustainable use and conservation of ecosystems, habitats and native species. Recovery Plans/Conservation Advices: Not Relevant – Abalone is not threatened species. Threat Abatement Plans: Not triggered by this aspect.
Good Industry Practice:	• The Australian National Guidelines for Whale and Dolpin Watching (DEWHA, 2005)
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with vessel and helicopter noise exposure to marine species within the Dorrigo MSS area. The EIA presented though this EP demonstrated compliance with the APPEA Code of Conduct Principles and adoptd the principles of ESD via all government frameworks (refer **Section 2.2**).
Acceptability statement:	Impacts to marine fauna from vessel and helicopter noise, with controls adopted, are acceptable based upon the following: • No injuries to marine fauna (i.e. whales, turtles, pinnipeds, fish) are predicted as the sound exposures fall below mortality/PTS thresholds (OSPAR, 2009; Popper et al, 2014); • Noise impacts are localised and temporary, resulting in behavioural impacts only, ensuring that there is no disruption to ecological processes which support the conservation values of the Zeehan CMP or impact upon those conservation values (migrating blue/humpback whales and foraging seabirds).
Environmental Monitoring	
Survey MFO observations	

Record Keeping
MFO CVs
Key vessel crew induction records
MFO datasheet records
MFO End of survey report
SSV Report
SIMOPs Procedures
Geophysical Acquisition Report
PMS Records – Vessel (Propulsion and Engines)
SIMOPS Communications records
SIMOPS Procedure
Vessel Logs/Track Records
Procedures for marine fauna protection (acoustic operations)
Consultation Records
NOPSEMA Website Monitoring Records

7.3 IMPACT: Treated Bilge Water Discharges

7.3.1 Hazard

Routine oily water discharges from the vessel's bilge water treatment system to marine waters is expected during survey activities. Bilge water consists of deck drainage that has been captured in a closed loop system (i.e., bunded oil-collection systems) and contains water, oil, and other chemicals/contaminants. Bilge water is managed by either retaining in an on-board tank for discharge to an onshore facility or treated on-board by an on-board oily-water separator (OWS). The oily water separator (OWS) treats bilge water prior to discharge overboard meeting an oil-in-water (OIW) content of less than 15 ppm in accordance with the Commonwealth *Navigation Act 2012*, *Protection of the Seas (Prevention of Pollution from Ships) Act 1983* and Marine Order Part 91 (Marine Pollution Prevention – Oil). The discharge only occurs when the vessel is moving.

7.3.2 Known and Potential Impacts

The known and potential environmental impacts of bilge water discharges are:

- Temporary and localised reduction of surrounding surface water quality; and
- Acute toxicity to marine fauna through ingestion of contaminated water (in the event of malfunction of the OWS).

Area affected by impact: Monitoring of wastewater discharges (sewage, colling water and produced water) from the Mutineer-Exeter floating, production, storage and offloading (FPSO) facility did not detect elevanted contaminants within ~250 m down-current of the vessel (GHD, 2014: cited in Santos, 2017). The discharge volume from a FPSO is significantly higher than for a seismic or support vessel so the area affected by treated bilge water discharge is < 250m from a vessel. Survey vessel discharge volumes are small, intermittent and the dynamic marine environment is expected dissipate water quality so impacts are localised around the release point. This impact may occur anywhere within Commonwealth waters of Dorrigo MSS operational area.

Possible environment/receptors affected by impact:
Receptors which may occur within this localised area, either as residents or migrants, are:

- Plankton; and
- Pelagic fish/sharks;
- Marine mammals & turtles.

7.3.3 Evaluation of Environmental Impacts

Temporary and localised reduction of surface water quality
Small volumes and low concentrations of oily water (<15 ppm) from bilge discharges may temporarily reduce water quality. The bilge water will be rapidly diluted, dispersed and biodegraded to undetectable levels. Discharge is only undertaken while the vessel is moving.

Acute toxicity to marine fauna
Small volumes and low concentrations of oil residue from bilge discharges may temporarily reduce water quality but are not expected to induce acute or chronic toxicity impacts to marine fauna or plankton through ingestion or absorption through the skin. Hydrocarbons are biodegradable in the environment.

Impacts to Matters of National Environmental Significance:
The discharge of bilge water will not have a 'significant' impact to any of the matters of NES applicable to this project, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Temporary and localised reduction in water quality will not result in significant impacts to populations or habitats of threatened fauna.	These TECs are not present within the area affected by water quality impacts.	Migration, feeding, resting or breeding activities or habitats will not be impacted by a localised and temporary reduction in water quality.	Localised discharge will not result in disturbance to an important or substantial area of habitat so an adverse impact on marine ecosystem functioning or integrity occurs. Nor will it impact on biodiversity or ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo MSS area associated with treated bilge water is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International or Nationally Important Wetlands	Commonwealth Marine Park (CMP)	Coastal protected areas
X / X	X	X	X

Temporary and localised reduction in water quality is limited to the upper water column. No impacts are predicted to these seabed features from discharge.	There are no international or nationally important wetlands within the affected area.	Temporary and localised reduction in water quality is possible within the upper water column within the Zeehan CMR if discharged. However, a spatial exclusion around the Zeehan CMP eliminating this discharge within the CMP will be applied to eliminate this impact.	Coastal protected areas are outside the area affected by bilge water discharges.

7.3.4 Environmental Impact Assessment

Table 7-40 provides the environmental impact assessment for treated bilge discharges.

Table 7-40: Treated Bilge Water Discharge EIA

Aspect	Treated bilge water discharge		
Impact Summary	Pollution impacts to surface waters. Acute toxicity to marine fauna exposed to pollution.		
Extent of Impact	Localised small radius around constantly moving vessel during discharge.		
Duration of Impact	Temporary (duration of survey) with rapid dispersion and dilution (~minutes).		
Level of Certainty of Impact	HIGH. Impacts from oily water discharges on marine environment are studied and well understood.		
Species possibly affected within survey environment:	• **Marine Fauna** (cetaceans and turtles are protected; pinnipeds are listed – widely distributed). • **Marine seabirds** (some protected, BIAs present for widely distributed seabirds). • **Fish** (not protected, widely distributed). • **Zooplankton** (not protected, widely but patchily distributed).		
Impact Decision Framework Context	**Decision Context: A** The use of vessel in offshore environments together with the impact of their discharges during normal operations is well understood and highly regulated through the MARPOL convention to prevent pollution impacts. On this basis, impacts have been recognised and are well understood and little uncertainty exists around this practice. The offshore management of wastewaters is well regulated and no issues or concerns have been raised by relevant stakeholders regarding these discharges. As such, decision context A will be applied to this aspect.		
Impact with controls failure (Inherent)			
MINOR: Localised, short-term effects on water quality. Timescale of recovery may be months if untreates waters are released.			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Comply with the Protection of the Seas (Prevention of Pollution by Ships) Act 1983 and Marine Order 91 (Marine Pollution Prevention –Oil).	Reduce (engineering control)	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry. **Control adopted.**
Contain and treat bilge water to an oil-in-water content < 15 ppm prior to marine discharge.	Reduce (Engineering Control)	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry. Environmental benefits outweigh costs. **Control adopted.**

<table>
<tr><td>Systems for treating bilge water are maintained and measurement equipment calibrated to ensure discharge concentrations are met</td><td>Reduce (Administrative control)</td><td>YES</td><td>Good practice – well defined and adopted by offshore petroleum sector. Environmental benefit outweighs cots. Control adopted.</td></tr>
<tr><td>Treated bilge water discharged outside of Zeehan CMP</td><td>Eliminate</td><td>YES</td><td>Best practice to eliminate impacts to CMP. Control is considered practicable with no substantial increase in costs. Control adopted.</td></tr>
<tr><td>Alternate Control: Survey and support vessel discharge treated bilge or all contaminated bilge to onshore facilities for treatment and disposal</td><td>Eliminate</td><td>NO</td><td>For MSS vessel there is substantial additional cost due to onshore treatment and disposal, acquisition downtime, increase in survey duration, increased fuel consumption given the additional transits required by support vessel. Risk of spills and leaks during transfer operations and additional safety risks to personnel during vessel transfer activities.

No net benefit observed if treated bilge can be discharged in accordance with MARPOL requirements. Control not adopted.</td></tr>
<tr><td colspan="4">Impact consequence with controls (residual)</td></tr>
<tr><td colspan="4">NEGLIGIBLE: Localised and temporary impacts with rapid recovery in water quality.</td></tr>
<tr><td colspan="4">ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS</td></tr>
<tr><th>EPO</th><th colspan="2">EPS</th><th>MEASUREMENT CRITERIA</th></tr>
<tr><td rowspan="2">No discharge of untreated bilge waters ro Commonwealth marine environment.</td><td colspan="2">Oil-Water Treatment System Standard

Bilge water is treated through an OWS system which complies with the requirements MARPOL Annex I requirements required by
• Protection of the Seas (Prevention of Pollution from Ships) Act 1983 (Section 9)
• Navigation Act 2012 (Chapter 4, Parts 3 & 4)
• Marine Order 91 (Marine Pollution Prevention – Oil)</td><td>Records confirm that the vessel has a MARPOL approved/compliant oily-water separator via an IOPP certification or equivalent documentation appropriate to vessel class.

<u>Responsibility</u>: 3D Oil Project Manager (or delegate)</td></tr>
<tr><td colspan="2">Treated bilge discharges

Treated bilge water discharges occur outside the Zeehan CMP if:
• Treatment is via a MARPOL approved OWS;
• The vessel is proceeding en-route;
• The oil content is less than 15 ppm; and
• Oil discharge monitoring and control equipment are operating.
If the above criteria cannot be met the oily water must be retained in on-board storage tanks for onshore disposal or further treatment.</td><td>Oil record book verifies bilge discharges were compliant with these requirements and is monitored through regular inspection review of the oil record book.

<u>Responsibility</u>: Chief Engineer</td></tr>
<tr><td>No discharge of untreated bilge waters ro Commonwealth marine environment (Con't).</td><td colspan="2">System Maintenance & Equipment Calibration:

The OWS and Oil Detection Monitoring Equipment (ODME) is maintained to manufacturer's specifications and calibrated to ensure reliable discharge concentrations are achieved.</td><td>Preventative Maintenance System (PMS) records verify that the OWS and ODME is maintained and calibrated.

<u>Responsibility</u>: Chief Engineer</td></tr>
</table>

No treated bilge water discharge in Zeehan CMP.	*Treated Bilge Discharges (within Zeehan CMP):* Treated bilge water will not be discharged within the Zeehan CMP.	Oil record book verifies bilge discharge location complies with this requirement. Responsibility: Vessel Master

Demonstration of ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
ALARP Statement	No additional, alternative or improved control measures would provide further environmental benefit.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The impact management strategy for treated bilge discharge impacts reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	Environmental Significance: As assessed above, treated bilge water discharge is localised around vessels, intermittent and temporary (due to vessel movement) and recoverable. No significance criteria is triggered for marine mammals, turtles, fish, plankton or seabirds. Key Ecological Features: KEFs (West Tasmanian Canyons & Shelf Rocky Reef and Hard Substrate) present are located on the seabed and not expected to be affected by surface discharges. Species Recovery Plans: The Dorrigo MSS area does not represent a unique area for the species which may be affected by localised vessel discharges. Species present are widespread in the environment during the period of the survey. The survey timeframe does not temporally overlap high productivity periods where larger concentrations of species may aggregate.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with vessel bilge discharges. As such, 3D oil considers that there is broad acceptability of the impacts associated with this discharge.
Legislation and Conventions	The Dorrigo MSS complies with the requirements of the following legislative provisions with respect to treated bilge discharges: Acts/Statutes: • Navigation Act 2012 (Chapter 4 (Prevention of Pollution)) and Marine Order Part 91 (Marine Pollution Prevention – Oil) • Protection of the Seas (Prevention of Pollution by Ships) Act 1983 (Section 9 - *Prohibition of Discharge of oil or oily mixture into Sea*) • EPBC Act 1999 (Action will not significantly impact matters of NES). International Conventions: MARPOL 73/78 – Annex I SE Marine Reserves Network Management Plan (2013-2023): • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMP in accordance with conditions of class approval (refer Management Plan Section 5.1); • Management of wastes in accordance with MARPOL is allowed within reserves in the SE Commonwealth Marine Reserves Network (Section 5.3.3). *3D Oil has elected to eliminate this discharge on an ALARP basis within this CMP.* South-east Marine Region Profile: No specific references in plan to MARPOL compliance. Recovery/Conservation Plans & Advices: Review and assessment of threatened species recovery plans and conservation advice (refer **Section 5.4**) did not identify threats associated with bilge water discharges except a requirement Recovery Plan for Marine Turtles 2017-1027 (DoEE, 2017) was to ensure that oil spill response strategies and programs adequately include management for marine turtles and their habitat (particularly slow to recover habitats – not present in the Dorrigo MSS area). Containment of spills from bilge system spills are addressed in the vessel's SOPEP. 3D oil has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement. Threat Abatement Plans: Not triggered by this discharge

Good Industry Practice	**APPEA CoEP:** Objectives met for MSS with respect to reducing the impacts to marine life to a level which is ALARP and acceptable including: • Adoption of management measures in accordance with legislative requirements/ guidelines; and • Utilising research /knowledge and latest data on local environment to assess potential impacts. **IAGC** Environment Manual (Worldwide Geophysical Operations): Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with bilge discharge impacts from vessels during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, impacts from treated bilge waters are localised, temporary and rapidly recoverable. On this basis there is no significant disruption to the ecological processes within the Commonwealth marine environment; no impact to CMP conservation values and no injury to protected species which may be impacted by the discharge (cetaceans, turtles, pinnipeds).
Environmental Monitoring	
Oil-in-Water content (treated bilge water discharges)	
Record Keeping	
IOPP PMS Records (Bilge Treatment System) ODME calibration records Oil Record Book	

7.4 IMPACT: Treated Sewage/Grey Water Discharges

7.4.1 Hazard

Sewage and grey water (comprising laundry, shower and sink water) discharges from vessel to marine waters is expected on an intermittent basis during survey activities. These discharges can cause temporary and localised turbidity and nutrient enrichment of surrounding waters.

All vessels engaged on the Dorrigo MSS will have sewerage treatment systems compliant to MARPOL 73/78 Annex IV requirements or comply with sewage discharge requirements of the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Order 93 (Marine Pollution Prevention – Sewage).

7.4.2 Known and Potential Impacts

The known and potential environmental impact of sewage/grey water discharges is:

- Temporary and localised reduction of surrounding surface water quality (organics, biological oxygen demand (BOD), bacteria and visual amenity) around the discharge location.

Area affected by impact: The area affected by sewage and grey water discharges from vessels is likely to be in 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 during the Torosa South-1 drilling program (in the Scott Reef complex), which found:

- Rapid horizontal dispersion of discharge 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).

This impact may occur anywhere within the Commonwealth waters of Dorrigo MSS area.

Possible environment/receptors affected by impact:
Receptors which may occur within this localised area, either as residents or migrants, are:

- Plankton;
- Pelagic fish;
- Marine mammals & turtles; and
- Seabirds.

7.4.3 Evaluation of Environmental Impacts

No sensitive receptors to turbidity and nutrient enrichment of waters, such as seagrass and coral reefs, are present in the Dorrigo MSS operational area.

Sewage discharge from vessels will comply with the requirements of MARPOL Annex IV. Vessels may treat sewage/grey water through a sewage treatment plant (STP) to a tertiary level; or if not treated, comminuted and disinfected and discharged from the vessel while en-route at distances greater than 4 nm from shore; or discharged from the vessel while en-route at distances greater than 12 nm from shore.

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. Pathogens are also an issue if ingested (not an issue with STP or comminution and disinfection treatment options). Grey water (used water from the galley, dishwashers, showers, hand basins and laundry) 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 also treated through the STP, so pollutants would be largely removed from the discharge stream.

The effects of treated sewage and sullage discharges on the water quality at Scott Reef were monitored for a drill rig operating near the edge of the deep-water lagoon area at South Reef. Monitoring at stations 50, 100 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 on-board a drill rig compared with vessels undertaking MSS activities, and the environment is much less dispersive than vessels in constant movement in the high energy Bass Strait environment.

Discharges of treated sewage and grey water will be rapidly diluted in the surface layers of the water column and dispersed by currents. The BOD 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 re-oxygenation of the discharge

Given the low volume intermittent-nature of the discharge, the treatment of the discharge, the high dilution and dispersal factor, and short discharge period, impacts from treated sewage and grey water discharged from vessels having an adverse effect on marine life is localised, temporary with rapid recovery (negligible consequence).

Impacts to Matters of National Environmental Significance:
The discharge of treated sewage and grey water will not have a 'significant' impact to any of the matters of NES applicable to this project, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Temporary and localised reduction in water quality will not result in any significant effects to populations or habitats of threatened fauna.	These TECs are not present within the Dorrigo MSS area.	Migration, feeding, resting or breeding activities or habitats will not be impacted by a localised and temporary reduction in water quality.	Localised and temporary discharge will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality adversely impacting on biodiversity of ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo MSS area associated with sewage and grey water discharge is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and Nationally Important Wetlands	Commonwealth Marine Reserves (CMR)	Coastal protected areas
X / X	X	X	X
Temporary and localised reduction in water quality is limited to the upper water column. No impacts are predicted to these seabed features from discharge.	There are no international or nationally important wetlands within the Dorrigo MSS area.	Temporary and localised reduction in water quality is possible within the upper water column within the Zeehan CMP if discharged. However, a spatial exclusion around the	Coastal protected areas are outside the Dorrigo MSS area.

		Zeehan CMP eliminating this discharge within the CMP will be applied to eliminate this impact.	

7.4.4 Environmental Impact Assessment

Table 7-41 provides the environmental impact assessment for treated sewage and grey water discharges.

Table 7-41: Treated sewage and grey water discharge EIA

Aspect	Treated sewage and grey water discharge		
Impact Summary	Increased nutrient content of surface waters, which may modify feeding habitats of pelagic fish and seabirds.		
Extent of Impact	Localised small radius around constantly moving vessel during discharge (~10 m vertically and 50 m horizontally).		
Duration of Impact	Temporary (duration of survey) with rapid dispersion and dilution (~minutes).		
Level of Certainty of Impact	HIGH. Impacts from sewage and grey water discharges on marine environment are studied and well understood.		
Species possibly affected within survey environment:	• **Marine Fauna** (cetaceans and turtles are protected; pinnipeds are listed – widely distributed). • **Marine seabirds** (some protected, BIAs present for widely distributed seabirds). • **Fish** (not protected, widely distributed). • **Zooplankton** (not protected, widely but patchily distributed).		
Impact Decision Framework Context	**Decision Context: A** The use of vessel in offshore environments together with the impact of their discharges during normal operations is well understood and highly regulated through the MARPOL convention to prevent pollution impacts. On this basis, impacts have been recognised and are well understood and little uncertainty exists around this practice. The offshore management of wastewaters is well regulated and no issues or concerns have been raised by relevant stakeholders regarding these discharges. As such, decision context A will be applied to this aspect.		
Impact with controls failure (Inherent)			
MINOR: Localised, short-term effects on water quality.			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Comply with the Protection of the Seas (Prevention of Pollution by Ships) Act 1983 and Marine Order 93 (Marine Pollution Prevention – Sewage).	Prevent (engineering control)	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry. **Control adopted.**
Sewage treated as per MARPOL Annex IV requirements prior to marine discharge.	Prevent (Engineering Control)	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry. Environmental bebefits outweigh cost. **Control Adopted**.
Systems for treating sewage and grey water are maintained to ensure discharge concentrations conditions are met.	Prevent (Administrative control)	YES	Good practice – well defined and adopted by offshore petroleum sector. Environmental benefit outweighs cost. **Control adopted.**

Vessel masters ensure that the POB does not exceed stated maximum carrying capacity for treatment equipment.	Prevent (administrative control)	YES	Good practice – well defined and adopted by offshore petroleum sector. Environmental benefit outweighs cost. **Control adopted.**
Treated sewage and grey water discharged outside of Zeehan CMP	Eliminate	YES	Best practice to eliminate impacts to CMP. Control is considered practicable with no substantial increase in costs. **Control adopted.**
Alternate Control: Survey and support vessel store untreated sewage which is transferred to shore for treatment and disposal.	Eliminate	NO	Substantial additional cost due to onshore treatment and disposal, acquisition downtime, increase in survey duration, increased fuel consumption given the additional transits required by support vessel. Risk of spills and leaks during transfer operations and additional safety risks to personnel during vessel transfer activities. This is weighed up against the environmental benefit of reducing a localised, intermittently discharged biodegradable waste stream. No net benefit observed if sewage can be discharged in accordance with MARPOL Annex IV requirements. **Control not adopted.**
Impact consequence with controls (residual)			
NEGLIGIBLE: Localised and temporary impacts with rapid recovery in water quality			
ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS			
EPO	**EPS**		**MEASUREMENT CRITERIA**
No sewage and grey water discharges from survey vessels to the marine environment which do not conform to MARPOL requirements to prevent pollution to receiving marine waters.	*Sewage Treatment Equipment* Treated sewage and grey water discharges must comply with the requirements of MARPOL Annex IV requirements reflected in: • *Protection of the Seas (Prevention of Pollution from Ships) Act 1983* (Section 26D) • Navigation Act 2012 (Chap.4, Part 3&4) • Marine Order 96 (Marine Pollution Prevention – Sewage)		Records confirm that the vessel has a MARPOL approved/compliant sewage treatment equipment via an ISPP certificate or equivalent documentation appropriate to vessel class. <u>Responsibility</u>: 3D Oil Project Manager (or Delegate)

	Sewage Discharge from Vessels:
	Sewage discharges occur outside the Zeehan CMP if:
	• Sewage is treated in an IMO approved/ MARPOL compliant sewage treatment plant and does not cause visible floating solids or discolouration;
	• Sewage is comminuted and disinfected when:
	  o Vessel is >3nm from land; and
	  o Sewage originating in holding tanks is discharged at a moderate rate (as defined by Marine Order 96) while the vessel is proceeding en-route as a speed not less than 4 knots;
	• Sewage not comminuted or disinfected when:
	  o The vessel is >12nm from land;
	  o Sewage originating in holding tanks is discharged at a moderate rate (as defined by Marine Order 96) while the vessel is proceeding en-route as a speed not less than 4 knots.
	If the above is not met the sewage must be retained in on-board storage tanks for onshore disposal or further treatment.
		Oil record book verifies bilge discharges are compliant with these requirements and is monitored through regular inspection review of the discharge records.
		
		<u>Responsibility</u>: Chief Engineer

	System Maintenance: Treatment equipment is routinely maintained to manufacturer's specifications to ensure reliable discharge parameters are achieved.	PMS records verify that sewage treatment equipment is being maintained. <u>Responsibility</u>: Chief Engineer
	Vessel Manning Restrictions: Vessel masters ensure that the POB does not exceed stated maximum carrying capacity for treatment equipment	Records verify that POB has not exceeded treatment equipment carrying capacity. <u>Responsibility</u>: Vessel Master
No sewage discharge in Zeehan CMP.	*Sewage Discharges (within Zeehan CMP):* Sewage will not be discharged within the Zeehan Commonwealth Marine Reserve.	Discharge records verify sewage have not been discharged in the Zeehan CMR. <u>Responsibility</u>: Vessel Master

Demonstration of ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice.
ALARP Statement	No additional, alternate or improved control measures would provide further environmental benefit.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The impact management strategy for sewage and grey water impacts reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); and • Environmental Performance Monitoring & Reporting (**Section 8.11**).

External Context: Natural Environment	<u>Environmental Significance:</u> As assessed above, sewarg discharges if discharged in accordance with MARPOL requirements are localised aound vessels, intermittent and temporary (due to vessel movement) and recoverable. No significance criteria is triggered for marine mammals, turtles, fish plankton or seabirds. <u>Key Ecological Features</u>: KEFs (West Tasmanian Canyons & Shelf Rocky Reef and Hard Substrate) present are located on the seabed and not expected to be affected by surface discharges. <u>Species Recovery Plans:</u> The Dorrigo MSS area does not represent a unique area for the species which may be affected by localised vessel discharges. Species present are widespread in the environment during the period of the survey. The survey timeframe does not temporally overlap high productivity periods where larger concentrations of species may aggregate.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with sewage and grey water discharges. As such, 3D oil considers that there is broad acceptability of the impacts associated with this discharge.
Legislation and Conventions	The Dorrigo MSS complies with the requirements of the following legislative porvisions with respect to sewage and grey water discharges: <u>Acts/Statutes</u>: • Navigation Act 2012 (Chapter 4 (Prevention of Pollution) and Marine Order Part 96 (Marine Pollution Prevention – Sewage)) • Protection of the Seas (Prevention of Pollution by Ships) Act 1983 (Section 26D - *Prohibition of Discharge of sewage into Sea*) • EPBC Act 1999 (Action will not significantly impact matters of NES). <u>International Conventions:</u> MARPOL 73/78 – Annex IV Sewage <u>SE Marine Reserves Network Management Plan</u>: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1); • Management of wastes in accordance with MARPOL is allowed within reserves in the SE Commonwealth Marine Reserves Network (Section 5.3.3). *3D Oil has elected to eliminate this discharge on an ALARP basis within the CMR.* <u>South-east Marine Region Profile:</u> No specific references in plan to MARPOL compliance. <u>Recovery/Conservation Plans & Advices</u>: Review and assessment of threatened species recovery plans and conservation advices (refer **Section 5.4)** did not identify threats associated with sewage discharges. 3D Oil has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement. <u>Threat Abatement Plans</u>: Not triggered by this discharge
Industry Standards/Good Industry Practice	**APPEA CoEP:** Objectives met for MSS with respect to reducing the impacts to marine life to a level which is ALARP and acceptable including: • Adoption of management measures in accordance with legislative requirements/ guidelines; and • Utilising research /knowledge and latest data on local environment to assess potential impacts. **IAGC** Environment Manual (Worldwide Geophysical Operations): Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with sewage discharge impacts from vessels during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, impacts from sewage and grey water discharges are localised, temporary and rapidly recoverable. On this basis there is no significant disruption to the ecological processes within the Commonwealth marine environment, no impact to CMP convervation values and no injury to protected species which may be impacted by the discharge (cetaceans, turtles, pinnipeds, seabirds).
Environmental Monitoring	
Nil	
Record Keeping	

ISPP PMS Records (Sewage System) Vessel Waste Log POB Listing

7.5 IMPACT: Food-scrap Discharges

7.5.1 Hazard

Food-scrap/putrescible wastes will be generated during MSS activity through cooking and food consumption, with the wastes macerated and discharged overboard. It is expected that the average volume of putrescible waste discharged overboard is ~1 litre/person/day (Woodside, 2011).

All vessels engaged on the Dorrigo MSS will dispose of food-scraps/putrescibles in accordance with MARPOL 73/78 Annex V and Section 26F of the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* Marine Order 95 (Marine Pollution Prevention – Garbage).

7.5.2 Known and Potential Impacts

The known and potential environmental impact of putrescible waste discharges are:

- Temporary and localised increase in the nutrient content of surrounding surface waters; and
- Increase in scavenging behaviour of marine fauna and seabirds.

Area affected by impact: The area affected by putrescible waste discharges from vessels given the small intermittent volumes released and the dynamic marine environment is expected to be localised around the discharge point. This impact may occur anywhere within the Commonwealth waters of Dorrigo MSS operational area.

Possible environment/receptors affected by impact:
Receptors which may occur within this localised area, either as residents or migrants, are:

- Pelagic fish; and
- Seabirds.

7.5.3 Evaluation of Environmental Impacts

Macerated food wastes discharged overboard has the result of creating a localised and temporary increase in the nutrient load within surface waters. This may in turn act as a food source for scavenging marine fauna or seabirds, whose numbers may temporarily increase as a result. Given the intermittent small volumes involved, the constant movement of vessels and short timeframe of the survey, no dependencies are expected.

The consumption of food waste by scavenging fauna, and its physical and microbial breakdown, ensures that the impacts of putrescible waste discharges are temporary. Nutrient accumulation in surrounding waters is not expected due to the minor quantities generated each day, the assimilative capacity of open waters and the high biodegradability/low persistence of the waste.

Impacts to Matters of National Environmental Significance:

The discharge of putrescible waste will not have a 'significant' impact to any of the matters of NES applicable to this project, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Temporary and localised reduction in water quality will not result in any significant effects to populations or habitats of threatened fauna.	These TECs are not prenet in the Dorrigo MSS area	Migration, feeding, resting or breeding activities or habitats will not be impacted by a localised and temporary reduction in water quality.	Localised discharge will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality adversely impacting on biodiversity of ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo MSS area associated with putrescible waste discharges is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and Nationally Important Wetlands	Commonwealth Marine Park (CMP)	Coastal protected areas
X / X	X	X	X
Temporary and localised reduction in water quality is limited to the upper water column. No impacts are predicted to these seabed features from discharge.	There are no nationally important wetlands within Dorrigo MSS operational area	Temporary and localised reduction in water quality is possible within the upper water column within the Zeehan CMR if discharged. However, a spatial exclusion around the Zeehan CMP eliminating this discharge within the CMP will be applied to eliminate this impact.	Coastal protected areas are outside the Dorrigo MSS area.

7.5.4 Environmental Impact Assessment

Table 7-42 provides the environmental impact assessment for putrescible waste discharges.

Table 7-42: Putrescible waste discharge EIA

Aspect	Putrescible waste discharge from vessel
Impact Summary	Increased nutrient content of surface waters, which may lead to scavenging behaviour in pelagic fish and seabirds.
Extent of Impact	Localised small radius around constantly moving vessel during discharge
Duration of Impact	Temporary (duration of survey) with rapid dispersion and dilution (~minutes).
Level of Certainty of Impact	HIGH. Impacts from putrescible waste discharges on marine environment are studied and well understood.

Species possibly affected within survey environment:	• **Marine seabirds** (some protected, BIAs present for widely distributed seabirds) • **Fish** (not protected, widely distributed).		
Impact Decision Framework Context	**Decision Context: A** The use of vessel in offshore environments together with the impact of their discharges during normal operations is well understood and highly regulated through the MARPOL convention to prevent pollution impacts. On this basis, impacts have been recognised and are well understood and little uncertainty exists around this practice. The offshore management of putrescible wastes is well regulated and no issues or concerns have been raised by relevant stakeholders regarding these discharges. As such, decision context A will be applied to this aspect.		
Impact with controls failure (Inherent)			
NEGLIGIBLE: Localised , temporary effects. Recovery in days to weeks.			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Comply with the Protection of the Seas (Prevention of Pollution by Ships) Act 1983 and Marine Order 95 (Marine Pollution Prevention – Garbage).	Prevent (engineering control)	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry. **Control adopted.**
Food-scraps treated as per MARPOL Annex V requirements prior to marine discharge.	Prevent (Engineering Control)	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry. Environmental benefits outweigh costs. **Control adopted.**
Equipment used for macerating food-scraps is routinely maintained to ensure discharge performance standards are met.	Prevent (Administrative control)	YES	Good practice – well defined and adopted by offshore petroleum sector. Environmental benefits outweigh costs. **Control adopted.**
Shipboard personnel are aware of the restrictions around overboard discharges or waste materials.	Prevent (Administrative control)	YES	Good practice – well defined and adopted by offshore petroleum sector. Environmental benefits outweigh costs. **Control adopted.**
Macerated food-scraps are discharged outside of Zeehan CMP	Eliminate	YES	Best practice to eliminate impacts to CMP. Control is considered practicable with no substantial increase in costs. **Control adopted.**

Alternate Control: Food-scraps/putrescibles stored and transferred to shore for treatment and disposal.	Eliminate	NO	Additional cost due to onshore treatment and disposal, acquisition downtime, increase in survey duration, increased fuel consumption given the additional transits required by support vessel. This is weighed up against the environmental benefit of eliminating a localised, intermittently discharged biodegradable waste stream which is rapidly assimilated into the marine environment. Alternate storage on board vessel may lead to health issues and if refrigerated, may lead to less vessel endurance time given a limitation on food storage space availability. No net benefit observed if food-scraps can be discharged in accordance with MARPOL Annex IV requirements. **Control not adopted.**
Impact consequence with controls (residual)			
NEGLIGIBLE: Localised , temporary effects. Recovery in days to weeks.			
ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS			
EPO	**EPS**		**MEASUREMENT CRITERIA**
No putrescible waste discharges from survey vessels to the marine environment which do not conform to MARPOL requirments to prevent pollution to receiving marine waters	*Macerator Standard:* Food-scraps are treated through a macerator which complies with the requirements of MARPOL Annex V requirements required by • *Protection of the Seas (Prevention of Pollution from Ships) Act 1983* (Section 26F) • Navigation Act 2012 (Chapter 4, Parts 3 & 4) • Marine Order 95 (Marine Pollution Prevention – Garbage)		Records confirm that the vessel has a MARPOL approved/compliant equipment for maceration of food-scraps in accordance with the Vessel Garbage Management Plan (or equivalent document appropriate to class). Responsibility: 3D Oil Project Manager (or delegate)

	Foodscrap Discharges:
	Food-scrap discharges occur outside the Zeehan CMP if:
	• If food-scraps are comminuted to a particle size > 25mm:
	  o Vessel is en-route;
	  o Vessel is moving more than 4 knots; and
	  o The discharge takes place as far as practicable from the nearest land, but in any case>3nm from the nearest land;
	• If food-scraps are not comminuted:
	  o The vessel is en-route; and
	  o The discharge takes place as far as practicable from the nearest land, but in any case>12 nm from the nearest land.
	If the above is not met the food-scraps must be retained in on-board storage tanks for onshore disposal or further treatment or incinerated in the vessel's incinerator.
			Garbage record book verifies food-scrap discharges are compliant with these requirements and is monitored through regular inspection review of the discharge records.
			
			Responsibility: Chief Engineer

No putrescible waste discharges from survey vessels to the marine environment which do not conform to MARPOL requirments to prevent pollution to receiving marine waters (Con't)	*System Maintenance* The macerator is routinely maintained in accordance with the vessel's PMS and manufacturer's requirements to ensure it is operating to specification.	PMS records verify that maceration equipment is being maintained. Responsibility: Chief Engineer
	Crew Environmental Induction. All vessel personnel are aware of the vessel garbage management arrangements through the information provided in the vessel survey induction.	Induction records verify crew have completed the vessel induction which include garbage management plan arrangements. Responsibility: Vessel Master
	Garbage Management Plan Compliance Non-putrescible galley waste is returned to shore for disposal or incinerated in ship incinerator (as available and appropriate) i9n accordance with the Garbage Management Plan.	Garbage record book verifies waste is returned to shore or incinerated. Responsibility: Vessel Master
No food-scrap/putrescible discharge in Zeehan CMP.	*Putrescible waste discharges (within Zeehan CMP):* Food-scrap/putrescibles will not be discharged within the Zeehan Commonwealth Marine Reserve.	Discharge records verify food-scraps have not been discharged in the Zeehan CMP. Responsibility: Vessel Master

Demonstration of ALARP	
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice as detailed below.
ALARP Statement	No additional, alternative or improved control measures would provide further environmental benefit.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The impact management strategy for managing putrescible waste impacts reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	Environmental Significance: As assessed above, putrescible waste discharge is localised around vessels, intermittent and temporary (due to vessel movement) and recoverable. No significance criteria is triggered for marine seabirds or fish. Key Ecological Features: KEFs (West Tasmanian Canyons & Shelf Rocky Reef and Hard Substrate) present are located on the seabed and not expected to be affected by surface discharges. Species Recovery Plans: The Dorrigo MSS area does not represent a unique area for the species which may be affected by localised vessel discharges. Species present are widespread in the environment during the period of the survey. The survey timeframe also does not temporally overlap high productivity periods where larger concentrations of species may aggregate.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with food-scrap discharges. As such, 3D Oil considers that there is broad acceptability of the impacts associated with this discharge.

Legislation and Conventions	The Dorrigo MSS complies with the requirements of the following legislative provisions with respect to putrescible waste discharges: Acts/Statutes: • Navigation Act 2012 (Chapter 4 (Prevention of Pollution) & Marine Order Part 95 (Marine Pollution Prevention – Garbage)) • Protection of the Seas (Prevention of Pollution by Ships) Act 1983 (Section 26F - *Prohibition of Discharge of garbage into Sea*) • EPBS Act 1999 (Action will not significantly impact matters of NES). International Conventions: MARPOL 73/78 – Annex V Garbage SE Marine Reserves Network Management Plan: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMP in accordance with conditions of class approval (refer Management Plan Section 5.1); • Management of wastes in accordance with MARPOL is allowed within reserves in the SE Commonwealth Marine Reserves Network (Section 5.3.3). *3D Oil has elected to eliminate this discharge on an ALARP basis within the CMP.* South-east Marine Region Profile: No specific references in plan to MARPOL compliance. Recovery/Conservation Plans & Advices: Review and assessment of threatened species recovery plans and conservation advices (refer **Section 5.4)** did not identify threats associated with food-scrap discharges. 3D Oil has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement. Threat Abatement Plans: Not triggered by this discharge
Industry Standards/Good Industry Practice	**APPEA CoEP:** Objectives met for MSS with respect to reducing the impacts to marine life to a level which is ALARP and acceptable including: • Adoption of management measures in accordance with legislative requirements/ guidelines; and • Utilising research /knowledge and latest data on local environment to assess potential impacts. **IAGC** Environment Manual (Worldwide Geophysical Operations): Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with putrescible waste impacts from vessels during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, impacts from putrescible wastes are localised, temporary and rapidly recoverable. On this basis there is no significant distruption to the ecological processes withinthe Commonwealth marine environment, no impact to CMP conservation values and no injury to protected species which may be affected by the discharge (seabirds).

Environmental Monitoring
Nil

Record Keeping
Garbage Management Plan Garbage Record Book Macerator Specifications PMS Records (Maceration Equipment) Vessel Induction Attendance Records

7.6 IMPACT: Air Emissions

7.6.1 Hazard

The following activities during the MSS will generate air emissions:

- Combustion of marine diesel for propulsion and power generation (continuous) and within mobile deck equipment (intermittent);
- Use of aviation fuel for transport of personnel using helicopters (intermittent); and

- Liquid and solid waste combustion within the vessel's incinerator (intermittent).

The use of fuel to power engines, generators, mobile/fixed plant and incinerators will result in gaseous emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_X) and nitrous oxides (NO_X). Combustion emissions will be expelled from exhaust stacks several metres above deck level to ensure adequate aerial dispersion.

7.6.2 Known and Potential Impacts

The known and potential environmental impact of atmospheric emissions are:

- Localised and temporary decrease in air quality due to emissions and particulate matter from diesel combustion; and
- Contribution to the global GHG effect.

Area affected by impact: The area affected by air emissions from vessels is the local airshed – with rapid dispersion around the discharge point due to the local wind regime.

Possible environment/receptors affected by impact:
Receptors which may occur within this localised area, either as residents or migrants, are:

- Seabirds.

7.6.3 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 NO_X and SO_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 level of particles inhaled. Similarly, the inhalation of particulate matter may affect the respiratory systems of fauna. Within the Dorrigo MSS area, this is limited to seabirds overflying the vessel/s.

Particulate matter released from the vessel/s is not likely to impact on the health or amenity of the nearest human coastal settlements (i.e. King Island), as offshore winds will rapidly disperse emissions 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
While emissions add to the GHG load in the atmosphere, adding to global warming potential, the level of emissions are relatively small on a global scale representing an insignificant contribution to overall GHG emissions. The MSS vessel would typically consume 45 m^3 of fuel per day during MSS activities. For a 35-day program this results in a total GHG contribution of 4225 tonnes $CO_{2\text{-}eq}$ which is 0.0008% of the National Greenhouse Gas inventory for 2016 (DoEE, 2018bb).

Impacts to Matters of National Environmental Significance:
Air emissions from vessels will not have a 'significant' impact to any of the matters of NES applicable to this MSS, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Temperate saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Temporary and localised reduction in air quality will not result in any significant effects to populations or habitats of threatened seabirds.	These TECs are not present in the Dorrigo MSS operational area where localised impacts may occur	Migration, feeding, resting or breeding activities or habitats will not be impacted by a localised and temporary reduction in air quality.	Localised discharge will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. Nor does it result in a substantial change in air quality adversely impacting on biodiversity of ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo MSS area associated with air emissions are outlined below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and Nationally Important Wetlands	Commonwealth Marine Reserves (CMP)	Coastal protected areas
X /X	X	✓	X
Temporary and localised reduction in air quality is limited to the upper water column. No impacts are predicted to these seabed features from discharge.	There are no international or nationally important wetlands within the Dorrigo MSS area.	Temporary and localised reduction in air quality is possible within the Zeehan CMP. Emissions do not result in impacts to conservation values.	Coastal protected areas are outside the Dorrigo MSS area.

7.6.4 Environmental Impact Assessment

Table 7-43 provides the environmental impact assessment for air emissions.

Table 7-43: Air emission EIA

Aspect	Vessel air emissions
Impact Summary	Air pollution and contribution to GHG effect.
Extent of Impact	Localised small radius around constantly moving vessel during discharge
Duration of Impact	Short-term (duration of survey) with rapid dispersion and dilution (~minutes).
Level of Certainty of Impact	HIGH. Impacts from air emissions have been studied and well understood.
Species possibly affected within survey environment:	• **Marine seabirds** (some protected, BIAs present for widely distributed seabirds, small portion of population potentially affected at any one time).

Impact Decision Framework Context	**Decision Context: A** The use of vessels in offshore environments and generation or air emissions occurs as part of normal operations. The management of air emissions is well practiced and highly regulated through the MARPOL convention to prevent pollution impacts. On this basis, impacts have been recognised and are well understood and there is little uncertainty around this practice. No issues or concerns have been raised by relevant stakeholders regarding these discharges. As such, decision context A will be applied to this environmental hazard.		
Impact with controls failure (Inherent)			
NEGLIGIBLE			
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Comply with the Protection of the Seas (Prevention of Pollution by Ships) Act 1983, Navigation Act 2012 and Marine Order 97 (Marine Pollution Prevention – Air Pollution).	Prevent (engineering control)	YES	Good Practice – well defined and established procedures adopted by offshore petroleum and general shipping industry. **Control adopted**.
Monitor and optimise fuel use to increase efficiency and minimise emissions	Reduce (Administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. Environmental benefits outweigh costs. **Control Adopted.**
Use of low sulphur diesel fuel when it is available to reduce sulphur emissions (SOx) from vessel combustion.	Prevent (engineering control)	YES	The survey and support vessels will use Marine Gas Oil (MGO) or Marine Diesel Oil (MDO) to power engines (rather than Intermediate Fuel Oil (IFO) or Heavy Fuel Oil (HFO)) as it has a lower sulphur content. MGO/MDO can cost twice as much as IFO and HFO. Environmental benefits (including oil spill impacts) outweigh costs. **Control Adopted.**
Emissions managed by the implementation of a planned maintenance system (PMS) on propulsion and generation equipment.	Prevent (Administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. Environmental benefits outweigh costs. **Control Adopted.**
Alternate Control: Use of alternate fuels (solar, wind, biofuels).	Eliminate	NO	Alternate fuel sources have not been commercially proven for use in large vessels. **Control not adopted.**
Alternate Control: Eliminate air emissions when operating in the Zeehan CMP	Eliminate	NO	Control would not allow for the operation of vessels through the area to collect data. Not practical. **Control not adopted.**
Alternate Control: No incineration of wastes on vessels	Eliminate	NO	Incineration of wastes on vessels using MARPOL-certified equipment and procedures is an accepted practice which avoids potentially greater impact through transport, treatment and disposal onshore. Incineration also saves space on board and may prevent health hazards created by long-term storage of wastes pending onshore disposal. Cost does not outweigh the environmental benefit. **Control not adopted.**

Impact consequence with controls (residual)		
NEGLIGIBLE: Localised temporary impacts		
ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
Air emissions during survey are limited to those required for operation to minimise contribution to localised air quality impacts	*Equipment Emissions Standards* Vessels with gross tonnage > 400 t which have engines which result in air emissions must comply with the requirements of MARPOL Annex VI requirements reflected in: • *Protection of the Seas (Prevention of Pollution from Ships) Act 1983* (Part IIID – Prevention of air pollution) • Navigation Act 2012 (Chapter 4, Parts 3 & 4) • Marine Order 97 (Marine Pollution Prevention – Air Pollution)	Survey vessel has a current International Air Pollution Prevention Certificate (IAPP) certificate, Engine International Air Pollution Prevention (EIAPP) certificate for each marine diesel engine installed on the vessel, and an International Energy Efficiency (IEE) Certificate or equivalent documentation appropriate to vessel class. Responsibility: 3D Oil Project Manager (or delegate)
	Fuel Selection: Vessels utilise low sulphur fuels when it is available to reduce SOx emissions from combustion sources (i.e. fuel that contains less than 3.5% m/m sulphur).	Vessel bunker receipts verify use of low-sulphur marine grade MDO/MGO. Responsibility: Chief Engineer
	Monitoring Fuel Usage: Fuel usage is monitored on all support vessels and abnormally high consumption investigated.	Fuel use is reported in the Daily Report. Responsibility: Vessel Master
Air emissions during survey are limited to those required for operation to minimise contribution to localised air quality impacts (Con't)	*SEEMP Implementation:* The survey vessel implements a Ship Energy Efficiency Management Plan (SEEMP) (MARPOL 73/78 Annex VI requirement from 1 January 2012) to monitor and reduce air emissions from vessel activities. This includes: • Emissions management via implementation of a planned maintenance system for propulsion systems in accordance with manufacturer's instructions. • Records of daily feel consumption and fuel sulphur content. • Other measures (vessel speed, etc.) to reduce air emissions.	SEEMP review records verify: • Energy saving measures have been implemented; • Propulsion systems have been maintained in accordance with manufacturer's instructions. Responsibility: Chief Engineer
	Equipment maintenance: Vessel engines and incinerator will be maintained in accordance with the planned maintenance system.	Maintenance records confirm engines are maintained to schedule. Responsibility: Chief Engineer

	Incineration Operations: Incinerator operation is in accordance with the requirements of MARPOL 73/78 Annex VI (Regulation 16): • Incinerator will be IMO certified; • Only wastes approved by the vessel garbage management plan shall be incinerated; • The incinerator shall operate in accordance with the manufacturer's operating manual by trained personnel; and • Flue gas outlet or combustion chamber temperatures shall be monitored during incineration activities. • All personnel operating incineration equipment are trained in its operation	Incinerator has IMO Certification <u>Responsibility</u>: 3D Oil Project Manager (or delegate) Incinerated waste details are recorded in the vessel's Garbage Record Book which verifies operation in accordance with MARPOL requirements. <u>Responsibility</u>: Chief Engineer Manufacturer's specifications and operating procedures are available for the operation of the incinerator. <u>Responsibility</u>: Chief Engineer Training Records <u>Responsibility</u>: Vessel Master
Demonstration of ALARP		
Hazard Consequence Criteria	A NEGLIGIBLE consequence ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).	
ALARP Statement	No reasonably practical additional, alternative and/or improved control measures exist.	
Demonstration of Acceptability		
Internal Context: 3D Oil Policy compliance	The impact management strategy for managing air emissions reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.	
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).	
External Context: Natural Environment	<u>Environmental Significance:</u> As assessed above, air emissions are localised around the vessel, rapidly dispersed and air quality impacts recoverable in any location. No significance criteria is triggered for seabirds. <u>Key Ecological Features</u>: KEFs (West Tasmanian Canyons & Shelf Rocky Reef and Hard Substrate) present are located on the seabed and not expected to be affected by air emissions. <u>Species Recovery Plans</u>: The Dorrigo MSS area does not represent a unique area for seabirds affected by localised vessel discharges. Seabird species present are widespread in the environment during the period of the survey. The survey also does not overlap high productivity periods when larger concentrations of species may aggregate.	
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with air emissions. As such, 3D Oil considers that there is broad acceptability of the impacts associated with this emission.	

Legislation and Conventions	The Dorrigo MSS complies with the requirements of the following legislative provisions with respect to air emissions: Acts/Statutes: • Navigation Act 2012 (Chapter 4 (Prevention of Pollution) & Marine Order Part 97 (Marine Pollution Prevention – Air Pollution)) • Protection of the Seas (Prevention of Pollution by Ships) Act 1983 (Part IIID – *Prevention of air pollution*) • EPBC Act 1999 (Action will not significantly impact on matters on NES). International Conventions: MARPOL 73/78 – Annex VI – Air Emissions SE Marine Reserves Network Management Plan: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1); • Management of wastes in accordance with MARPOL is allowed within reserves in the SE Commonwealth Marine Reserves Network (Section 5.3.3). 3D Oil cannot eliminate air emissions within the CMP as survey objectives would not be met. South-east Marine Region Profile: No specific references in plan to MARPOL compliance. Recovery/Conservation Plans & Advices: Review and assessment of threatened species recovery plans and conservation advices (refer **Section 5.4)** did not identify threats associated with air emission discharges. 3D Oil has adopted all relevant controls contained in marine pollution law to limit marine pollution from vessels as per this requirement. Threat Abatement Plans: Not triggered by this discharge
Good Industry Practice	**APPEA CoEP:** Objectives met for MSS with respect to reducing the impacts to marine life to a level which is ALARP and acceptable including: • Adoption of management measures in accordance with legislative requirements/ guidelines; and • Utilising research /knowledge and latest data on local environment to assess potential impacts. **IAGC** Environment Manual (Worldwide Geophysical Operations): Practice is consistent with advice provided in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management & Section 8.6 Hazardous Materials).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with air emissions from vessels during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, impacts from air emissions are localised, temporary and air quality is rapidly recoverable. Given this impact, there is no significant disruption to ecological processes within the Commonwealth marine environment; no impact to CMP conservation values and no injury to protected species (i.e. seabirds).
Environmental Monitoring	
Fuel Usage	
Record Keeping	
IAPP, EIAPP, IEE Certificates Bunkering Records Garbage Management Plan Garbage Record Book Incinerator Specification and Operating Instructions Daily Vessel reports Vessel SEEMP SEEMP Implementation Records PMS Records (Combustion Equipment)	

7.7 RISK: Introduction of Invasive Marine Species

7.7.1 Hazard

The following activities during the MSS have the potential to introduce IMS to the Dorrigo MSS area:

- Discharge of vessel ballast water containing foreign species; and
- Translocation of foreign species through biofouling of the vessel hull, niches (e.g., sea chests, bilges, strainers) or in-field equipment.

While on location, vessel(s) may ballast and de-ballast to improve stability, even out vessel stresses and adjust vessel draft, list and trim, accommodating the weight of equipment on board at any one time. The Commonwealth Biosecurity department indicates that ballast water is responsible for 20-30% of all marine pest incursions into Australian waters (DAWR, 2015a). The DAWR (formerly AQIS) 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).

Biofouling is the accumulation of aquatic micro-organisms, 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, 2015b).

7.7.2 Known and Potential Impacts

The known and potential environmental impact of IMS introduction (assuming survival, colonisation and spread) include:

- Ecological disruption through increased competition with native species for resources;
- Reduction in native marine species diversity and abundance;
- Socio-economic impacts on commercial fisheries; and
- Changes to conservation values of protected areas.

Area affected by impact: The area which could be affected by IMS introduction is the Dorrigo MSS area, though this can become more widespread in suitable environments if colonisation occurs. The area is located within Commonwealth waters.
Possible environment/receptors affected by impact:
Receptors which may occur within this area and are at risk from IMS introduction are:

- Benthic species (because their ability to move to other suitable areas is more restricted than demersal and pelagic species);
- KEF receptors:
    - West Tasmanian canyons (sponges); and
    - Shelf rocky reefs and hard substrates (sponges, bryozoans, etc.).

7.7.3 Evaluation of Environmental Risk

Successful IMS colonisation requires the following three steps (CoA, 2009):

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., Dorrigo MSS 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.

Colonisation of IMS may 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 Australia has over 250 established marine pests, and it is estimated that approximately one in six introduced marine species becomes pests (DoEE, 2017a). Colonisation requires favourable environmental conditions for the species to establish including water temperature, depth and habitat range. As most IMS species are translocated from port or shallow water areas where vessels are stationary for extended periods, marine pests typically colonise in ports and marinas (shallow waters) (Kinloch et al, 2003).

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. For example, the introduction of the Northern Pacific seastar (*Asterias amurensis*) in Victorian and Tasmanian coastal waters was linked to a decline in scallop fisheries (DSE, 2004). 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.

Factors which influence the risk of IMS presence on a vessel include the following (CoA, 2009):

- Regularity of vessel cleaning and maintenance (hull, internal niches and internal seawater systems);
- Presence of an effective anti-fouling coating which is suited to the vessel, surface and operational activity type which is within date;
- The amount of stationary or low speed working periods the vessel has undertaken. The longer the wetted surface remains stationary or moving at low speed in port or coastal waters, the more likely it will accumulate biofouling. If a vessel is inactive, operated intermittently or at low speeds it may accumulate substantial biofouling in as little as a month, especially in circumstances where the vessel is not operated in accordance with anti-fouling coating manufacturer's recommendations; and
- IMS survival is less on north-south voyages where temperature changes are greater; in geographic locations were salinity and water depth range and habitat (substrate) type differs; during longer transits across oceanic areas where there is limited food for the species; and for vessels operating in offshore deep-water environments IMS are less likely to accumulate compared with vessels and equipment that operate in ports or coastal waters where almost all marine pests are located.

No obvious introduced pest species were observed during 2002 seabed inspections for the adjacent Otway Gas Project (Woodside, 2003).

Survey Vessels

The Dorrigo MSS survey vessel(s) may mobilise from an international location or from other Australian ports/Commonwealth waters. Prior to mobilisation to the Dorrigo MSS area, survey vessel contractors mobilising vessels from international locations or domestic vessels mobilising from ports outside the IMCRA Otway bioregion[58], will need to undertake an IMS risk assessment in accordance with the Biofouling Risk Assessment Tool[59] 'Vessel Check' developed by the WA

58 Vessels operating within the Otway Bioregion are not considered to have IMS species located outside the bioregion.

59 Vessel Check is available at http://www fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biosecurity/Vessels-And-Ports/Pages/Biofouling-management-tools-and-guidelines.aspx

Department of Fisheries (or equivalent assessment tool with prior approval by 3D Oil). For survey vessels demonstrating by the risk assessment that IMS risk is LOW without further corrective actions, the vessel is deemed suitable for use in survey operations. For vessels demonstrating via the risk methodology that the IMS risk is MEDIUM or HIGH, the contractor will need to engage a qualified independent third-party marine pest inspector to determine the corrective actions to reduce the vessel IMS risk to low. The vessel contractor must demonstrate to 3D Oil that all corrective actions have been implemented and necessary clearences obtained prior to mobilisation to the Otway bioregion.to ensure that the risk of IMS introduction is low.

Survey vessel(s) will also undertake ballast water exchange activities in deep water during its transit to Australia in accordance with the Australian Ballast Water Management Requirements (DAWR, 2017) to eliminate IMS species within ballast water tanks. These vessel(s), if mobilising from international waters, must first dock at an Australian port whereby the Department of Agriculture and Water Resources (DAWR) may determine the vessel's compliance with the Commonwealth biosecurity standards legislated under the Commonwealth *Biosecurity Act 2015*.

Survey vessel(s) will be coated in an appropriate anti-fouling system considered suitable for the vessel activity and will have a current International Anti-Fouling System (IAFS) Certificate to verify the currency of the system in accordance with the *Protection of the Seas (Harmful Anti-Fouling Systems) Act 2006*.

Immersible seismic survey equipment

Most marine species cannot tolerate prolonged exposure to air and removal of equipment from water is an effective control option for marine pests. Complete removal from water, exposure to direct sunlight, warm temperatures and low humidity will kill most marine species within seven days out of water. Immersible equipment carried by seismic survey vessels is typically stored in air environments when not in use and do not normally pose a threat for biofouling accumulation and translocation. Experience indicates that most components are generally free of biofouling except for the streamers where biofouling can be present in the joints. It is recommended that hairy fairleads are replaced between projects as these can be quickly biofouled (CoA, 2009b).

Biofouling can also settle and grow in the gaps of collar joints which provide niches enabling colonisation and entanglement of other biofouling biota including seaweed. However, unless the streamers are being deployed in shallow coastal waters, the most likely biofouling organisms in deep open waters (as per the Dorrigo MSS area) are goose barnacles and green filamentous seaweed (not marine pests) (CoA, 2009b).

Risk Assessment Outcome

If a IMS was introduced to the Dorrigo MSS area, the unfavourable environmental conditions (i.e. light limitations with water depths) might allow localised IMS impacts, however long-term IMS survival and colonisation would not be expected (significant consequence). With the adoption of the control measures to prevent IMS introduction the likelihood of introduction is very unlikely (remote) and the residual risk is assessed as low.

Impacts to Matters of National Environmental Significance:

The introduction, colonisation and possible spread of IMS will not have a 'significant' impact to any of the matters of NES applicable to this project, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
No benthic species are listed within the EPBC PMST for the Dorrigo MSS area. Habitat resources for pelagic species are plentiful within the area with any IMS colonisation in the Dorrigo MSS (if possible due to depths in the survey area), unlikely to represent a limiting resource for threatened species.	These TECs are not located in the Dorrigo MSS area.	Migration, feeding, resting or breeding activities are unlikely to be impacted through the introduction and colonisation of IMS.	Given the depth of water (& associated light limitations) within the Dorrigo MSS area together with the adopted controls to prevent IMS presence on survey equipment and vessels, the potential for an IMS species becoming established in the Commonwealth marine area is remote.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:

Impacts to areas of conservation significance within the Dorrigo MSS area associated with putrescible waste discharges is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	Internationally and Nationally Important Wetlands	Commonwealth Marine Park (CMP)	Coastal protected areas
✓ / ✓	X	✓	X
Given the depth of water (& associated light limitations) within the Dorrigo MSS area together with the adopted controls to prevent IMS presence on survey equipment and vessels, the potential for an IMS species modifying, destroying, fragmenting, or disturbing these seabed KEFs such that an adverse impact on marine ecosystem functioning or integrity is remote.	There are no international or nationally important wetlands within the Dorrigo MSS area	Given the depth of water (& associated light limitations) within the Dorrigo MSS area together with the adopted controls to prevent IMS presence on survey equipment and vessels, impacts to CMR conservation values (migratory whales and foraging seabirds) are not expected. Seabed ecosystems/ benthic habitats present in the CMR are not expected to be significantly impacted (refer KEFs/ Commonwealth Marine environment).	Coastal protected areas are outside the Dorrigo MSS area.

7.7.4 Environmental Risk Assessment

Table 7-44 provides the environmental risk assessment for IMS.

Table 7-44: IMS ERA

Aspect	Introduction of IMS into the Dorrigo Operational Area
Impact Summary	Competition with and loss of, diversity and abundance of, native species in the survey area.
Extent of Impact	Localised with possible medium-term effects if IMS survives in the water depths of the Dorrigo MSS area. IMS are translocated from coastal environments where there is high light availability (not present in survey area).
Duration of Impact	Medium-term if the IMS survives.

Level of Certainty of Impact	**HIGH.** Studies undertaken as part of the adjacent Otway Gas Project, which lies in a major shipping lane in similar depth waters has not identified any IMS (i.e. area carries a higher IMS introduction risk). The Dorrigo MSS area is in similar water depths to this development. IMS species have been extensively studied. Corresponding regulatory guidelines controlling these vectors have been established to prevent impacts.
Species possibly affected within survey environment:	**Benthic species** (sponges, bryozoans, invertebrates which are (not protected) **KEF - Rocky shelf reefs and hard substrates** (Water Depths 50m+) **KEF - West Tasmania canyons** (water depths 200m+).
Impact Decision Framework Context	**Decision Context A** The introduction of marine pests is not a planned activity. The use of vessels offshore is well practiced and the pathways for the introduction of an IMS well understood and regulated. Two KEFs are present within the Dorrigo MSS area. However, the introduction of an IMS into the Dorrigo MSS area is expected to rapidly spread due to the depths of waters present (100^{+}m). The introduction of IMS will be handled via best practice adopting a verifiable preventative approach prior to mobilising to Australian/Otway Bioregion waters. The WA Fisheries 'Vessel Check' will be utilised to assess for IMS risk. The WA Fishery guidelines have been identified as control measures and consequently decision context A will be applied to this hazard.

Impact with controls failure (Inherent)					
Consequence:	Significant	Likelihood:	Possible	Risk:	MEDIUM

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)

CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Vessels comply with ballast requirements in accordance with the Australian Ballast Water Management Requirements (Revision 7) (DAWR, 2017)	Prevent (engineering/ administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted.**
Survey vessels during survey activities do not undertake routine discharge of ballast water.	Eliminate	NO	Given the location of the survey, ballast water is required to maintain vessel stability during survey activities. Option may compromise safety of personnel on-board. **Option not considered practicable**.
Vessels mobilising from regions outside the Otway Bioregion undertake an IMS risk assessment with respect to biofouling on hull and niche areas and for trailing equipment which has been immersed during surveys in accordance with Fisheries WA 'Vessel Check' with corrective actions initiated (as required)	Prevent (Administrative/ Engineering control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. Environmental benefit outweighs cost. **Control adopted**.
Vessels will have current anti-fouling coating systems to prevent adherence of IMS species to the hull and niche areas.	Prevent (Engineering control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**.
Hull cleaning and new anti-fouling coat application to vessel hull and niche areas on every occasion prior to entry into bioregion waters.	Prevent (Engineering control)	NO	If not justified via a risk assessment due to a high IMS risk this control is a substantial cost without a net environmental benefit. **Control not adopted as a routine measure**.

All in-field equipment has been removed from the water, inspected and cleaned (where required) prior to deployment in South Australian waters	Prevent (Administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector unless mobilising from an adjacent permit in the Otway Basin. **Control adopted**.

Impact consequence with controls (residual)					
Consequence:	Significant	Likelihood:	Very Unlikely	Risk:	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
No introduction of marine pest species from ballast water exchange during the Dorrigo MSS.	*Ballast Water Exchange* Ballast water management is undertaken in accordance with the requirements of the *Australian Ballast Water Management Requirements* (Revision 7) (DAWR, 2017). This includes: o Use of a Ballast Water Treatment System (BWTS); o Ballast water exchange outside of Australian Territorial seas (<12nm from coastline) involving full exchange of ballast in water depths of at least 50m; o Use of low risk ballast water (e.g. fresh potable or high seas water); o Retention of high-risk ballast water on-board; or o Discharge to an approved ballast water reception facility. International vessels have submitted a Ballast Water Report and been issued with a Biosecurity Status Document.	Records identify that a Ballast Water Report submitted to the DAWR and a Biosecurity Status Document is available prior to entry into port facilities. BWTS Certification is available demonstrating equipment availability (*timing is relevant to IOPP inspection triggers for vessel*). Responsibility: Vessel Manager
	Ballast Water Management Plan Vessel must have a certified Ballast Water Management Plan which complies with: o Regulation B1 of the international Convention for the Control and Management of Ships Ballast Water and Sediments 2004; and o IMO Guidelines for Ballast Water Management and the Development of Ballast Water Management Plan (IMO Resolution MEPC.127(53)).	Valid Ballast Water Management Certificate for the vessel Responsibility: Vessel Manager
	Maritime Arrivals Reporting System International vessels contracted will receive biosecurity clearence from DAWR to enter Australian waters.	Record of Biosecurity Clearence from DAWR Responsibility: Vessel Master
	Ballast Water Exchange in the Zeehan CMR Any ballast water exchange within the Zeehan CMR must be undertaken in accordance with the *Australian Ballast Water Management Requirements* (Revision 7) (DAWR, 2017.	Ballast Water Management Records Responsibility: Vessel Master

No introduction of marine pest species from biofouling of the survey or support vessel hulls, other niches and immersible equipment during Dorrigo MSS	*IMS Risk Assessment & Corrective Action* For survey vessels mobilising from regions outside the Otway Bioregion, prior to mobilisation, contractors are required to undertake an IMS risk assessment supplying relevant supporting information to 3D Oil to validate the IMS risk status. The risk assessment is undertaken in accordance with the *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2009)* and the WA IMS Risk Assessment Methodology currently managed by WA Fisheries ('Vessel Watch') or equivalent approved system. For vessels demonstrating via the risk assessment methodology that the IMS risk is LOW without further corrective actions, the vessel is deemed suitable for use in survey activities. For vessels demonstrating via the risk assessment methodology that the IMS risk is MEDIUM or HIGH the vessel will require inspection by a qualified independent third-party marine pest inspector to determine the corrective action to reduce the vessel to low risk. The vessel must demonstrate to 3D Oil that all corrective actions have been implemented prior to mobilisation to the Otway bioregion.	Records verify risk assessment has been undertaken and all corrective actions implemented. Responsibility: Vessel Contractor
	Anti-fouling System Cetrificate Vessels carry current International Anti-fouling System Certificates (IAFS) prior to entry into Australian waters.	Records verify IAFS Certificate is current for vessels. Responsibility: Vessel Contractor
	In-water Equipment Inspection All in-field equipment has been removed from the water, inspected and cleaned (where required) prior to deployment in Otway Basin waters.	Records verify in-field equipment does not present an IMS risk Responsibility: Vessel Contract Manager

Demonstration of ALARP	
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).
ALARP Statement	All known controls have been adopted.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The risk management strategy for managing IMS reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); and • Incident management (**Section 8.12**).

External Context: Natural Environment	Environmental Significance: Matters which may be present in the area affected by IMS risk include benthic habitats (sponges, bryozoans, invertebrates) (not protected). Given the depth of water within the MSS area and the adopted controls to prevent IMS introduction, the MSS activity **does not** represent a significant impact to the Commonwealth marine environment (refer impact assessment to MNES). Key Ecological Features: IMS impacts to KEFs (West Tasmanian Canyons & Shelf Rocky Reef and Hard Substrate) present in the MSS area with risk controls adopted is considered remote. A mitigator is that the depth of water in the MSS area will not support pest species which are typically picked up in shallow-water environments and require shallow waters to replicate. As such the Commonwealth marine environment NES criteria (known pest species becoming established) with controls adopted is remote Species Recovery Plans: Not applicable to this risk. Zeehan CMR (Multiple Use Zone): Provides for the general sustainable use of the area allowing activities which do not significantly impact on benthic habitats. Significant impacts to benthic habitats will not occur with controls adopted and mitigating factors within the MSS area (i.e. water depth). Prescriptions within the SEMRNMP (S5.3.5 requires ballast water to be exchanged in accordance with Australian Ballast Water Requirements)
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**). No stakeholder concerns have been raised to date associated with IMS. As such, 3D Oil considers that there is broad acceptability of the IMS risk associated with this activity.
Legislation and Conventions	The Dorrigo MSS MSS complies with the following legislative provisions with respect to IMS management and risk prevention: Acts/Statutes: • *Biosecurity Act 2015* (Chapter 5, Part 3 – Management of discharge of ballast water & Chapter 4 – Managing Biosecurity risks: conveyances) • *Protection of the Sea (Harmful Anti-Fouling Systems) Act 2006* & Marine Order Part 98 (Marine Pollution Prevention – anti-fouling systems) • *EPBC Act 1999 (& EPBC regulations 2000 (IUCN Management Principles)* International Conventions: • International Convention for Control & Management of Ship Ballast Water & Sediments 2004 • International Convention on Control of Harmful Anti-Fouling Systems in Ships 2001 SE Marine Reserves Network Management Plan (2013-2023): • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMP in accordance with conditions of class approval (refer Management Plan Section 5.1); • Ballast water may be discharged/exchanged in accordance with the Australian Ballast Water Management Requirements (S5.3.5). *3D Oil will ensure adherence to this requirement*; • Multiple Use Zone Management Approach – general sustainable use by allowing activities that do not significantly impact on benthic habitats (*with control no significant impact predicted*); South-east Marine Region Profile: No specific references in plan to IMS compliance. Recovery/Conservation Plans & Advices: Review and assessment of threatened species recovery plans and conservation advices (refer **Section 5.4** did not identify threats or pressures associated IMS impacts. No action objectives from recovery plans are applicable to this risk. Threat Abatement Plans: Not triggered by this hazard.
Industry Standards/ Good Industry Practice	Compliance with industry standards: APPEA CoEP & IAGC Environment Manual and the following IMS-related guidelines: • Australian Ballast Water Management Requirements (DAWR, 2017). • National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2009) • WA Marine Pest Management Guidelines – Biofouling Risk Assessment Tool for Commercial/non-trading/petroleum/commercial fishing vessel for International and Interstate Movements (Department of Fisheries, 2015)
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with IMS during the Dorrigo MSS due to the depth of water in the MSS area and the preventative controls adopted. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted and the inherent water depths in the Dorrigo MSS, the risk of IMS introduction remote within no significant impact to the benthic habitats. Given this, no significant disruption to ecological processes within the Commonwealth marine environment and no impact to CMP conservation values are expected.

Environmental Monitoring
Nil
Record Keeping
Biofouling Risk Assessment (with supporting verified information); and as required: ○ Independent 3rd Party Inspection Report; ○ Corrective Action Closeout Records (vessels mobilising from outside Otway Bioregion)
Ballast Water Management Plan & IMO Ballast Water Management Certificate
IAFS Certificate
"In-water equipment" Inspection Records
Ballast Water Report (submitted to DAWR)
Biosecurity Clearence (DAWR)
BWTS Certification (as appropriate to IOPP recertification dates).
Ballast Water Management Records.

7.8 RISK: Disruption to Commercial Vessels

7.8.1 Hazard

The physical presence of the Dorrigo MSS vessels may spatially impact upon third-party vessel operators in the region such as commercial shipping and fishing. This section deals with vessel interference on a spatial basis. Risk associated with vessel collision/diesel spill is addressed in **Section 7.12** and catch/abundance impact to commercial fishing associated with sound impacts addressed in **Section 7.2.3.2** (Invertebrates) & **Section 7.2.3.3** (Fish).

As identified in **Section 5.7.3**, AMSA (2018) has identified that the Dorrigo MSS area generally lies to the south of the main east–west and west–east international shipping route from Bass Strait to Cape Leeuwin which includes international/national cargo and tanker trade services. When the survey vessel is operating in the northern extremities of the MSS area, encounter with heavier concentrations of transiting high levels of commercial shipping is expected. A smaller commercial vessel route also crosses the MSS area transiting between King Island and the Fleurieu Group of Islands. AMSA advise that vessels may be encountered anywhere within the Dorrigo MSS area.

The Dorrigo MSS area lies in areas of commercial fishing. **Table 7-45** provides details of the commercial fisheries which actively fished in the area, their seasonal presence and the level of fishing effort in the MSS area (where available) .

Table 7-45: Commercial Fishing Activity within the Dorrigo MSS Area (SETFIA/Fishwell Consulting, 2018)

Fishery	Level of Effort	Seasonal Effort	Area/extent of overlap
Commonwealth Trawl Sector (CTS)	6-9 Vessels entering the MSS area since 2008	Oct-March (Effort Highest) Feb-March (Highest Catch)	Active fishery overlap is in the SW corner of the Dorrigo MSS operational area (622 km^2) along the continental slope.
Gilnet Hook and Trap (GHaT)	18 vessels entering the MSS area since 2008	Sept-April (Highest Effort) Nov-April (Highest Catch)	Fishery has advised that the shark gillnet fishermen fish inshore of the MSS area Area of Dorrigo MSS operational area overlap (on shelf) 2730 km^2.

Fishery	Level of Effort	Seasonal Effort	Area/extent of overlap
Squid Jig Fishery	< 5 vessels pa	January to July (*not active during the Dorrigo MSS*)	Area of Dorrigo MSS operational area overlap is 1898 km^2
Giant Crab Fishery (Victoria)	< 5 vessels pa	15 Nov – 14 Sept (*active only 1-15 September*)	Area of Dorrigo MSS operational area overlap is 497 km^2 (shelf-break 150-300m)
Giant Crab Fishery (Tasmania)	Not Available	All year Nov-May (Highest Catch)	Area of Dorrigo MSS operational area overlap is 622 km^2 continental shelf/shelf break (140-270m)
Southern Rock Lobster (Victoria)	< 5 vessels pa	15 Nov – 14 Sept (*active only 1-15 September*) December – January (Highest Effort)	Area of Dorrigo MSS operational area overlap is 1164 km^2 on continental shelf (0-150m)
Southern Rock Lobster (Tasmania)	Not Available	15 Nov-30 Sep December-April (Highest Catch)	Area of Dorrigo MSS operational area overlap is 1285 km^2 on continental shelf (0-150m) Most catch is harvested from water depths < 40m on coastal reefs (outside Dorrigo MSS area)

As identified in **Section 5.7.4**, no recreational fishing activity has been identified within the Dorrigo MSS area during the MSS timeframe.

7.8.2 Known and Potential Impacts

The known and potential impacts of interference with commercial vessels are:

- Displacement/disruption to transiting commercial vessels (route deviation);
- Displacement of commercial fishermen; and
- Damage to, or loss of, fishing equipment and associated commercial catch.

Area affected by impact: The area for interference with third-party commercial vessels is immediately around the MSS vessel and its trailing equipment. The Dorrigo MSS area is located entirely within Commonwealth waters.

Possible environment/receptors affected by impact:
Receptors which may occur within this area and are at risk of spatial conflict are:

- Commercial shipping; and
- Commercial fisheries.

7.8.3 Evaluation of Environmental Risk

Disruption to third-party vessels
The presence of the MSS vessel, towed array and a requested 'safe distance' around the MSS vessel/array may disrupt commercial vessels in portions of the Dorrigo MSS area intermittently over the 35-day survey duration. A 'safe distance' is implemented to prevent interference/collision with towed equipment/vessels and to prevent interruptions to survey activities.
Transiting Vessels (Merchant Shipping): Vessels transiting through the area, such as merchant vessels and charter boat operators, will not be restricted in their activities. Normal navigation at sea processes are undertaken whereby shipping vessels will move through the area using navigational aids to avoid the MSS vessel as per any other vessels. In the worst case a merchant ship may need to go around the survey vessel which may result in them having to go ~ 6-7 km from their route.

Thus, any potential impacts will be within a localised area that needs to be avoided (vessel/streamers ~ 6-7 km) (Minor consequence) and short term (~ 1 hr for vessel/streamer to pass) (unlikely). Residual risk is LOW.

Fishing Vessels: In the Dorrigo MSS operational area, impacts to some of the fisheries can be minimised by coordinating access to fishing areas prior to and after the MSS vessel has surveyed an area (i.e. pre-notification of 1 month prior to survey). For safe operations, the seismic vessel monitors other vessels within approximately 20 km of the survey vessel and seismic array to take into account any horizontal movement of the 6 km streamers. For the majority of time that the seismic and support vessels will be within the acquisition and operational area they will be moving at a rate of 4.5 – 5. Knots (8-9 km/hr) along the sail lines. The long operational area around the survey acquisition area is required to allow the seismic vessel to turnaround without entanglement of the streamers. It takes approximately 12-14 hours to complete a sail line.

Coordinating access to fishing areas prior to and after the MSS vessel has surveyed an area will be managed by working with SETFIA, on behalf of the fishers, to coordinate the planned location of the survey vessel, on a frequency (daily, weekly etc.) that allows the fishers to be able to plan ahead. A 48-hr look ahead will also be provided on the 3D Oil website.

CTS (Demersal Otterboard Trawl):

This demersal trawl fishery operates in the south-west section of the Dorrigo MSS area at the shelf-break and along the continental slope. The operational area spatially overlaps the CTS fishing area by ~622 km^2 and their fishing season (from October 1, 2019). The CTS is a trawl fishery which trawls the continental slope at a constant depth. Displacement of activities can be avoided by coordinating each party's activities so as not to restrict either party. Potential impacts will be in a localised area and short-term (in the order of hours as the vessel/streamers move from the overlap area).

If the Dorrigo MSS results in the displacement of the CTS, there is potential for localised and short-term impacts (Minor consequence), however given there is only a small area of overlap and with good communication controls displacement is considered unlikely (low residual impact).

GHaT Fishery (Gillnets & Hook):

The Dorrigo MSS overlaps a small portion of the GHaT (gillnet) fishery (2370 km^2), however advice provided by Sustainable Shark Fishing (SSF) has advised that shark gillnet fishermen fish inshore of the MSS area towards King Island. Accordingly, impacts to the GHaT (gillnet) will be incidental (negligible consequence) with any spatial overlap very unlikely (low residual risk).

One hook fisherman has provided feedback through consultation, that he occasionally fishes to the west of King Island (**Stakeholder No 61**), however fishing activities are normally to the west of Tasmania. With survey notifications in place, spatial overlap with this fisherman is considered very unlikely (low residual risk).

Southern Rock Lobster (SRL) & Giant Crab Fishery (Victoria):

The Victorian SRL Fishery has an operational overlap with the Dorrigo MSS area of ~1164 km^2 in continental shelf waters to approximately 150 m water depth. The giant crab fishery, located at the shelf-break, overlaps the Dorrigo MSS area by ~497 km^2. The Dorrigo MSS will overlap the SRL an giant crab fishing season by 14 days (1-14 September 2019). Individual fishermen have advised that there is a low level of SRL fishing within the Dorrigo MSS. VFA (2018) identify that most SRL fishing comes from inshore waters less than 100 m deep. All catch data for the SRL within the Dorrigo MSS area has been consolidated with giant crab data due to confidentiality provisions and has < 5 fishermen fishing within the area (SETFIA/Fishwell Consulting, 2018) (negligible consequence). Spatial interaction with this fishery in Victorian waters (northern section of Dorrigo MSS) is therefore unlikely (low residual risk).

Southern Rock Lobster (SRL) Fishery (Tasmania):

The Tasmanian SRL fishery has an operational overlap of 1285 km^2 with the Drrigo MSS on the continental shelf. Most catch is harvested from waters depths < 40 m on coastal reefs however some catch is taken as deep as 200m (SETFIA/Fishwell Consulting, 2018). High catch periods are between November to April. Closure of this fishery (male & female) is between 1 October to 15 November so limited spatial overlap occurs during November.

If the Dorrigo MSS results in the displacement of Tasmanian SRL fishermen, there is potential for localised and short-term impacts (Minor consequence), however given there is only a small area of overlap, the Dorrigo MSS is undertaken during the low effort/closed season for the fishery and with good communication controls when the fishery is open, spatial conflict is considered very unlikely (low residual impact).

Giant Crab Fishery (Tasmania):

The Tasmanian giant crab fishery has an operational overlap with the Dorrigo MSS of ~ 622 km^2 in shelf break waters between 140-270 m water depths. The Dorrigo MSS is coincident with the opening of the fishery, however while the fishery is open all year round, seasonal effort along the west coast is lowest August to October and highest November to February (SETFIA/Fishwell Consulting, 2018). Individual fishermen have advised that the period September to November is the windiest in the area. One fisherman (**Stakeholder No: 39**) advised that he fishes for giant grab within the Dorrigo MSS area from the Marine Park boundary to the south of the proposed survey area. Fishing occurs between November and March and there is also a June run. Another fisherman (**Stakeholder No 50**) also identified fishing within the southern area of the Dorrigo MSS, however no further detail has been provided.

The giant crab fishery is a 'pot' fishery in continental slope waters. Displacement of activities can be avoided by coordinating each party's activities so as not to restrict either party, particularly given the coincident area is so small. If the Dorrigo MSS results in the displacement of Tasmanian giant crab fishermen, there is potential for localised and short-term impacts (Minor consequence), however given there is only a small area of overlap, the Dorrigo MSS is undertaken during the low effort season for the fishery and with good communication controls, spatial conflict is considered unlikely (low residual impact).

Impacts to Matters of National Environmental Significance:
The potential interference between MSS and third-party vessels is not an impact which is covered by matters of NES as outlined below:

Nationally threatened species	Nationally threatened ecological communities (i.e Giant Kelp Forests & Sub-tropical and temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
X	X	X	X
Not Applicable	Not Applicable	Not Applicable	Not Applicable
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
The potential interference with third party vessels in the Dorrigo MSS is not a hazard which impacts on an area of conservation significance as outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	Wetlands of International and National Importance	Commonwealth Marine Reserves (CMR)	Coastal protected areas
X / X	X	X	X
Not Applicable	Not Applicable	Not Applicable	Not Applicable

7.8.4 Environmental Risk Assessment

Table 7-46 provides the environmental risk assessment for interference with third party vessels.

Table 7-46: ERA for displacement of commercial vessels and fishing equipment damage.

Aspect	Survey vessel activity in the Dorrigo MSS area
Impact Summary	Vessel navigation disruption, displacement from fishing grounds, damage to fishing equipment and loss of equipment catch.
Extent of Impact	Localised around the survey vessel
Duration of Impact	Temporary (in any one spot) and recoverable
Level of Certainty of Impact	HIGH. Information is based upon consultation feedback and published literature.
Species possibly affected within survey environment:	**Commercial (merchant) vessels** – primarily within the northern part of the Dorrigo MSS area. **Commercial fisheries** – Commonwealth – CTS, GHaT; Victoria – SRL & giant crab; Tasmania – SRL & giant crab.

<table>
<tr><td>Impact Decision Framework Context</td><td colspan="4">Decision Context B
The Dorrigo MSS area overlaps six commercial fisheries with various levels of impact and transiting vessels. Consultation with fisheries to determine the potentila for impact has been ongoing since March 2018 for the Dorrigo MSS. Previous MSS activity in the permit – the Flanagan MSS (2014) also consulted similar stakeholders. Concerns regarding seismic have been heightedn amongst fishers, particularly since the McCauley et al, 2017 plankton paper. While most fisheries have a closed season, these do not temporally align amongst all fisheres which utilise the area. The MSS survey window overlaps available closure periods to avoid spatial conflicts and is generally in the low catch months or all fisheries. The management of vessel interactions is well regulated and seismic surveys have been successfully undertaken with fishers being able to access areas prior to and after they have been surveyed. As concerns have been raised by relevant stakeholders in regard to displacement from fishing area, 3D Oil believes that decision context B be applied to this hazard.</td></tr>
<tr><th colspan="5">Impact with controls failure (Inherent)</th></tr>
<tr><th>Hazard</th><th colspan="2">Consequence</th><th>Likelihood:</th><th>Risk:</th></tr>
<tr><td>Disruption to Commercial (merchant) Vessels</td><td colspan="2">MINOR</td><td>POSSIBLE</td><td>MEDIUM</td></tr>
<tr><td>CTS – Fishing Disruption</td><td colspan="2">MINOR</td><td>POSSIBLE</td><td>MEDIUM</td></tr>
<tr><td>GHaT – Fishing Disruption</td><td colspan="2">NEGLIGIBLE</td><td>POSSIBLE</td><td>LOW</td></tr>
<tr><td>SRL (Victoria) – Fishing Disruption</td><td colspan="2">NEGLIGIBLE</td><td>POSSIBLE</td><td>LOW</td></tr>
<tr><td>Giant Crab (Victoria) – Fishing Disruption</td><td colspan="2">NEGLIGIBLE</td><td>POSSIBLE</td><td>LOW</td></tr>
<tr><td>SRL (Tas) – Fishing Disruption</td><td colspan="2">MINOR</td><td>POSSIBLE</td><td>MEDIUM</td></tr>
<tr><td>Giant Crab (Tas) – Fishing Disruption</td><td colspan="2">MINOR</td><td>POSSIBLE</td><td>MEDIUM</td></tr>
<tr><th colspan="5">ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)</th></tr>
<tr><th>CONTROL MEASURE</th><th>CONTROL TYPE</th><th colspan="2">PRACTICABLE AND IMPLEMENTED</th><th>JUSTIFICATION</th></tr>
<tr><td>Adherence to the requirements of the Navigation Act 2012 and specifically Marine Order Part 30: Prevention of collisions</td><td>Prevent (engineering/ administrative control)</td><td colspan="2">YES</td><td>Good Practice – well defined and established standard practice by the offshore petroleum sector. Environmental benefits outweigh cost.
Control adopted.</td></tr>
<tr><td>Issue of marine navigation warnings and notice to mariners of survey presence and towed array (and establishment of a safety zone around vessel)</td><td>Prevent (administrative control)</td><td colspan="2">YES</td><td>Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. Environmental benefits outweigh cost.
Control adopted</td></tr>
<tr><td>Support vessel is available to manage vessel interactions</td><td>Prevent (Administrative/ control)</td><td colspan="2">YES</td><td>Good Practice – well defined and established standard practice by the offshore petroleum sector. Environmental benefits outweigh cost.
Control adopted.</td></tr>
</table>

All marine crew are appropriately trained to detect and interact with commercial shipping if this poses a threat to the survey	Prevent (Administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. *Environmental benefits outweigh cost.* **Control adopted**
Trailing equipment will be identified, and day shapes displayed to identify the survey activity	Prevent (Administrative)	YES	Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. *Environmental benefits outweigh cost.* **Control adopted.**
Seismic acquisition will only occur outside areas with substantial commercial vessel movements (e.g. recognized shipping routes)	Eliminate	NO	This would create large gaps in survey data coverage with substantial costs require to fill those gaps. An infill acquisition would be required at a future date with possible increased vessel traffic in the area. *Greater potential environmental impacts with the adoption of this control.* **Control not adopted.**
Seismic acquisition will only occur during daylight hours to provide for visual identification	Prevent (Administrative control)	NO	Measure would double survey duration and 3D Oil which would encroach upon high productivity upwelling periods with higher environmental impacts. If equipment was deployed and retrieved daily, survey objectives would not be realised as the time taken to deploy and retrieve is greater than the daylight hours. **Control not practicable.**
Use of automatic radar plotting aid (ARPA) to calculate objects course and closest point of approach	Prevent (Administrative control)	YES	Good Industry Practice. ARPA is standard equipment on-board survey vessels to facilitate awareness of potential collisions. *Environmental benefits outweigh cost.* **Control adopted.**
Consult and inform fishery stakeholders of survey activity to identify controls to prevent disruption/ displacement.	Prevent (Administrative control)	YES	Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. *Environmental benefits outweigh cost.* **Control adopted.**
Streamer deployment occurs away from known areas of fishing effort to avoid any spatial conflicts	Eliminate	YES	Good Practice – well defined and established standard practice adopted by the Offshore Petroleum Industry. *Environmental benefits outweigh cost.* **Control adopted.**

Fishing Compensation for Temporarily displaced/ damaged Fishing Equipment	Mitigate (Administrative)	NO (Displacement)/YES (Equipment Damage)	The Dorrigo MSS area does not represent primary fishing grounds for any of the fisheries present in the area. All fishing impacts have been identified through sceintific literature to be localised and incidental to the species (i.e. SRL, crab) or to be localised, temporary and recoverable (CTS, GHaT target species). The timeframe of the Dorrigo MSS also does not represent the 'major catch' period for fish/invertebrate species. Given the assessed lack of impact to fisheries, 3D Oil considers fishing compensation for displacement is warranted. **Control not adopted.** 3D Oil will compensate any fishermen for fishing equipment damaged as a result of Dorrigo MSS activities. **Control adopted.**
Undertake survey outside key 'catch' fishing periods.	Eliminate	YES	The Dorrigo MSS timeframe has been established to avoid highly productivity (upwelling) periods which also lead to increased fishery catch. There is no one period where all fisheries are excluded. The Dorrigo MSS temporally overlaps seasonal closures of giant crab and SRL fisheries where these exist. The period September 1 to October 31 avoids high catch periods for all fisheries present and has been adopted for the Dorrigo MSS. A temporal assessment of active fisheries within the Dorrigo MSS area is provided in **Table 7-45**). *Environmental benefits outweigh cost.* **Control adopted.**
Seismic acquisition will occur outside any fishing grounds	Eliminate	NO	The Dorrigo MSS area overlaps active fishing grounds. Not undertaking survey over this area would result in significant gaps in data and not meet the objectives of the survey. Impacts to fisheries from survey activities have been assessed as locatised, temporary and recoverable. *Cost out-weighs any environmental benefits.* **Control not adopted.**
Provide notice to fisheries of impending survey commencement (one month prior) to allow for fish harvest within the Dorrigo MSS area prior to if possible, or after, survey operations.	Eliminate	Yes	Good Practice – well defined and established standard practice adopted by the Offshore Petroleum Industry. *Environmental benefits outweigh cost.* **Control adopted.**

Provide daily updated forward plan and near real-time web-based seismic vessel positioning to inform fishing activities and SMS notification of activity.	Prevent (Administrative Control)	Yes	Good Practice – well defined and established standard practice adopted by the Offshore Petroleum Industry. *Environmental benefits outweigh cost.* **Control adopted.**

Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Disruption to Commercial (merchant) Vessels	MINOR	UNLIKELY	LOW
CTS – Fishing Disruption	MINOR	UNLIKELY	LOW
GHaT – Fishing Disruption	NEGLIGIBLE	VERY UNLIKELY	LOW
SRL (Victoria) – Fishing Disruption	NEGLIGIBLE	UNLIKELY	LOW
Giant Crab (Victoria) – Fishing Disruption	NEGLIGIBLE	UNLIKELY	LOW
SRL (Tas) – Fishing Disruption	MINOR	VERY UNLIKELY	LOW
Giant Crab (Tas) – Fishing Disruption	MINOR	UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
Survey is undertaken such that no unplanned incidents of spatial conflict* with a commercial vessel (fishing or merchant) occurs during the Dorrigo MSS. ** Defined as a MSS significantly vessel deviating from a seismic line due to the presence of a commercial vessel; or complaint by third-party vessel to Dorrigo MSS vessel.* .	*Navigation Warning*: AMSA RCC will be notified of survey activities 24-48 hours before operations commence, at survey commencement and at completion. A daily notification of position is made to the RCC and a vessel exclusion zone applied to the activity.	Available records verify AMSA RCC notifications have been made. <u>Responsibility</u>: Vessel Master
	Notice to mariners The Australian Hydrographic Service (AHS) is advised 4 weeks prior to Dorrigo MSS commencement to allow for the issue of a Notice to Mariners	Records verify that Notice to Mariners issued by AHO prior to Dorrigo MSS commencement. <u>Responsibility</u>: 3D Oil Exploration Manager
	Vessel Hardware Requirements Survey vessels conform to the hardware requirements of AMSA: • *Marine Order 30: Prevention of Collisions* for AIS, navigation lighting, sound signals, day shapes, and ARPA[60] and • *Marine Order 27: Safety of Navigation and radio equipment*	Class survey certificate verifies that navigational safety equipment is compliant with the requirements of Marine Order 30 & 27. <u>Responsibility</u>: 3D Oil Exploration Manager
	MSS Warning Display The seismic vessel will display appropriate day shapes, lights and streamers, reflective tail buoys, radar reflectors during the survey so third-party vessels are aware the vessel is in tow and restricted in manoeuvrability	Records verify that warning signals are displayed. <u>Responsibility</u>: Vessel Master

[60] Not required on escort or support vessel.

Survey is undertaken such that no unplanned incidents of spatial conflict* with a commercial vessel (fishing or merchant) occurs during the Dorrigo MSS (Con't) ** Defined as a MSS significantly vessel deviating from a seismic line due to the presence of a commercial vessel; or complaint by third-party vessel to Dorrigo MSS vessel.*	*Vessel Watch* Visual and radar watches to be maintained on the bridge at all times. The Vessel Master and deck officers are appropriately qualified in accordance with AMSA Marine Order 3 (seagoing qualifications) (e.g. *International Convention on Standards of Training, Certification and Watch-keeping for Sea-farers [STCW95], GDMSS proficiency)* (or equivalent according to vessel class) to operate radio equipment to warn of potential unplanned interference between vessels.	Bridge log verifies watch is undertaken 24/7 during survey activities. <u>Responsibility</u>: Vessel Master Training and competency records verify all relevant marine crew are qualified to fulfil required roles. <u>Responsibility</u>: Vessel Manager
	ARPA Availability The survey vessel will be fitted with and make use of an automatic radar plotting aid (ARPA) to calculate third party vessel course and the closest point of approach (CPA) and Automatic Identification System (AIS). The CPA procedure and spatial extent of the CPA will be determined in-field at the commencement of individual surveys (specific to the vessel and tow length). The procedure will incorporate third party communication requirements between the survey vessel and third-party vessels.	Records verify vessel holds current survey certification for the Class type (i.e. confirms required anti-collision monitoring equipment is in place) and that the equipment in on-board, tested and operational. <u>Responsibility</u>: 3D Oil Exploration Manager CPA procedure available for the survey with spatial dimensions identified. Radio logs verify CPA Procedure is implemented. <u>Responsibility</u>: Vessel Master
	Support Vessels A support vessel, with multiple communication methods patrols the area around the streamers to prevent, and to escort, third-party vessels away from interacting with the streamers or are at risk of entering the path/safety zone of the seismic vessel and equipment.	Bridge radio log verifies that support vessels are scouting for third-party vessels. <u>Responsibility</u>: Vessel Master
	Fishing Notifications Based upon consultation information received, fishing stakeholders which may be present in the area are clearly identified for continued liaison and information is provided to these stakeholders through the survey activities (refer **Section 4)**. 3D Oil will keep relevant fishing stakeholders updated on activities on following triggers (minimum requirements): • At least one month prior to survey commencement; • 5 days prior to streamer deployment; • At survey commencement; • Daily SMS of activity; • Website updated for survey activity with 48 hrs look ahead (during survey); and • Survey completion.	Consultation and notification records verify these stakeholders have been informed of MSS activities throughout the survey period. <u>Responsibility</u>: 3D Oil Exploration Manager

Survey is undertaken such that no unplanned incidents of spatial conflict* with a commercial vessel (fishing or merchant) occurs during the Dorrigo MSS (Con't) ** Defined as a MSS significantly vessel deviating from a seismic line due to the presence of a commercial vessel; or complaint by third-party vessel to Dorrigo MSS vessel.*	*Tamar Radio Broadcasts* 3D Oil to contacti TAMAR Radio 4533 to provide daily updates during survey activity.	Notification records verify Tamar Radio has broadcasted details of survey throughout the survey period. Responsibility: 3D Oil Exploration Manager
	Equipment Deployment The survey vessel will deploy/ retrieve equipment away from known fishing areas to avoid fisheries interaction.	Vessel log verifies streamer deployment occurs in deep waters which are non-active fishing areas (Depths <1000 m). Responsibility: Vessel Master
	Bad Weather Refuge 3D Oil will place within seismic vessel tender that the vessel will either stand out to sea or pull in streamers in the event of bad weather.	Seismic Vessel tender contains this information and relevant protocols are accepted in the HSE Plan. **Responsibility: 3D Oil Project Manager**
	Survey Timeframe The Dorrigo MSS is undertaken in the period 1 September to 31 October to prevent spatial conflicts with active fisheries as far as practicable.	Vessel log verifies seurvey is undertaken within this period. **Responsibility: Vessel Master**
	Equipment Damages 3D Oil will compensate for fishing equipment damage incurred to active fishermen within the Dorrigo MSS area during the survey period.	Incident and claims records. **Responsibility**: 3D Oil Project Manager
Demonstration of ALARP		
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).	
ALARP Statement	All known controls have been adopted.	
Demonstration of Acceptability		
Internal Context: 3D Oil Policy compliance	The risk management strategy for managing spatial conflict with third party vessels reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.	
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Consultation (**Section 4**) • Contractor & Supplier Management (**Section 8.7**); • Notification & Reporting (**Section 8.11**).	
External Context: Natural Environment	Environmental Significance: Dorrigo MSS overlaps six active fisheries. Natural environment is identified as having habitat for giant crab. Key Ecological Features: Not Applicable.	

External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**). The following stakeholder concerns have been raided with respects to spatial conflicts: • CTS (**Stakeholder No 12**) requested the southwest corner of the Dorrigo MSS area be removed. 3D Oil assessed this and identified to the CTS that assessment of the target was critical to the survey and if not assessed during the Dorrigo MSS would potentially be assessed as part of a future survey activity. SETFIA acknowledged that acquiring the whole area was preferable to a subsequent MSS. Issue was resolved. • SSF (**Stakeholder No 13**) expressed concern around the seismic vessel sheltering during bad weather and damage it caused to fishing equipment. 3D Oil agreed that within the vessel tender, 3D Oil would request that the seismic vessel stand out to sea or pull in streamers so it did not tear up fishing gear as it came into shallow water. This was accepted by the stakeholder. • Other fishermen had concerns relating to the MSS, however this related to the noise impacts to stock and not the spatial disruption during fishing activity. Given the controls adopted, 3D Oil considers that there is broad acceptability of the spatial conflict risk associated with this activity.
Legislation and Conventions	In adopting controls to prevent spatial conflict with commercial vessels, 3D oil has complied with the following legislative provisions. Act/Statutes: • *Offshore Petroleum & Greenhouse Gas Storage Act 2006* Section 280 (Interference with other rights): *A person carrying on activities in an offshore area under an authority must carry on those activities in a manner that does not interfere with (a) navigation; or (b) fishing; or (c) the conservation of the resources of the sea and seabed; or (d) any activities of another person being lawfully carried on; or (e) the enjoyment of native title rights and interests; to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.* Control measures adopted ensure that interference with commercial vessels is reduced to levels which are as low as reasonably practicable. • *Navigation Act 2012* ○ Marine Order 3 (Seagoing Qualifications) ○ Marine Order 27 (Safety of navigation and radio equipment) ○ Marine Oder 30 (Prevention of Collisions) ○ Marine Order 58 (Safe Management of Vessels) International Conventions: • International Regulations for Preventing Collisions at Sea 1972 • International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW) SE Marine Reserves Network Management Plan: Not Relevant South-east Marine Region Profile: Not Relevant Recovery/Conservation Plans & Advices: Not Relevant Threat Abatement Plans: Not triggered by this hazard.
Industry Standards	Compliance with industry standards: APPEA CoEP & IAGC Environment Manual.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with spatial conflict with commercial vessels/equipment during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, spatial disruption to fishing activities should not occur. This is acceptable as survey activities will not interfere with fishing activities to a greater extent than it is necessary for the reasonable exercise of acquiring seismic.
Environmental Monitoring	
Support/escort vessel patrol for third-party vessels during survey Bridge log verifies 24/7 surveillance for third party vessels	

Record Keeping
Stakeholder Consultation Records (AMSA, AHS, Fisheries)
Class certification for anti-collision and safety navigation equipment
STCW (or equivalent) Certificates [Marine Crew)
Vessel Log/Bridge Log (including support vessels)
Closest point of approach (CPA) procedure
48 hr "look-ahead" records
SMS records
Incident/claims records

7.9 RISK: Waste Overboard Incident

7.9.1 Hazard

Both non-hazardous and hazardous wastes will be generated on the vessels during the survey. With the exception of food scraps (refer **Section 7.5**) and wastes that can be incinerated (refer **Section 7.6**) all wastes will be sent to shore for recycling or disposal.

Solid non-biodegradable/hazardous wastes on-board vessels are handled in accordance with the vessel's Garbage Management Plan with a 'no solid non-biodegradable/hazardous waste overboard' policy. Routine protocols for waste disposal (excluding MARPOL compliant discharges) is disposal at appropriately licensed onshore facilities, by licenced contractors, so impacts to the marine environment are eliminated. Therefore in normal circumstances, no impacts to the marine environment should occur. However, accidental release to the marine environment is possible especially in rough seas when items may roll off or be blown (packaging materials) from the deck.

Solid non-biodegradable wastes include:
- Paper and cardboard;
- Wooden pallets;
- Scrap steel, metal, aluminium, paint cans;
- Glass; and
- Plastics and ropes.

Hazardous wastes include:
- Hydrocarbon contaminated materials (e.g., oily rags, oil filters, hydraulic oils); and
- Batteries, empty paint cans, cleaning products, aerosol cans, fluorescent tubes.

7.9.2 Known and Potential Impacts

Potential impacts associated with the accidental release of solid/non-biodegradable wastes include:
- Disturbance (smothering or pollution) of seabed habitats;
- Injury, ingestion or entanglement by marine fauna (i.e. plastics by turtles and seabirds);
- Hydrocarbon-contaminated wastes resulting in localised water quality reduction (including toxics); and
- Litter (visual pollution).

Area affected by impact: The area which could be affected by accidental waste loss overboard may extend for kilometres from the release site (as buoyant waste drifts with the currents) or localised for non-buoyant material sinking to the seabed. The Dorrigo MSS area is located within Commonwealth waters.

Possible environment/receptors affected by impact:
Receptors present and at risk from accidental release of wastes overboard are:

- Benthic species and habitat;
- Pelagic fish;
- Marine mammals;
- Marine turtles; and
- Seabirds.

7.9.3 Evaluation of Environmental Risk

Hazardous Materials/Waste
Hazardous materials/wastes released to the sea may cause water quality reduction and contamination, with either direct or indirect effects on marine organisms. Impacts from an accidental release would be limited to the immediate area surrounding the release point, prior to dilution with the surrounding seawater. In an open ocean environment such as the Dorrigo MSS area, it is expected that any minor release would be rapidly diluted and dispersed, and thus impacts are temporary and localised.

Solid hazardous materials (e.g. paint cans, batteries) are expected to settle on the seabed if dropped overboard. Over time, this may result in the leaching of hazardous materials to the seabed, which may result in a small area of substrate becoming unsuitable for colonisation by benthic fauna. Given the possible size of materials release it is expected that only very localised impacts to benthic habitats would be affected and unlikely to contribute to a significant loss of benthic habitat or species diversity.

Non-hazardous Materials/Waste
Discharged overboard, non-hazardous wastes can smother benthic habitats and cause injury or death to marine fauna/seabirds through ingestion or entanglement (e.g., plastics). For example, the TSSC (2015a) identifies that there have been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion since 1998 (humpback whales are the main species).

If dropped objects such as bins are not retrievable, these items permanently smother very small areas of seabed, resulting in the loss of benthic habitat. However, as with most hard, subsea structures, the items themselves are likely to become colonised by benthic fauna over time and become a focal area for sea life, so the net environmental impact is likely to be neutral. This would affect extremely localised areas of seabed and would be unlikely to contribute to the loss of benthic habitat or species diversity.

Impacts to Matters of National Environmental Significance:

The accidental release of waste to the marine environment is not assessed as having a 'significant' impact on matters of NES, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Forests & Subtropical and Temperate Coastal Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Small quantities of waste that settles on the seabed or floats will not result in any 'significant impacts' to populations of threatened fauna.	These TECs are distant from the MSS area and will not be affected by waste incidents overboard.	Migration, feeding, resting or breeding activities to a migrating population will not be impacted by small quantities of waste that settle on the seabed or floats will not.	Given the small volume of material released the localised discharge will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. It also does it result in a substantial change in water quality adversely impacting on biodiversity or ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:

Potential impacts to areas of conservation significance associated with accidental release of waste overboard is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and National Westlands of Importance	Commonwealth Marine Park (CMP)	Coastal protected areas
✓ / ✓	X	✓	X
It is possible that accidental release of waste overboard may impact upon these KEFs, however given the small localised area of impact will not result in '*disturbance to a substantial area of habitat such that an adverse impact on ecosystem functioning or integrity occurs*'. Nor does it result in a substantial change in water quality which would adversely impacting on biodiversity or ecological integrity.	There are no international of nationally important wetlands within the impact area for this hazard.	Temporary and localised reduction in water quality is possible within the upper water column in the CMP; or localised impacts to benthic habitat within the Zeehan CMP if waste is accidently released. This localised release will not result in a significant impact to benthic habitats in the CMP nor impact on conservation values within the CMP.	Coastal protected areas are outside the area affected by a waste overboard release.

7.9.4 Environmental Risk Assessment

Table 7-47 provides the ERA for a hazardous/non-hazardous waste overboard incident.

Table 7-47: ERA for release of waste overboard.

<table>
<tr><td>Aspect</td><td colspan="4">Release of waste overboard to the marine environment</td></tr>
<tr><td>Impact Summary</td><td colspan="4">• Localised decrease in water quality with possible impacts to marine biota (e.g. fish plankton).
• Injury or damage to individual marine fauna through ingestion of plastics.
• Localised seabed smothering or contamination by non-buoyant solid hazardous waste;
• Visual impacts to other marine users.</td></tr>
<tr><td>Extent of Impact</td><td colspan="4">In general, if incident occurs this will generally result in localised impacts around point of discharge. Solid, buoyant materials may be dispersed by local currents and may travel long distances, but volumes will be small.</td></tr>
<tr><td>Duration of Impact</td><td colspan="4">Short-term (water quality impact). Longer term (seabed smothering, species ingestion)</td></tr>
<tr><td>Level of Certainty of Impact</td><td colspan="4">HIGH. Impacts from waste disposal overboard (particularly plastics) has been well studied and documented. This is verified through the production of regulatory guidelines for threat abatement from marine debris.</td></tr>
<tr><td>Species possibly affected within survey environment:</td><td colspan="4">○ For water quality impacts: Plankton and Fish (not protected)
○ For benthic impacts (continental shelf environment, Zeehan CMP): Porifera, ascidians and bryozoans.
○ For buoyant materials at the sea surface: Marine seabirds, whales and turtles (protected).</td></tr>
<tr><td>Impact Decision Framework Context</td><td colspan="4">Decision Context A
The use of vessels and management of vessel waste is well practiced and understood. There is little uncertainty associated with this aspect and vessel waste is well regulated. No objections or concerns were raised by relevant stakeholders regarding waste management. Consequently decision context A will be applied to this aspect.</td></tr>
<tr><td colspan="5">Impact with controls failure (Inherent)</td></tr>
<tr><td>Hazard</td><td colspan="2">Consequence</td><td>Likelihood:</td><td>Risk:</td></tr>
<tr><td>Fauna Impact (Ingestion)</td><td colspan="2">SIGNIFICANT</td><td>POSSIBLE</td><td>MEDIUM</td></tr>
<tr><td>Seabed impact</td><td colspan="2">MINOR</td><td>POSSIBLE</td><td>MEDIUM</td></tr>
<tr><td>Water Quality Impact</td><td colspan="2">MINOR</td><td>POSSIBLE</td><td>MEDIUM</td></tr>
<tr><td colspan="5">ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)</td></tr>
<tr><td>CONTROL MEASURE</td><td>CONTROL TYPE</td><td>PRACTICABLE AND IMPLEMENTED</td><td colspan="2">JUSTIFICATION</td></tr>
<tr><td>Compliance with Protection of the Seas (Prevention of Pollution from Ships) Act 1983 and Marine Order – Part 95 – Garbage</td><td>Prevent (engineering/ administrative control)</td><td>YES</td><td colspan="2">Good Practice – well defined and established standard practice by the offshore petroleum sector. Control Adopted.</td></tr>
<tr><td>All wastes will be segregated into clearly marked containers for onshore disposal in accordance with the Garbage Management plan.
Containers shall have tightly fitting, secure lids to prevent solid wastes from blowing overboard.</td><td>Prevent (isolation control)</td><td>YES</td><td colspan="2">Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. Environmental benefit outweighs cost. Control adopted.</td></tr>
</table>

Waste storage areas shall be routinely inspected, and high levels of housekeeping maintained.	Prevent (Administrative/ control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. Environmental benefit outweighs cost. **Control adopted.**
All vessel crew are inducted into the garbage management arrangements on-board survey vessels.	Prevent (Administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. Environmental benefit outweighs cost. **Control adopted.**
Immediate removal of the garbage from the survey vessel to a shore-based facility to prevent 'overboard' incidents.	Eliminate	NO	This would result in additional fuel usage (emissions increase) and increased risk associated with the increased number of waste transfer events between vessels. The additional impacts and risks are not considered a suitable alternative to secure storage on the survey vessel. Control not practical.
For wastes considered suitable for incineration according to the vessel's Garbage Management Plan, ensure that wastes are incinerated on an "as soon as practicable" basis.	Eliminate	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector. Environmental benefit outweighs cost. **Control adopted.**
Incinerate wastes generated on-board the survey vessel.	Eliminate	Yes (for relevant wastes)	Incineration of materials not listed within the Garbage Management Plan as being suitable for incineration may lead to toxic emissions and contaminated ash material to the environment. This may have health impacts to personnel and will be non-compliant with MARPOL legislation. **Control adopted**.

Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Fauna Impact (Ingestion)	SIGNIFICANT	VERY UNLIKELY	LOW
Seabed Impact	MINOR	VERY UNLIKELY	LOW
Water Quality Impact	MINOR	VERY UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
To protect marine species and habitats, no release of hazardous or solid wastes from vessels will occur during the Dorrigo MSS.	*Garbage Management Plan* Survey vessels will operate under an approved Vessel Garbage Management Plan(s) (applicable to vessels >100 GRT or certified to carry more than 15 people).	Records verify that Survey Vessel Garbage Management Plan meets these IMO requirements. Responsibility: Vessel Master

To protect marine species and habitats, no release of hazardous or solid wastes from vessels will occur during the Dorrigo MSS (Con't).	*Waste Handling & Segregation* Handling of solid and hazardous wastes on-board the survey and support vessels will ensure waste storages reflect the following standards: • No discharge of general operational or maintenance wastes or plastics; • Waste containers are tightly covered; • All solid, liquid and hazardous wastes (other than bilge water, sewage and food wastes) are incinerated or compacted (if possible) and stored in designated areas before being sent ashore for recycling, disposal or treatment; • Deck liquid waste storages must have at least one barrier (i.e. bunding) to prevent deck spills entering the marine environment. • Correct segregation of solid and hazardous wastes	Inspection records verify that hazardous and solid wastes are being stored and handled to prevent overboard incidents. <u>Responsibility</u>: Vessel Master
	Crew Members Environmental Induction Crew members are inducted into garbage management procedures to minimise the potential for unpermitted wastes being discharged overboard and to ensure effective waste segregation	Induction records verify that all crew personnel are aware of these requirements. <u>Responsibility</u>: Vessel Master

Demonstration of ALARP	
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).
ALARP Statement	No additional, alternative and improved control measures would dprovide further environmental benefit.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The risk management strategy for managing waste reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); • Competence and Awareness (**Section 8.4**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	<u>Environmental Significance:</u> The Dorrigo MSS is located in open ocean which spatially overlaps foraging BIAs for threatened/migratory seabirds. These species are particularly sensitive to marine debris (particularly plastics). The MSS area also spatially overlaps a BIA for blue whale foraging. The MSS is not present during this period but marine debris may affect the health of these species. <u>Key Ecological Features</u>: As above for assessed conservation values, accidental release of waste overboard may result in localised contamination within the KEFs. <u>Zeehan CMR</u>: Conservation values for the Zeehan CMR include migrating whales (humpback and blue) and foraging seabird BIAs (petrels/albatross/shearwaters). Marine debris is a significant concern for these species (refer to conservation advices below).
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with no issues raised with respect to accidental waste releases from vessels. Given the controls adopted and the lack of feedback from stakeholders, 3D Oil considers that there is broad acceptability of the accidental release risk associated with this activity.

<table>
<tr><td>Legislation and Conventions</td><td>The Dorrigo MSS waste management controls comply with the requirements of the following legislative provisions:

<u>Act/Statutes</u>:
• Navigation Act 2012
• Protection of the Sea (Prevention of Pollution from Ships) Act 1983
• Marine Order 94 (Marine Pollution Prevention – Packaged Harmful Substances)
• Marine Order 95 (Marine Pollution Prevention – Garbage)
<u>International Conventions</u>:
• International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78)
<u>SE Marine Reserves Network Management Plan (2013-2023)</u>:
• MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1).
• Waste disposal meets Plan requirements of MARPOL implementation (refer Section 5.3.3)
<u>South-east Marine Region Profile:</u> No specific references in plan which relate to waste disposal.
<u>Recovery/Conservation Plans & Advices</u>
• Conservation advice for cetaceans (humpback whales); hooded plover (TSSC, 2014); Recovery plan for marine turtles (DoEE, 2017); Recovery plan for threatened albatross and petrels all identify marine debris as a threat. Controls listed and implemented in the survey eliminate marine debris from MSS activities entering the environment
<u>Threat Abatement Plans</u>: The Threat Abatement Plan for the impacts of marine debris on vertebrate marine life (DoEE, 2018bc) identifies that shipping waste management is a priority area with actioned identified to have less waste discarded from vessels. Control sliste align with these requirements.</td></tr>
<tr><td>Industry Standards</td><td>Compliance with industry standards: APPEA CoEP & IAGC Environment Manual.</td></tr>
<tr><td>Indusrt Standards/Good Industry Practice</td><td>APPEA CoEP: Objectives met for MSS with respect to reducing the risk of release of substances into the marine environment to a level which is ALARP and acceptable by:
• Demonstrating appropriate management measures are in place and implemented; and
• Wastes are disposed in accordance with statutory requirements and agreed procedures.
IAGC: The stated controls are compliant with the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.5 Waste Management).</td></tr>
<tr><td>ESD principles</td><td>There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with accidental release of waste during the Dorrigo MSS.

The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer Section 2.2)</td></tr>
<tr><td>Acceptability Assessment:</td><td>With controls adopted, no solid or hazardous waste will be released overboard from vessels involved in the Dorrigo MSS. This aligns with the requirements of the TAP for theimpacts of marine debris on vertebrate marine life (DoEE, 2018); marine species conservation and recovery plans for marine debris; and the implementation of MARPOL requirements as outlined in the SE Marine Network Management Plan for CMRs. Inplementation of these controls will result in:

• No injury to seabirds, shorebirds; turtles; and marine mammals;
• Maintains the ecological integrity of KEFs present in the MSS area;
• Preserves the conservation values in the Zeehan CMP; prevents sihnificant impacts to the benthic habitat within the CMP and is consistent with the IUCN principles which provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species.</td></tr>
<tr><td colspan="2">Environmental Monitoring</td></tr>
<tr><td colspan="2">Nil</td></tr>
<tr><td colspan="2">Record Keeping</td></tr>
</table>

Garbage Management Plan(s) Crew induction and attendance records Garbage Record Book Vessel Housekeeping Inspections Shore-based Waste Contract Incident Reports

7.10 RISK: Equipment (Seismic Streamer) Loss

7.10.1 Hazard

The loss of towed equipment during MSS activities may result in seabed disturbance.

7.10.2 Known and Potential Impacts

Potential impacts associated with the accidental loss of a seismic streamer include:

- Disturbance (smothering) of seabed habitats; or
- Marine hazards leading to impacts to third party vessels or equipment damage (e.g fishing equipment).

Area affected by impact: The area which could be affected by a streamer loss is within the Dorrigo MSS area located in Commonwealth waters.

Possible environment/receptors affected by impact:

Receptors which may occur within this area and are at risk from streamer loss are:

- Benthic species and habitat (i.e. KEFs – West Tasmanian Canyons and Shelf Rocky Reefs and Hard Substrates); and
- Third party vessels.

7.10.3 Evaluation of Environmental Risk

Disturbance to Benthic Habitats: The Dorrigo MSS is spatially coincident with two KEFs, both containing diverse bentic habitats which comprise of sponges, sites for macroalgal attachment and sessile invertebrates (DoE, 2015). These structures provide structural habitat for fish and crustaceans (DoE, 2015).

Seabed disturbance is not planned for tis survey given the solid streamers to be utilised in the Dorrigo MSS are positioned in the water column by depth controllers (‘birds’). The streamers are also fitted with pressure activated, self-inflating buoys designed to bring the equipment to the surface if accidentally lost during a survey. As the steamer sinks it passes a certain water depth (hydrostatic pressure equivalent to ~40 m depth) at which point the buoys inflate (via a compressed CO_2 gas cartridge) and bring the equipment back to the surface where it can be retrieved by the seismic or support vessel. A tail-buoy is connected to each of the streamers to provide both a hazard warning (lights and radar reflector) of each submerged towed streamer between the tail-buoy and vessel, and to act as a platform for the positional systems of the streamer (i.e. housing a Differential Global Positioning System (GDPS) receiver.

In the unlikely case that the streamer was not recovered, localised impacts to benthic habitats would occur due to the size of the object interacting with the seabed. As recovery of the streamer would be expected, impacts would be short-term (Minor consequence). Given the controls present on the streamer to prevent benthic impacts (refer **Table 7-48**), the loss of a streamer making contact with the seabed is considered unlikely (LOW residual risk).

Damage to Third-Party Vessels/Equipment: As described in **Section 7.8**, the Dorrigo MSS overlaps commercial fishing and shipping areas. In the unlikely event that a streamer was lost and unable to be recovered, there is potential for the equipment to snag demersal trawl operations which occur in the south-west section of the Dorrigo MSS area. This could lead to damage to trawl equipment. To prevent this , the location of any unrecovered equipment would be communicated to the fishery (CTS). No damage would be expected to other fisheries (i.e. SRL / giant crab) who fish in the Dorrigo MSS area.

Equipment damage to trawl equipment might result in damages < $1M (negligible consequence). For this impact to be realised, equipment would need to be lost and not recovered, and a CTS trawler would need to intested the equipment which is considered unlikely (LOW residual risk).

Impacts to Matters of National Environmental Significance:
Accidental release of equipment to the marine environment will not have a 'significant' impact to any of the matters of NES as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
X	X	X	✓
Equipment that settles on the seabed or floats will not result in any 'significant impacts' to populations of threatened fauna.	Equipment that settle on the seabed or float will have no significant effects on this TEC.	Migration, feeding, resting or breeding activities will not be impacted by equipment that settles on the seabed or floats with current.	Given the limited size of equipment released it will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality adversely impacting on biodiversity or ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts from an accidental release of equipment to areas of conservation significance within the Dorrigo MSS are outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and Nationally Important Wetlands	Commonwealth Marine Parks (CMP)	Coastal protected areas
✓ / ✓	X	✓	X

It is possible that accidental equipment release may impact upon these KEFs, however given the limited size of impact, it is not expected to result in disturbance to a substantial area of habitat such that an adverse impact on ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality which would adversely impacting on biodiversity or ecological integrity.	Lost equipment is unlikely to enter nationally important wetlands along the coast.	Localised impacts to benthic habitat within the Zeehan CMR is possible if equipment is accidently released in that area. This localised release will not result in impacts to conservation values within the CMR.	Coastal protected areas are outside the area affected by an equipment release.

7.10.4 Environmental Risk Assessment

Table 7-48 provides the ERA for an equipment release (i.e. streamer) incident.

Table 7-48: ERA for release of equipment to marine environment.

Aspect	Loss of towed equipment (seismic streamer) in the marine environment		
Impact Summary	• Marine hazard, causing potential damage to third party vessels. • Localised benthic habitat disturbance.		
Extent of Impact	Localised impact around the equipment loss area.		
Duration of Impact	Short-term (streamer retrieved), long-term (equipment not recovered)		
Level of Certainty of Impact	HIGH. The effects of loss of seismic streamers have been studied and measures to prevent their loss to the environment includes as standard industry practice.		
Species possibly affected within survey environment:	○ For benthic impacts (continental shelf environment, Zeehan CMP): Porifera, ascidians and bryozoans. ○ For materials within the water column/seabed – third party vessels.		
Impact Decision Framework Context	**Decision Context A** Seabed disturbance is not a planned aspect of this activity. As such there is an inherently low risk that seabed disturbance would occur. As the events that could create seabed disturbance are known and well understood, there is a high level of certainty that the event would result in a limited environmental impact. Two KEFs are present within the MSS area, with the survey spatially overlapping only small areas of both KEFs. The Zeehan CMR (Multi-use zone) also overlaps the MSS area. However, any unplanned disturbance would be small in extent, and very unlikely to impact the West Tasmanian Canyon KEFs with a greater chance of impacting (diue to spatial overlap with the Zeehan CMR and Shelf rosky reef and hard substrate KEF. As seabed disturbance is not a planned component of this activity, and as no objections or concerns were raised by relevant stakeholders regarding lost equipment, decision context A will be applied to this aspect.		
Impact with controls failure (Inherent)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Marine Hazard	NEGLIGIBLE	POSSIBLE	LOW
Benthic Habitat Disturbance	MINOR	POSSIBLE	MEDIUM
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Procedures used to deploy and retrieve seismic streams to prevent loss.	Prevent (administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted.**

Streamer equipment is fit-for-purpose.	Prevent (isolation control)	YES	Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. **Control adopted**
Streamers are fitted with equipment which allows for recovery (streamers self-inflating.	Prevent (Engineering control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted.**
Where-ever possible lost in water equipment will be recovered.	Mitigate	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector. **Control adopted**
Recording and reporting of incidents involving loss of equipment (e.g. streamer loss).	Reduce (Administrative Control)	YES	Good Practice – well defined and established standard practices adopted by the offshore petroleum sector. **Control adopted.**

Impact consequence with controls (residual)

Hazard	**Consequence**	**Likelihood:**	**Risk:**
Marine Hazard	NEGLIGIBLE	UNLIKELY	LOW
Benthic Fauna Impact	MINOR	UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS

EPO	**EPS**	**MEASUREMENT CRITERIA**
No impacts to benthic habitats or the marine environment from lost streamers/equipment unrecovered loss of equipment	*Deployment/Retrieval Procedures* The survey vessel will operate under approved procedures for streamer deployment and retrieval and these procedures are adhered to at all times.	Approved procedures are available and used on-board. Responsibility: Survey Party Chief
	Equipment Inspection Streamer equipment (bridles and harnesses) are routinely maintained and inspected for wear and tear to ensure the equipment is fit-for purpose and will not detach during MSS activities.	Inspection records verify streamers are fit-for-purpose. Responsibility: Survey Party Chief
	Streamer Equipment Streamers will be fitted with the following equipment while they are deployed from the MSS vessel to allow for easy retrieval: • Self-inflating recovery devices • Surface marker buoys • Secondary retaining devices • Radar Reflectors	Equipment deployed meets minimum specification requirements. Responsibility: Survey Party Chief
No impacts to benthic habitats or the marine environment from lost streamers/equipment unrecovered loss of equipment (Con't)	*Dropped Object Management* Support vessels will search for and retrieve in-water equipment loss (where possible). Detailed records maintained of any loss of in-water equipment. If equipment loss is irretrievable maintain records of the circumstances that prohibited equipment recovery	Dropped objects recorded in incident report and vessel log. Responsibility: Survey Vessel Chief
	Marine Stakeholder Notification Marine stakeholder notifications (VHF Channel 16) are made in the event of an in-water equipment loss.	Vessel log records notification on loss of streamer. Responsibility: Vessel Master

	AMSA Notification Loss of equipment will be reported to AMSA as soon as possible of the potential hazard to other mariners.	Incident report to AMSA. <u>Responsibility</u>: Vessel Master
	Stakeholder Complaints All marine stakeholder complaints associated with the in-water equipment loss will be recorded and actioned (as appropriate).	Incident record of complaint. <u>Responsibility</u>: Survey Party Chief
Demonstration of ALARP		
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).	
ALARP Statement	All known control measures have been adopted.	
Demonstration of Acceptability		
Internal Context: 3D Oil Policy compliance	The risk management strategy for managing equipment loss to the marine environment reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.	
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); • Notifications and Reporting (**Section 8.11**); and • Environmental Performance Monitoring & Reporting (**Section 8.12**).	
External Context: Natural Environment	<u>Environmental Significance:</u> The Dorrigo MSS is located in open ocean which spatially overlaps foraging BIAs for threatened/migratory seabirds and a foraging BIA for the blue whale (not temporally coincident with the MSS). A loss of equipment in the MSS area would not significantly impact these conservation values. Note that streamers are not considered marine debris which can be ingested by fauna. <u>Key Ecological Features</u>: As above for assessed conservation values, accidental release of equipment overboard may result in localised impact to the KEFs however it is is not expected to result in disturbance to a substantial area of the KEF such that an adverse impact on ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality affecting biodiversity or ecological integrity. <u>Zeehan CMR</u>: Conservation values for the Zeehan CMR include migrating whales (humpback and blue) and foraging seabird BIAs (petrels/albatross/shearwaters). Equipment overboard is not expected to impact upon these conservation values. <u>Commercial Fisheries:</u> The CTS operates in the south-west corner of the Dorrigo MSS area.	
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with no issues raised with respect to accidental equipment loss from vessels.Given the controls adopted and the lack of feedback from stakeholders, 3D Oil considers that there is broad acceptability of the accidental release risk associated with this activity.	

Legislation and Conventions	The controls adopted fr the loss of equipment in the mare environment complies with the following legislative provisions: Act/Statute: • *Navigation Act 2012* (Section 185 & 186 – Incidents) • *Offshore Petroleum & Greenhouse Gas Storage Act 2006* (S280) – *Interference with Other's Rights* International Conventions: None Identified. SE Marine Reserves Network Management Plan: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1). • The management plan does not detail requirements for equipment loss. South-east Marine Region Profile: No specific references in plan which relate to equipment loss. Recovery/Conservation Plans & Advices: Review and assessment of threatened species recovery plans and conservation advices (refer **Section 5**) has not identified lost equipment as being a threat to these species. No actions apply to in-water equipment loss (not considered marine debris). Threat Abatement Plans: No threat abatement plans are triggered.
Good Industry Practice	**APPEA CoEP:** Objectives met for MSS with respect to reducing the impacts from events such as loss of equipment to a level which is ALARP and acceptable by: • Demonstrating appropriate management measures are in place and implemented; and • Contingency plans are in place in case of loss. **IAGC:** The Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) requirements for deployed equipment and retrieval of lost equipment are satisfied (refer Section 8.8. Vessel Operations).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with accidental release of equipment during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, no streamers/equipment will be released overboard from vessels involved in the Dorrigo MSS. Inplementation of these controls will: • Prevent significant disruption to fisheries through equipment damage; • Maintains the ecological integrity of KEFs present in the MSS area; • Preserves the conservation values in the Zeehan CMP; prevents significant impacts to the benthic habitat within the CMP and is consistent with the IUCN principles which provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species.

Environmental Monitoring
Nil

Record Keeping
Towed equipment Deployment and Recovery Procedures Equipment Inspection Records (in-water equipment) Incident Records Vessel log (dropped object location) Vessel radio logs (marine warnings) AMSA Notification

7.11 RISK: Marine Fauna Collision with Vessel

7.11.1 Hazard

Movement of vessels through the survey area has the potential to interact with fauna.

Vessels associated with the Dorrigo MSS will operate on a 24/7 basis. The Dorrigo MSS area is recognised as having habitats which seasonally support the presence of cetaceans and pinnipeds which forage and transit the area. Collision between marine megafauna and survey vessels is considered credible. When the vessels are stationary or slow moving, the risk of collision with cetaceans is extremely low, as the vessel size and underwater noise 'footprint' particularly of the MSS vessel itself will alert cetaceans to its presence and thus illicit avoidance behaviours.

7.11.2 Known and Potential Impacts

Known and potential impacts of vessel strike to air-breathing megafauna include:
- Injury; and
- Death.

Area affected by impact: The area which could be affected by this hazard is limited to the survey area. The Dorrigo MSS area is located in Commonwealth waters.

Possible environment/receptors affected by impact:
Receptors which may occur within this area and are at risk from streamer loss are:
- Cetaceans (whales and dolphins);
- Turtles; and
- Pinnipeds.

7.11.3 Evaluation of Environmental Risk

Receptor Sensitivity: Marine fauna such as cetaceans, turtles and pinnipeds likely to be in surface waters are potentially at risk from being struck by a vessel.

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 close to a vessel (e.g., narwhals) 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 (47%) followed by the southern right whale (12%) (DoEE, 2017c). **Figure 7-18** provides the approximate locations of reported vessel collisions with whales in Australian waters between 1990 and 2015 and the location of stranded whales where the

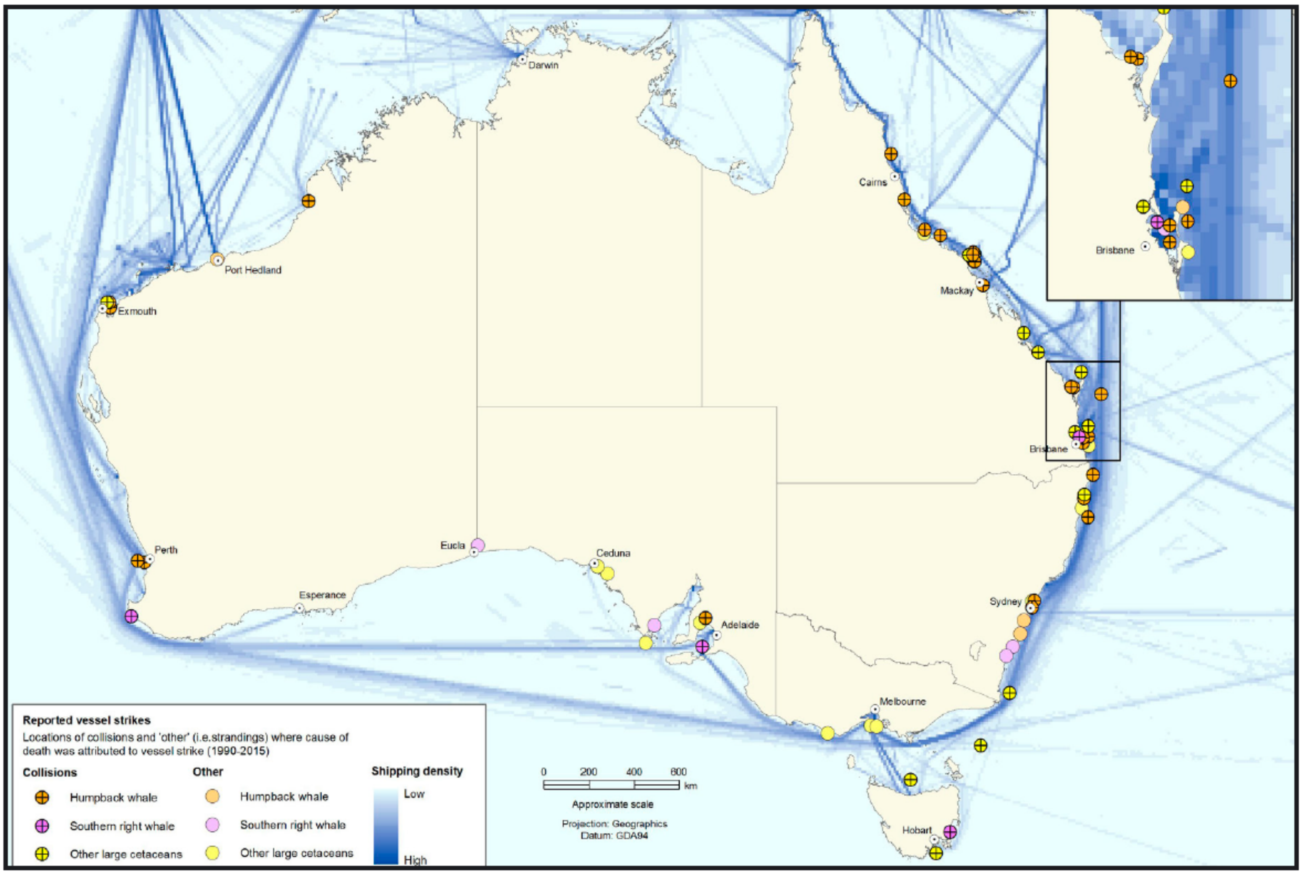
death was attributed to vessel strike. Southern right whales are considered vulnerable to vessel strike due to their presence in near shore waters during critical life phases such as breeding, as well as their profile, lack of dorsal fin, slow swimming behaviour and time spent at the surface (DoEE, 2017). Species that are known to spend more time at the surface include Sperm whale, which have been observed sleeping at or just below the surface (Miller et al. 2008; cited in DoEE, 2017). Juvenile and unwell individuals may also spend more time at the surface (Koschinski 2003; cited in DoEE, 2017c).

- Dolphins including the Australian humpback, common bottlenose, Indo-pacific bottlenose and Risso's dolphin 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 Dorrigo MSS area;
- There were no vessel interaction reports in 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 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 effect of vessel speed and turtle flee response can be significant. A study by Hazel et al. (2007 – DoEE, 2017) recorded 60 per cent of Green turtles (benthic and non-benthic) fleeing from vessels travelling at 4 km/h, while only four per cent fled from vessels travelling at 19 km/h. When fleeing 75 per cent of turtles moved away from the vessel's track, eight per cent swam along the vessel track and 18 per cent crossed in front of the vessel. The study concluded that most turtles would be unlikely to avoid vessels travelling at speeds greater than 4 km/h (DoEE, 2017). The presence of turtles within the Dorrigo MSS area is considered low.

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) (WDCS, 2006), though the data indicates this is more likely to be associated with container ships and fast ferries. The Whale and Dolphin Conservation Society (WDCS) (2006) also indicates that some cetacean species, such as humpback whales, can detect and change course to avoid a vessel. 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 (2015) reported two blue whale strandings in the Victoria in the Bonney Upwelling with suspected ship strike injuries visible.

Laist et al. (2001) identified larger vessels (container vessel and fast ferries), moving faster than 10 knots may cause fatal or severe injuries to cetaceans, with the most severe injuries caused by vessels travelling at speeds greater than 14 knots. Individuals engaged in behaviours such as feeding, mating or nursing may also be more vulnerable to vessel collisions when distracted by these activities (DoEE, 2017).

Figure 7-18: Location of reported vessel collisions with whales and other strandings attributed to vessel strikes (DoEE, 2017)



Extent and duration of Exposure and Identified Potential Impact:

The risk of vessel strike and entanglement is limited to the footprint of the vessels, which is temporary in nature at any one position as the vessel transits through the survey and operational area over the survey duration (35 days). Within these areas, it is expected that numbers of cetaceans, pinnipeds and turtles present will be low and transitory as no feeding, breeding, or aggregation areas are present. The Dorrigo MSS operational area is approximately 110 km from the nearest aggregation area, located at Warrnambool, for the southern right whale.

As the MSS vessel transits the survey area at low speeds (typically less than 5 knots), with MFO observers on-board, the likelihood of a vessel-strike and associated injury to megafauna is considered very unlikely. Support/escort vessels, also with MFOs on-board, generally travel at higher speeds to effectively patrol the requested clearance zone around the survey vessel and the towed array. It is considered that these vessels may have a higher potential for collision and damage with megafauna.

If an activity results in a vessel strike, there is potential for a localised and short-term impact to an itemd of NES (i.e. cetacean, turtle) (Significant impact). For this activity to result in fauna death or inhury it is considered very unlikely (LOW residual risk).

Impacts to Matters of National Environmental Significance:
Fauna impacts from vessel strike will not have a 'significant' impact to any of the matters of NES as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Temperate Saltmarch)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Vessel strike that result in injury or death would need to occur to many individuals before it was considered 'significant' at a population level. Dorrigo MSS is not located in the nearshore BIA for the southern right whale during critical life phases such as breeding.	Not applicable.	Migration, feeding, resting or breeding activities may be impacted by vessel strike, but it would need to occur to many individuals before it was considered 'significant' at a population level.	Vessel strike that result in injury or death would need to occur to many individuals before it was considered 'significant' at a population level and affect marine ecosystem functioning, biodiversity or ecological integrity.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Fauna impacts to areas of conservation significance associated with vessel strikes to marine megafauna is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and Nationally Important Wetlands	Commonwealth Marine Parks (CMP)	Coastal protected areas
X / X	X	✓	X
KEFs are not affected by vessel strike to marine megafauna.	Not applicable.	Vessel strike that result in injury or death would need to occur to many individuals before it was considered 'significant' at a population level with impacts to conservation values within the CMR. Conservation values are not affected by this hazard.	Coastal protected areas are outside the area affected by an equipment release.

7.11.4 Environmental Risk Assessment

Table 7-49 provides the ERA for vessel strikes on air-breathing marine megafauna.

Table 7-49: ERA for vessel strike to marine megafauna.

Aspect	Vessel strike to megafauna
Impact Summary	Injury or death to air-breathing megafauna.
Extent of Impact	Limited to individuals contacting the vessel within the Dorrigo MSS area.

Duration of Impact	At a population level, impact is considered short-term.		
Level of Certainty of Impact	HIGH. Impacts from cetacean and pinniped strikes have been studied and the impacts are well documented resulting in the National Strategy for Reducing Vessel Strikes on Cetaceans and other Marine Megafauna (DoEE, 2017) and Marine Notice 15/2016 (Minimising the risk of collisions with cetaceans).		
Species possibly affected within survey environment:	○ Whales (protected); ○ Pinnipeds; and ○ Turtles (protected).		
Impact Decision Framework Context	**Decision Context A** Vessel interaction with marine fauna is not a planned activity but is possible within all marine environments with activities which utilise vessels. The potential for vessel interaction with marine fauna is well understood. Although the Dorrigo MSS is undertaken during a low productivity period, the area overlaps a blue whale foraging BIA and other cetacean and pinniped species move through the MSS area. The vessels will be slow moving and as such potential interactions were considered to be unlikely. The offshore management of fauna interactions is well regulated in Australia. No objections or concerns were raised by relevant stakeholders regarding fauna strike / interaction, and decision context A will be applied to this hazard.		
Impact with controls failure (Inherent)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Whales	SIGNIFICANT	POSSIBLE	MEDIUM
Pinnipeds	MINOR	POSSIBLE	MEDIUM
Turtles	SIGNIFICANT	UNLIKELY	MEDIUM

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Survey Vessels (non-acquisition periods), Support Vessels (all times): Compliance with EPBC Regulation 2000 (Part 8) requirements for vessel proximity distance, approach and vessel management near whales and dolphins (vessels to adopt dolphin buffers for pinnipeds)	Prevent (administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**.
Environmental induction for support vessel crews to ensure awareness of requirements.	Prevent (Administrative/ control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**
Survey acquisition outside of pygmy blue whale foraging and feeding period (November to April).	Prevent (Isolation)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**
Seismic acquisition only to occur in daylight hours	Prevent (Administrative)	No	Measure would double survey duration. If equipment was deployed and retrieved daily, survey objectives would not be realised as the time taken to deploy and retrieve is greater than the daylight hours. Control not practical.

Use of additional MFOs on vessels.	Prevent (Administrative)	YES	Additional MFOs on vessels ensure that trained personnel are available to sight cetaceans. MFOs on support vessels will be relieved periodically by crew trained in cetacean observation. **Control adopted**
Notify other vessels if cetaceans are identified	Prevent (Administrative Control)	YES	Good Industry Practice – compliance with Marine Notice 15/2016 and National Strategy for Mitigating Vessel Strike of marine fauna. **Control adopted**

Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Whales	SIGNIFICANT	VERY UNLIKELY	LOW
Pinnipeds	MINOR	VERY UNLIKELY	LOW
Turtles	SIGNIFICANT	VERY UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
No injury or death to marine fauna as a result of vessel colllisions by survey vessels in Dorrigo MSS area.	*Vessel Management* Support vessel operations (all times) and survey vessel (non-acquisition periods) to conform to proximity distances, speeds and management measures contained in the EPBC Regulations 2000 (Chapter 8) for cetaceans when in the operational survey area. Vessel Masters observe 'dolphin' speed restrictions and proximity distances as required in the EPBC Regulations 2000 (Chapter 8) for pinniped species.	MFO Master Data Sheet verifies interaction between the MSS vessel and marine mammals comply with these requirements. Responsibility: MFO Support Vessel observation sheet verifies interactions between the vessel and marine mammals comply with these requirements. Responsibility: Vessel Master
	Crew Induction All vessel crews have completed an environmental induction covering the requirements for pinniped and cetacean/vessel interaction consistent with EPBC Regulations 2000 (Chapter 8) and are familiar with the requirements.	Induction records verify that all crews have completed an environmental induction. Responsibility: Survey Party Chief
	Marine Fauna Observations MSS vessel with streamers deployed will meet the requirements of EPBC Policy Statement 2.1 for MFO observations of marine fauna.	MFO Records Responsibility: MFO
	Vessel Warnings Vessel Masters will advise surrounding third-party vessels of cetacean presence on marine radio	Vessel log verifies alert has been made based upon MFO records. Responsibility: Vessel Master
	Vessel Strike Reporting Any vessel strike incident to whales, dolphins or pinnipeds shall be reported as soon as possible via the National Vessel Strike Database at https://data.marinemammals.gov.au/report/shipstrike within 72 hrs of collision **(refer Section 8.11).**	Records verify incident has been reported. Responsibility: Vessel Master
Demonstration of ALARP		

Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).
ALARP Statement	No reasonably practical, additional, alternative and/or improved control measures exist.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The risk management strategy for managing equipment loss to the marine environment reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.7**); • Notifications and Reporting Requirements (**Section 8.11**); and • Environmental Performance Monitoring and Reporting (**Section 8.12**).
External Context: Natural Environment	<u>Environmental Significance:</u> Accidental collision of marine megafauna does not result in significant impacts to matters of NES (refer assessment above). The Dorrigo MSS area lies in a blue whale foraging BIA where foraging is known to occur in the Bonney upwelling period (November to April). Other foraging baleen whale species are present at that time. The MSS area also contains transitting pinnipeds and turtles foraging in the Otway bioregion. <u>Key Ecological Features</u>: Accidental collision of vessels with marine megafauna does not affect KEFs present in the Dorrigo MSS area. <u>Zeehan CMR</u>: Conservation values for the Zeehan CMR include migrating whales (humpback and blue) and foraging seabird BIAs (petrels/albatross/shearwaters) which require protection.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with no issues raised with respect to vessel strikes on cetaceans. Given the controls adopted and the lack of feedback from stakeholders, 3D Oil considers that there is broad acceptability of this risk associated with this activity.

Legislation and Conventions	The Dorrigo MSS adopts control measures to prevent vessel collisions with marine fauna in accordance with the following legislated provisions: Acts/Statutes: • *Environment Protection and Biodiversity Conservation Act 1999 and associated Regulations (Part 8)* • *Navigation Act 2012 and Marine Notice 15/2016* International Conventions: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) SE Marine Reserves Network Management Plan: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1). • The management plan does not detail requirements for vessel collision with megafauna. South-east Marine Region Profile: No specific references in plan which relate to vessel strikes with marine fauna. Recovery/Conservation Plans & Advices: Review and assessment of threatened species recovery plans and conservation advices (refer **Section 5**) identified vessel strikes to be a threat in the following plans: • Conservation Management Plan for the southern right whale (SEWPC, 2012) (Objective A5.1) requires DoE to develop a national ship strike strategy which quantifies vessel movements within the distribution range of the southern right whale and outlines appropriate mitigation measures that reduce impacts from vessel collisions. This EP has considered increased MSS traffic requirements and controls have been adopted to prevent impacts. • Blue Whale Conservation Management Plan (DoE, 2015) (Objective A4.2 & A4.3) requires all vessel strikes to be reported in the National Ship Strike Database; and ensure that the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in area where blue whales occur and, if required, appropriate mitigation measures are implemented. This has been undertaken in this risk assessment; • The Conservation Advice for the humpback, fin and sei whales (TSSC, 2015c; TSSC, 2015d; TSSC 2015e) requires all vessel strikes to be reported on the National Ship Strike Database and when assessing actions that increase vessel traffic in an area, appropriate mitigation measures should be adopted. This has been undertaken in this risk assessment; 3D Oil has assessed the potential for cetacean strikes associated with the Dorrigo MSS activity in accordance with the draft *National Strategy for reducing vessel strike on cetaceans and other marine megafauna* (DoEE, 2017) and the requirements of Marine Notice 2016/15 – Minimising the risk of collisions with cetaceans. This includes: Maintaining a look out for cetaceans (adopted control); Warning other vessels in vicinity if cetaceans have been sighted (adopted control); Consider reducing speed in areas where cetaceans have been sighted (vessels will undertake MSS activities occur at low speeds but controls also adopted via EPBC Regulations 2000 (Part 8) requirements); and consider modest course alterations away from sightings (also adopted via controls detailed in EPBC Regulations 2000 (Part 8)). 3D Oil will also report any vessel strikes to cetaceans to both DoEE and NOPSEMA. 3D Oil considers that all requirements outlined in the recovery/conservation plans are captured by these management actions. Threat Abatement Plans: No threat abatement plans are triggered by this hazard
Good Industry Practice/Industry Standards	**APPEA CoEP:** Objectives met for MSS with respect to reducing the impacts from events such as vessel strike to a level which is ALARP and acceptable by: • Demonstrating appropriate management measures are in place and implemented in accordance with legislative requirements; and • Utilise appropriate research studies/knowledge and latest data records to provide knowledge of environment in which the vessels operate and assess potential impacts. **IAGC:** Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) requirements met for Aquatic Life (Section 8.7) requirements.

ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with vessel strikes to megafauna during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, no marine fauna interaction with vessels involved in the Dorrigo MSS will occur. Inplementation of these controls will: • Prevent injury to whales , pinnipeds, turtles; and • Preserves the conservation values in the Zeehan CMP and is consistent with the IUCN principles which provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species.
Environmental Monitoring	
MFO and crew observations from vessels during surveys	
Record Keeping	
MFO/crew sighting report MFO End of Survey Report Project Induction and attendance records Incident Records (DoEE and NOPSEMA)	

7.12 RISK: Diesel Spill (Vessel)

7.12.1 Hazard

MDO or Marine gas oil (MGO) will be utilised as fuel in survey vessels during the Dorrigo MSS. The following activities have the potential to result in a fuel spill during the Dorrigo MSS:

- **Hull damage** [*structural failure, loss of stability or flooding, fire*]: Vessels selected for the Dorrigo MSS have appropriate class certifications, training and competencies of crew members and vessel maintenance standards. Given this selection process, vessels with integrity issues which might be prone to hull damage (failure) are essentially eliminated and vessel integrity is not seen as contributing significantly to the risk of hull damage. Conservatively, it has been assumed that should an event occur which leads to hull damage, the largest fuel tank volume might escape to the marine environment (refer *vessel collision* below).
- **Vessel Collision (Intra-field Vessels):** Collision between two survey vessels with sufficient energy to result in a fuel tank rupture is considered an unlikely scenario. While collisions have been recorded between these vessels, records identify that these events have resulted in hull damage with no damage severe enough to cause a tank rupture and subsequent oil spill.

  Where the survey vessel and support vessels are working close to each other, activities are conducted a very low speed, only in safe sea-states and under strict control of the Vessel Masters. During normal seismic operations, the support vessels will be scouting the seismic line well in front and to one side of the seismic vessel not in the direct path of the vessel or the towed equipment. While the support vessel is more manoeuvrable than the survey vessel (due to streamer constraints), and can divert with increased speed, these activities are controlled, and it is not considered that the vessels would approach each other with sufficient speed to cause a collision resulting in an oil spill.

- **Vessel Collision (Large Third-Party Commercial Vessel):** A survey vessel collision with a third-party vessel travelling at speed (i.e. high energy) is a collision scenario which may have sufficient energy to damage a vessel's hull with the potential for a fuel spill. AMSA has identified that the Dorrigo MSS area does not lie in major shipping lanes although vessel encounter is possible anywhere in the survey area.
- **Refuelling:** Refuelling of the survey vessel will preferentially occur in port facilities however may occur in offshore waters by support vessels. This is a planned activity undertaken in suitable weather conditions and controlled by both vessel masters in accordance with approved bunkering procedures. This activity is a credible spill source although it would result in a much smaller spill volume that a high energy vessel collision. Causal pathways leading to refuelling spills include hose breaks, coupling failures and tank over-fill. Spills resulting from overfilling are contained within the vessel drains and slops tank system. In the event the refuelling pipe is ruptured, the fuel bunkering activity will cease by turning off the pump; the fuel remaining in the transfer line will escape to the environment as well as fuel that was released prior to the halt of transfer operations.

No emergent features are present in the Dorrigo MSS area with minimum water depths in the survey area of 80 m. DNV (2011) identifies that the risk of powered grounding within 4 nm of the shoreline or emergent system is negligible. Vessel grounding during the MSS is therefore not a credible scenario.

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.

Fuel Type and Volume Released: Dorrigo MSS vessel selection has not been undertaken, however a survey of seismic contractors and their vessels being considered for the Dorrigo MSS has identified a maximum fuel tank size of 400m^3 fuelled by MDO/MGO. This is considered the largest volume spill which could be released from survey vessels during MSS activities, is consistent with AMSA's Technical Guidelines for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, 2015) and has been used as the basis for this oil spill risk assessment. This volume is assumed to be released over a six-hour period however in reality this may occur over a considerable period (~days).

A refuelling spill volume, based on an expected pumping rate of 150 m^3/ hour and a conservative time of 15 minutes to shut down the pumping operation once the fuel spill had been identified, results in a total spill volume of approximately 37.5 m^3. This scenario and volume of fuel released was determined according to AMSA's technical guidance (AMSA, 2015). Given the refuelling spill volume is smaller than the fuel tank release volume estimated for a vessel collision, the impacts assessed in this section also cover a refuelling spill. However, to place this spill in context, based upon ADIOS modelling for average weather conditions expected in the survey area (15 knot wind speed, 15^oC water temperature) a release of this size would dissipate with 12 hours. In addition, the maximum area a spill of this size would cover assuming no evaporation at a thickness of 10 µm, is approximately 1.8 km^2.

If a vessel with a larger fuel tank is utilised in the survey, a risk assessment will be undertaken to determine if there is a significant increase in environment risk and therefore an increased risk not covered under the scope of this EP (refer to **Section 1.6**). It is to be noted that this spill scenario volume is very conservative. In the event of an MDO tank failure, the volume lost to the marine environment would be expected to be less than the tank volume given the fuel level in the tank would reduce to a level equivalent to the water line and emergency procedures would reduce the volume in the tank by transfer to another tank on-board the vessel.

Hydrocarbon properties of MDO are provided in **Table 7-50**. 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). Fuel spills, due to the physical characteristics of MDO (low pour point and dynamic viscosity), quickly evaporates (~ 50% lost within 12 hours depending on sea temperature and winds) and spreads quickly on the sea surface thinning out to small thickness levels; which increases the rate of evaporation. It is common for the residues of diesel spills after weathering to contain n-alkanes, iso-alkanes and naphthenic hydrocarbons. Minor quantities of PAHs may be present.

MDO has a strong tendency to entrain into the upper water column in the presence of moderate winds and breaking waves (>12 knots) but re-floats to the surface when the conditions calm, this process delaying the evaporation processes. Approximately, 5% (by mass) of the oil is considered "persistent hydrocarbons". These oil properties categorise MDO as a Group 2 oil according to the International Tanker Owners Pollution Federation (ITOPF, 2014)

Table 7-50: MDO Fuel Properties (RPS, 2018)

Characteristic	**Volatiles (%)**	**Semi-Volatiles (%)**	**Low Volatiles (%)**	**Residual (%)**	**Density (kg/m3)**	**Dynamic Viscosity (cP)**	**Pour Point (°C)**	**Oil Category**
Boiling Point (°C)	**<180**	**180-265**	**265-380**	**>380**				
MDO	6	34.6	54.5	5	829@25°C	4@25°C	-14	Group 2

Diesels are considered to have a high short-term aquatic toxicity when compared to many crude oils (e.g. heavy fuel oil) and condensates due to the presence of soluble smaller-compound hydrocarbons and their ease of entrainment/dispersion into the water column. Diesel spills on this basis may have a greater ecological impact in comparison to other floating oil slicks and are known to taint seafood. According to the International Maritime Organisation (IMO), diesel oil has a GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) rating of 3 for acute toxicity (damage to living organisms) and 4 for bioaccumulation/tainting (4 = high potential to bioaccumulate, 5 is the highest) (GESAMP,2002).

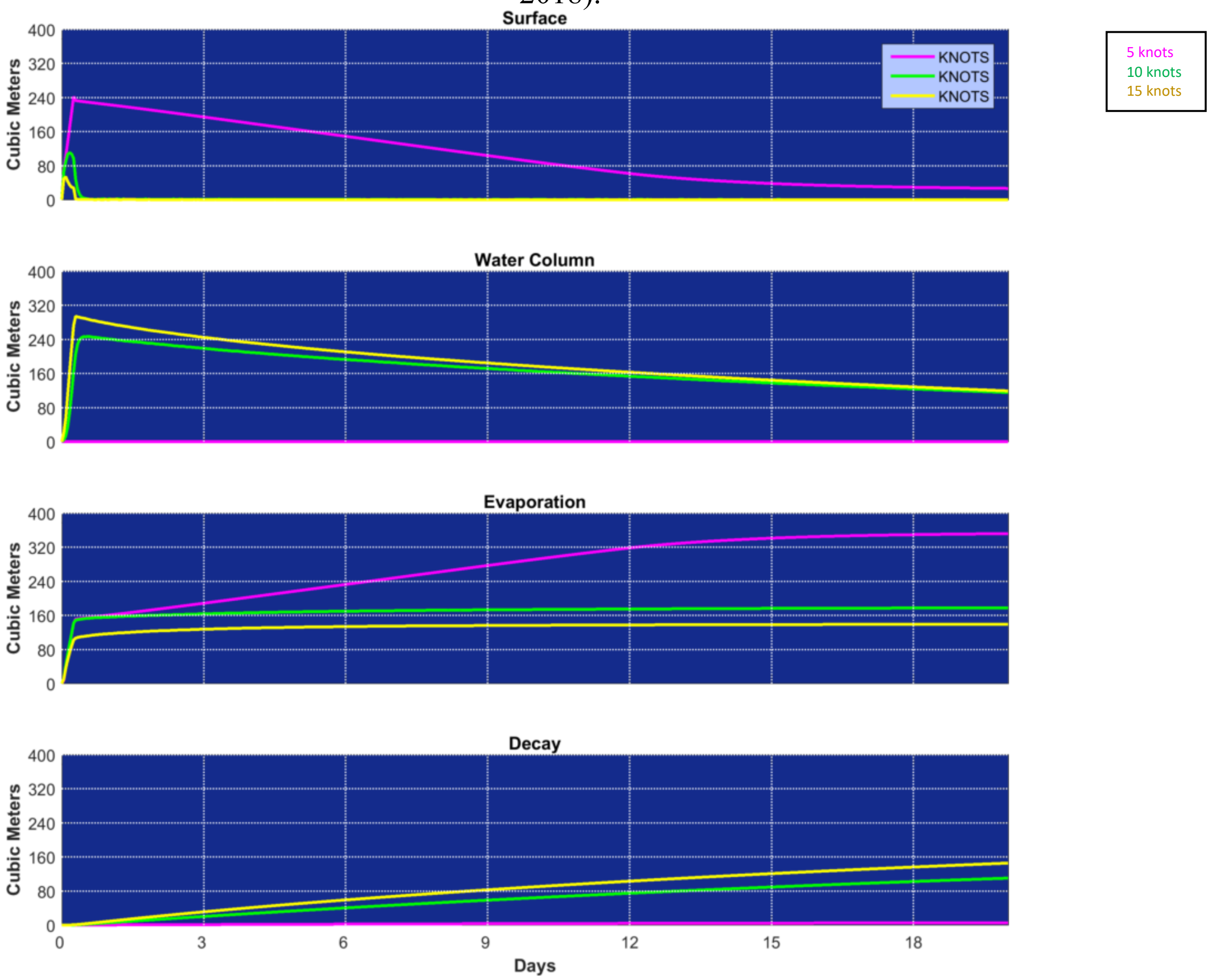
MDO contains very low concentrations of aromatic components. ADIOS (NOAA, 2016b) identifies the following aromatic content for MGO/MDO:

- Boiling Point Range <180°C: 1.9mol% (MGO), 1.7mol% (MDO)
- Boiling Point Range (180-264°C): 1.1 mol% (MGO), 1.0mol% (MDO); and
- Boiling Point Range (265-380°C): 0.15 mol% (MGO), 0.1mol% (MDO).

Generally, for components with boiling points <180°C, evaporation occurs within a few hours, and for components between 180-264°C evaporation/dissolution will occur within one day (RPS, 2018). Accordingly, MGO/MDO after 24 hours has very little toxicity associated with aromatics in the weathered residue.

Weathering characteristics of the hydrocarbon, undertaken as part of oil spill trajectory modelling, identifies under the conditions within the Dorrigo MSS area (wind speed ~15knots), within 3 days of the spill, approximately 60% of the spill has dispersed within the water column, 30% has evaporated and 10% has decayed (RPS, 2018). No MDO persisted on the water surface beyond 5 days above the low exposure threshold of 0.5µm (i.e. visible sheen). Weathering characteristics of MDO in the Dorrigo MSS area is provided in **Figure 7-19.**

Figure 7-19: Weathering and fate graph as a function of volume under 5, 10 and 15 knot static wind conditions. Results are based on 400 m^3 of MDO over 6 hours (tracked for 20 days) (RPS, 2018).



Oil Spill Trajectory Modelling (OSTM): To understand the potential effects and impacts associated with a 400 m^3 MDO release, the hydrocarbon release scenarios which were modelled are provided in **Table 7-51**. The hydrocarbon thresholds used to interpret impacts, together with the justified use of the threshold, is provided in **Table 7-52**. OSTM results using these thresholds are contained in **Table 7-53**.

The model period was October to April. September's wind roses are provided in the modelling report (Appendix 6, Figure 11, page 24) and indicate that stronger maximum and average westerly wind may occur. In the context of the Dorrigo risks this might mean a further westerly travel of surface concentrations than predicted. As noted in the modelling report, the EP, and in relevant literature previously cited, increased winds would predict elevated entrainment of diesel and thus less shoreline accumulations. Thus, the conditions expected in September would result in less shoreline loading than predicted and greater subsurface concentrations of hydrocarbon. These predictions have been accounted for in the evaluation of environmental risk below.

Table 7-51: Summary of oil spill modelling settings

Parameter	Value
Scenario Description	Vessel Collision in the Dorrigo MSS Operational Area
Number of randomly selected spill start times	100
Model Period	October to April (*Note September currents/wind directions and speeds are present in the October to April period. Simulation is valid for that timeframe*).
Oil Type	Marine Diesel Oil
Spill Volume (m3)	400
Release Depth (m)	Surface
Release Duration (hrs)	6
Simulation Length (days)	20
Surface Oil Concentration Thresholds (g/m2)	0.5, 10 and 25
Shoreline Load Thresholds (g/m2)	10, 100 and 1000
Dissolved aromatic dosages to assess the potential exposure (ppb.hrs)	576 (6 ppb x 96 hrs, potential low exposure) 4,800 (50 ppb x 96 hrs, potential moderate exposure) 38,400 (400 ppb x 96 hrs, potential high exposure)
Entrained oil dosages to assess the potential exposure (ppb hrs)	11,844 (70.5 ppb x 168 hrs, potential low exposure) 67,200 (700 ppb x 96 hrs, potential moderate exposure) 676,800 (7,050 ppb x 96 hrs, potential high exposure)

Table 7-52: Hydrocarbon Thresholds for Oil Spill Impact Assessment

Threshold	Supporting Literature
Sea Surface Oiling	
LOW: 0.5-10 g/m^2 (0.5-10μm)	This threshold provides a visual extent of oil on the sea surface. While the threshold is not at a level which measures ecological impacts, it does define a threshold of 'community concern' particularly around high tourism areas or fishing areas (i.e. trigger temporary closures of areas). ***Threshold has been selected to define socio-economic impacts and the surface oil EMBA***
MODERATE: 10 - 25 g/m^2 (10 - 25μm)	This is the minimum thickness of oil imparting a lethal dose to wildlife when contacted. Research has shown that harm to seabirds through preening contaminated feathers or loss of thermal protection in their feathers occurs at 10μm to 25μm (French-McCay, 2009) ***Threshold has been selected to define ecological impacts.***
HIGH: > 25 g/m^2 (> 25μm)	Scholten et al. (1996) and Koops et al. (2004) indicate that a concentration of surface oil equal to 25 g/m2 or greater would be harmful for all birds that contact the slick. Marine birds may experience mortality from ingestion during preening, or from hypothermia from matted feathers

Threshold	Supporting Literature
Shoreline Oiling	
OIL STAIN/FILM: 10-100 g/m^2	A conservative threshold to assess the potential for socioeconomic impact such as the need for shoreline clean-up on man-made features/amenities. Thresholds below 100g/m^2 are considered to 'stain' shoreline fauna and are not considered to impact the species survival and reproductive capacity (French-McCay, 2009)
OIL COAT: 100-1000 g/m^2	Threshold is considered enough to coat shorebirds and wildlife (furbearing aquatic mammals and marine reptiles) and likely impact their survival and reproductive capacity based upon sub-lethal and lethal impacts (French-McCay, 2009). Thus 100 g/m^2 (approximately equivalent to 100 µm) is considered the ecological threshold for impacts to invertebrates living on hard substrates (rocky, artificial/man-made, rip-rap, etc.) and sediments (mud, silt, sand or gravel) in intertidal habitats. French-McCay (2009) based on the work of Albers (1980) identifies a 100µm as having a significant potential to affect the survivability and breeding success of protected shoreline birds while a reduction to 50µm identified no significant reduction in hatchling success. Threshold is also recommended in AMSA's foreshore assessment guide as the acceptable minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone (AMSA, 2007). ***Threshold has been selected to define ecological impacts.***
OIL COVER: > 1000 g/m^2	Observations by Lin and Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m2 of oil during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing oil impacts on mangroves (Grant et al., 1993; Suprayogi and Murray, 1999). Threshold is representative of higher-level ecological impacts (i.e. ecosystem wide impacts).
Dissolved Aromatic Hydrocarbons	
LOW EXPOSURE (6 ppb – 96Hr LC_{50}): 576 ppb-hrs Very Sensitive Species (99% species protection)	Studies indicate that the dissolved aromatic compounds commonly contribute most to the toxicity of oil/water solutions (Di Toro et al., 2007). Exposure levels (threshold concentration over a given duration) has been adopted to assess the potential for exposure to sub-sea habitats and species by dissolved aromatic hydrocarbons. Threshold values 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 LC_{50}) under different environmental conditions varied from 6 to 400µg/l (ppb) with an average of 50 ppb. French-McCay (2002) identified that an average 96-hour LC_{50} of 50 ppb and 400 ppb could serve as an acute lethal threshold to 5% and 50% to biota, respectively. The range 6-400 ppb covered 95% of aquatic organisms tested, which included species during sensitive life stages (eggs and larvae).
MODERATE EXPOSURE (50 ppb – 96Hr LC_{50}): 4,800 ppb-hrs Average sensitive species (95% species protection)	
HIGH EXPOSURE (400 ppb – 96Hr LC_{50}): 38,400 ppb-hrs Tolerant species (50% species protection)	
Entrained Phase Hydrocarbons	
LOW EXPOSURE (70.5 ppb (PNEC) – 168Hr): 11,844 ppb-hrs Very Sensitive Species (99% species protection)	As entrained oil has undergone processes analogous to weathering and/or water-washing (i.e., many of the toxic soluble hydrocarbons have been removed through evaporation and/or dissolution), its toxicity is representative of true 'dispersed oil' phase impacts. OSPAR (2012) published predicted no effect concentrations (PNEC) for 'dispersed oil' in produced formation water (PFW) discharges. Dispersed oil in PFW discharges are small, discrete droplets suspended in the discharged water very similar to insoluble dispersed oil droplets formed from subsea blowouts. The oil has been partitioned (naturally separated) from gas/oil/water mixture by
MODERATE EXPOSURE (700 ppb – 96Hr LC_{50}): 67,200 ppb-hrs Average sensitive species (95% species protection)	

Threshold	Supporting Literature
HIGH EXPOSURE (7050 ppb – 96Hr LC_{50}): 676,800 ppb-hrs Tolerant species (50% species protection)	solubility (washing) and vapour pressure (evaporation) based on the individual hydrocarbon chemical properties. The OSPAR PNEC for PFW is 70.5 ppb for protection of 95% of species, based on biomarker testing (i.e. whole organism responses) to total hydrocarbons (THC) by Smit et al., 2009. This PNEC represents an acceptable long-term chronic exposure level from continuous point source discharges in the North Sea, which is one of the most concentrated areas in the world for oil and gas production. Appropriate threshold values can be extrapolated from the NOECs examined in Smit et al., 2009 based on effects ranging from oxidative stress to impacts on growth, reproduction and survival and are represented by: 7µg/l (7ppb) (for 1% affected fraction of species), 70.5µg/l (70ppb) (for 5% affected fraction of species) and 804µg/l (804 ppb) (for 50% affected fraction of species). Utilising methodologies contained in ANZECC (2000), based upon USEPA Guidelines, PNECs can be back-calculated to determine LC_{50} values by applying a factor of 100 to the PNEC values. This approach is supported by assessment factor criteria contained within the European Chemicals Agency (2008) and the OECD Existing Chemicals Programme 2002 (OECD, 2002). Based upon this, the following threshold values for entrained hydrocarbons are applied for assessment purposes: • PNEC (95% species protection: 70.5µg/l (ppb) x 168 hours (chronic exposure) (LOW Exposure); • LC_{50} (99% species protection): 700µg/l (ppb) x 96 hours (acute exposure) (MODERATE Exposure); and • LC_{50} (95% species protection): 7,050µg/l (ppb) x 96 hours (acute exposure) (HIGH Exposure).

Table 7-53: MDO spill modelling results summary

Threshold	OSTM Results
Sea Surface Oiling (Refer Figure 7-20)	
LOW: 0.5-10 g/m^2 (0.5-10µm) (*Socio-economic impacts*)	• Maximum distance of travel from the release site was 48 km to the south. • Intersection with the Zeehan CMR (20% probability) and Apollo CMR (2% probability). • 2% probability of intersection with King Island at this concentration. • No persistence longer than 2-5 days.
MODERATE: 10 - 25 g/m^2 (10 - 25µm) (*ecological impacts*)	• Maximum distance of travel from the release site was 14 km to the south. • Intersection with the Zeehan CMR (15% probability). No intersection with Apollo CMR. • No intersection with King Island at this concentration. • No persistence longer than 1-2 days.
HIGH: > 25 g/m^2 (> 25µm)	• Maximum distance of travel from the release site was 6km to the south. • Intersection with the Zeehan CMR (6% probability). No intersection with Apollo CMR. • No intersection with King Island at this concentration. • No persistence longer than 12-24 hours.
Shoreline Oiling (refer Figure 7-21)	
OIL STAIN/FILM: 10-100 g/m^2	• 2% probability of shoreline loading > 10g/m^2. • Average shoreline length affected at threshold – 5km; maximum shoreline length affected – 8km. • Minimum time to shoreline accumulation – 30 hrs.
OIL COAT: 100-1000 g/m^2	• 2% probability of shoreline loading > 100g/m^2. • Average shoreline length affected at threshold– 4km; maximum shoreline length affected – 6km. • Minimum time to shoreline accumulation – 39 hrs.
OIL COVER: > 1000 g/m^2	• No contact with shorelines at this level.
Dissolved Aromatic Hydrocarbons	

Threshold	OSTM Results
LOW EXPOSURE (6 ppb – 96Hr LC_{50}): 576 ppb-hrs [*Very Sensitive Species (99% species protection)*]	No exposure of any meaningful level.
MODERATE EXPOSURE (50 ppb – 96Hr LC_{50}): 4,800 ppb-hrs [*Average sensitive species (95% species protection)*]	No exposure of any meaningful level.
HIGH EXPOSURE (400 ppb – 96Hr LC_{50}): 38,400 ppb-hrs [*Tolerant species (50% species protection)*]	No exposure of any meaningful level.
Entrained Phase Hydrocarbons	*Note – entrained phase hydrocarbon is limited to the 0-10 m depth layer. No zones of exposure are present at depths > 10 m.*
LOW EXPOSURE (70.5 ppb (PNEC) – 168Hr): 11,844 ppb-hrs [*Very Sensitive Species (99% species protection)*]	• 1% probability of intersecting King Island or Tasmanian state waters. • Intersection with the Zeehan CMR (2% probability) and Apollo CMR (1%).
MODERATE EXPOSURE (700 ppb – 96Hr LC_{50}): 67,200 ppb-hrs [*Average sensitive species (95% species protection)*]	No exposure of any meaningful level.
HIGH EXPOSURE (7050 ppb – 96Hr LC_{50}): 676,800 ppb-hrs [*Tolerant species (50% species protection)*]	No exposure of any meaningful level.

Figure 7-20: Zones of Potential Exposure to sea surface oiling (RPS, 2018)

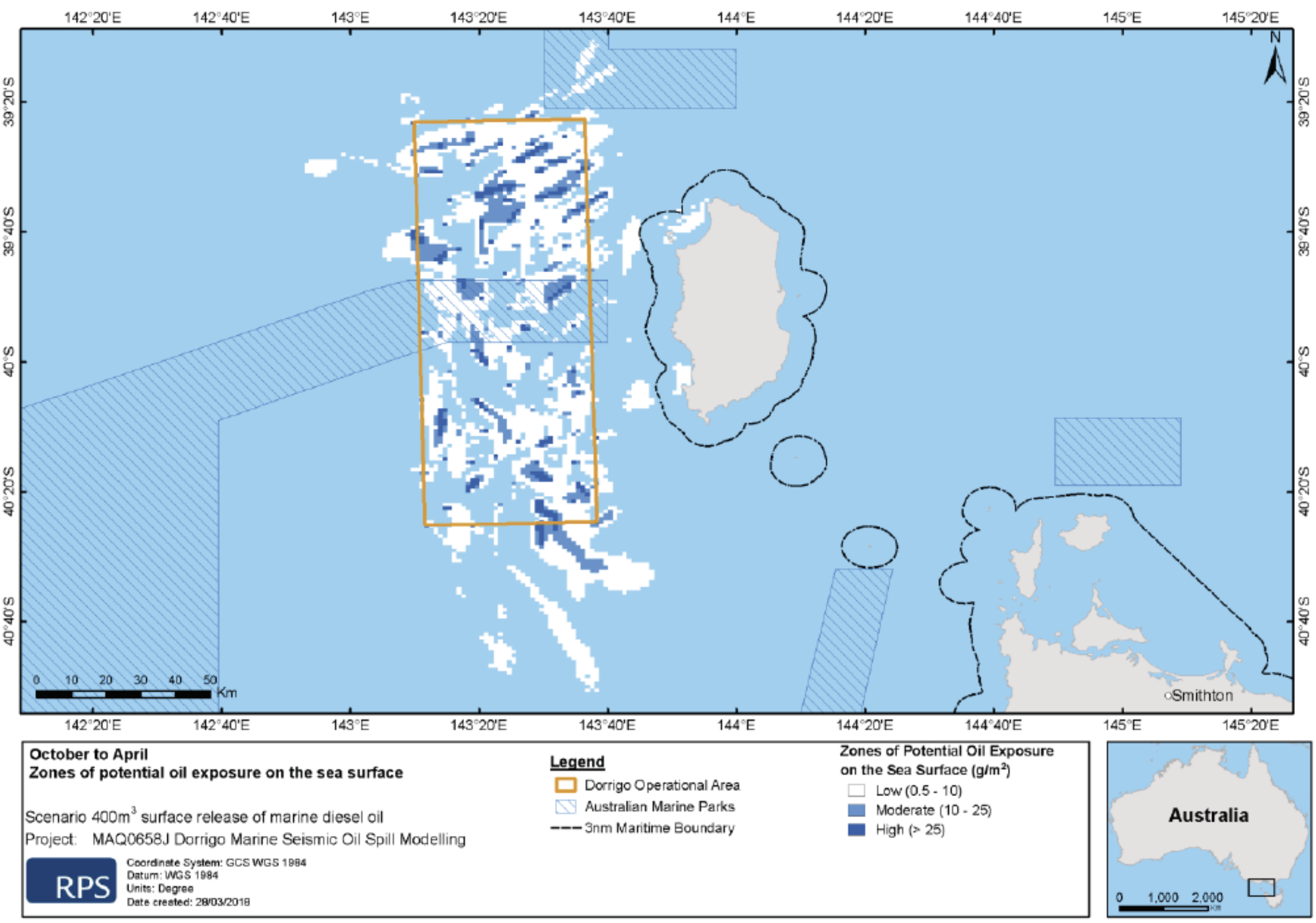
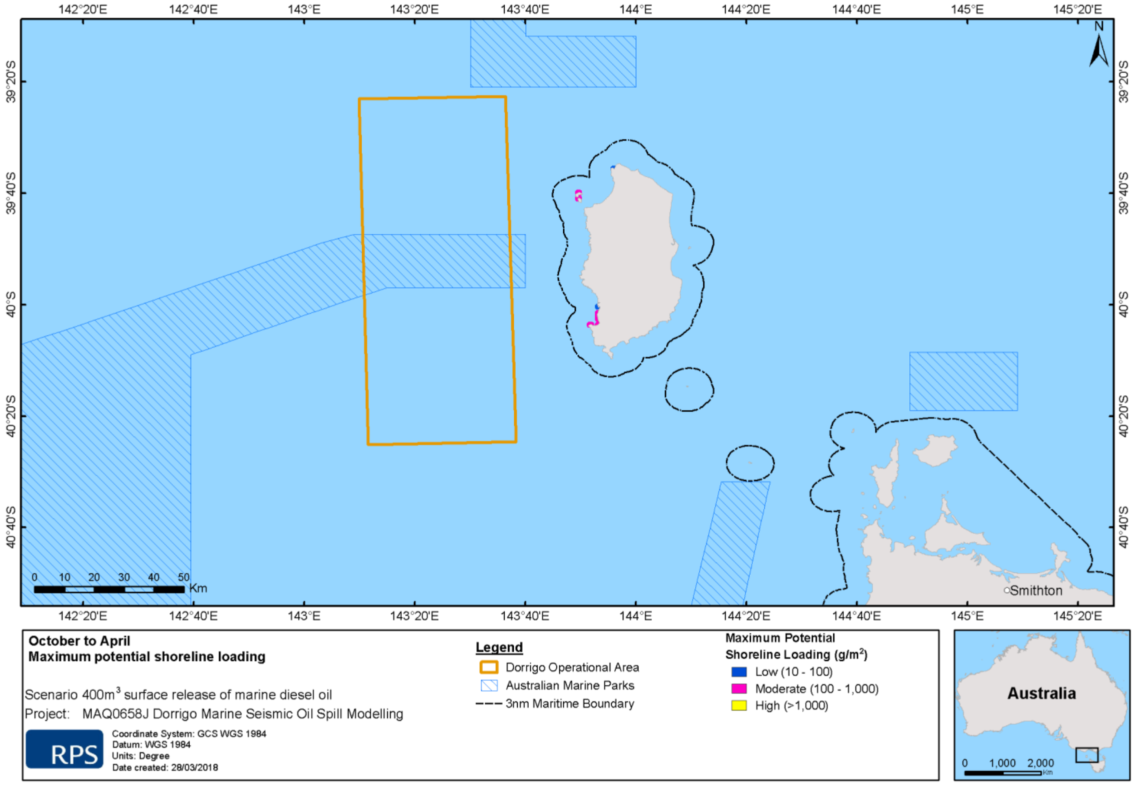


Figure 7-21: Maximum potential shoreline loading (RPS, 2018)



7.12.2 Known and Potential Impacts

The known and potential impacts associated with a MDO release are:

- A temporary and localised reduction in water quality; and
- Injury or death of marine fauna and seabirds exposed to the MDO.

Area affected by impact: The area which could be affected by a significant MDO spill is based upon OTSM which indicates that a 400m^3 MDO spill may, as a surface sheen, travel up to 48km in a southerly direction (refer **Figure 7-20)**. This also includes the area affected with entrained phase hydrocarbon at LOW thresholds (>11,844 ppb.hrs). This spill may affect both Commonwealth and Tasmanian state waters.

Possible environment/receptors affected by impact:
Receptors which may occur within this area, either resident or migrant are:

- Plankton;
- Benthic species (sponges, bryozoans);
- Pelagic and demersal fish;
- Marine mammals (cetaceans and pinnipeds);
- Marine turtles;
- Seabirds and shorebirds;
- Commercial and recreational fishing;
- Tourism.

Habitat occurring within the area affected where these species may be present includes:

- Sandy beaches;
- Rocky shoreline;
- Submerged shelf rocky reefs and hard substrates;
- West Tasmanian Canyons;
- Macroalgal habitats;
- Saltmarsh;
- Marine and coastal waters.

Protected areas or features that occur within the area affected include:

- Zeehan and Apollo CMP;
- Christmas Island Nature Reserve (shoreline);
- New Year Island Game Reserve (shoreline); and
- Seal Rocks State Reserve (shoreline).

A summary of receptors, their location within the Dorrigo MSS EMBA and the type of hydrocarbon exposure is provided in **Table 7-55**.

7.12.3 Evaluation of Environmental Risk

Table 7-56 to **Table 7-69** presented in this section provides an evaluation of environmental impact to receptors present in the oil spill EMBA. The sensitivity of these receptors listed in these tables is defined as per **Table 7-54** below.

Table 7-0-5455: Sensitivity Criteria for receptors in the EMBA

Sensitivity	Code	Criteria
HIGH	S1	Identified marine sanctuary or reserve. Presence of known threatened species feeding, breeding, nesting or aggregation areas. Areas of national significance or biological processes for species of national significance (e.g. breeding sites and National and State Parks, Commonwealth Heritage listed areas). Region of known sensitive habitat (mangrove, salt marshes, and sheltered tidal flats) which if impacted may have significant impacts and long recovery periods.
MEDIUM	S2	Region of known moderately sensitive habitats (sheltered rocky rubble coasts, exposed tidal flats, gravel beaches, mixed sand and gravel beaches) that have a medium recovery period (~2-5 years). Presence of known threatened species or cultural heritage impacted. Presence of non-threatened species feeding, breeding, nesting or aggregation. Region of significant commercial activity (e.g. fishing, tourism). Places of public interest such as beaches or conservation reserves.
LOW	S3	Region of known low sensitivity habitat (fine grained beaches, exposed wave-cut platform and exposed rocky shores) which have a rapid recovery period (~ year). Minimal impact to marine life, business, public areas or cultural heritage items.

Table 7-56: Receptors, their location and exposure type within the Dorrigo MSS 400 m^3 MDO Spill EMBA

CONSERVATION ISSUE	ENVIRONMENTAL RECEPTOR	SENSITIVITY	DISTANCE FROM MSS OPERATIONAL BOUNDARY	MARINE									SHORELINE											PREDICTED HYDROCARBON IMPACT				
				Ecological							Socioeconomic		Ecological				Habitat				Socio-economic							
				Cetaceans	Pinnipeds	Turtles	Seabirds	Fish (incl. Sharks)	Invertebrates	Plankton	Commercial Shipping	Commercial Fishing	Seal Colonies/Haul-out	Bird Colonies (Shore/Sea)	Macrophages	Saltmarsh	Sandy Beaches	Subtidal Reefs	Rocky Shoreline/Cliffs	Cobble Beaches	Heritage (incl. Shipwrecks)	Tourism/Water-sports	Rec & Com Fishing/Aquaculture	Surface Oil > 0.5µm	Surface Oil > 10 µm	Entrained Phase (> 70.5 x 148 hrs)	Entrained Phase (> 700ppb x 96 hrs)	Shoreline Loading > 100 g/m^2
GENERAL MARINE SENSITIVITIES				S1	S2	S2	S1	S3	S3	S3	S3	S2	S1	S1	S2	S1	S3	S3	S3	S2	S3	S2	S2					
BIA – High Annual Use Foraging	Pygmy Blue Whale	S1	Coincident	✓																				✓	✓	✓		
BIA – Connecting Corridor	Southern Right Whales	S1	15 km east	✓																				✓				
BIA – Known Distribution/Foraging	White Shark	S2	Coincident/15km E					✓																✓	✓	✓		
BIA – Foraging (Chick Provisioning)	Wedge-tailed shearwater	S1	Coincident				✓																	✓	✓	✓		
BIA - Foraging	Short-tailed shearwater	S1	Coincident				✓																	✓	✓	✓		
BIA - Foraging	Antipodean albatross	S1	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Wandering albatross	S1	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Common diving petrel	S2	Coincident				✓																	✓	✓	✓		
BIA – Foraging	White-faced storm petrel	S2	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Buller's albatross	S1	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Tasmanian shy albatross	S1	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Indian yellow-nosed albatross	S1	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Campbell albatross	S1	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Black-browed albatross	S1	Coincident				✓																	✓	✓	✓		
BIA – Foraging	Little penguin	S2	8 km east (starts)				✓																	✓		✓		
BIA – Foraging	Australasian gannet	S2	20km east (starts)				✓																	✓				
BIA – Foraging	Black-faced cormorant	S2	5 km east (starts)				✓																	✓		✓		
Commercial Fishing	Abalone	S2	~15km east						✓			✓												✓		✓		
Commercial Fishing	Rock Lobster & Giant Crab	S2	Coincident						✓			✓												✓	✓	✓		
Commercial Fishing	GHaT	S2	Coincident					✓				✓												✓	✓	✓		
Commercial Fishing	CTS – Demersal Trawl	S2	Coincident					✓				✓												✓	✓	✓		
SPECIFIC LOCATION SENSITIVITIES																												
Zeehan CMR	CMR (IUCN VI)	S1	Coincident	✓			✓	✓	✓	✓	✓													✓	✓	✓		
Apollo CMR	CMR (IUCN VI)	S1	3 km North	✓	✓		✓	✓	✓	✓	✓										✓			✓		✓		
Christmas Is. Nature Reserve (Tas)	Nature Reserve (IUCN 1a)	S1	18 km east											✓(B)			✓	✓	✓	✓				✓		✓		✓
New Year Island Game Reserve (Tas)	Game Reserve (IUCN VI)	S1	17 km east											✓			✓	✓	✓	✓				✓		✓		✓
Seal Rock State Reserve (Tas)	State Reserve (IUCN III)	S1	20 km east											✓				✓	✓					✓		✓		
Cape Wickham Conservation Area	Conservation Area (IUCN V)	S2	~29 km East											✓	✓			✓	✓		✓	✓		✓		✓		✓
Yellow Rock River	Estuary (King Island)	S1	24 km east											✓	✓	✓	✓	✓					✓	✓				
Porky Beach Conservation Area	Conservation Area (IUCN VI)	S2	~18-20 km east											✓	✓		✓	✓	✓	✓			✓	✓		✓		✓
Currie Harbour	Tourism	S2	19 km east											✓	✓		✓	✓			✓	✓	✓	✓		✓		✓
Cataraqui Point Conservation Area	Conservation Area (IUCN V)	S2	~20-22 km east											✓	✓		✓	✓	✓	✓	✓		✓	✓		✓		✓
Stokes Point Conservation Area	Conservation Area (IUCN V)	S2	~20-24 km east											✓			✓	✓	✓	✓				✓		✓		✓

Table 7-57: Potential impacts of hydrocarbons on plankton (including fish larvae)

General sensitivity to oiling - plankton		
A description of plankton in the EMBA is provided in **Section 5.4.2**. Plankton has a 'Low' sensitivity rating. 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 which are dissolved or entrained in the water column. Phytoplankton is typically not sensitive to the impacts of oil, though they do accumulate oil 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 a prolonged presence of surface hydrocarbons over an extensive area. 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 contacting 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 an oil 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 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, 2014b), allowing for seasonal influences on the assemblage characteristics. Planktonic Eggs A description of fish spawning within the Dorrigo MSS area is provided in **Section 5.4.4**. Fish species which spawn and temporally overlap the Dorrigo MSS period are species which spawn on a widespread basis or have protracted multiple or partial spawning over weeks. Other commercial species include abalone (broadcast spawners in months between October to April) and Rock Lobster (egg hatching between September and November). Most recruitment of lobster larvae into Victorian waters is from South Australia. For lobsters it is noted that waters may contain multiple larval cohorts at any time of the year. Some fish and other marine organisms (e.g. abalone) are broadcast spawners where they release eggs into the water column to be fertilised. Eggs then stay in the upper water column while the embryo develops. Although positively buoyant they are mixed into the water column by wind, waves and currents. Because of their small size and high lipid content, eggs accumulate hydrocarbons from the dissolved phase very rapidly and are sensitive to PAH concentrations down to 0.5µg/l. Fish that survive initial oiling have been observed to have decreased swimming speeds and decreased ability to capture prey and escape from predators (Hook et al, 2016). However, there are no case histories to suggest that oil pollution has significant effects on fish populations in the open sea. This is partly because any oil-induced deaths of young fish are often of little significance compared with natural losses each year through natural predation and given fish spawn over large areas (AMSA, 2011).		
Potential impacts from Dorrigo MSS		
Surface Oiling	**Water Column**	**Shoreline**
Plankton and planktonic eggs found in open waters of the EMBA are expected to be widely represented within waters of the wider Bass Strait region. Plankton in the upper water column is likely to be directly (e.g., through smothering and ingestion) and indirectly (e.g., toxicity from decrease in water quality and bioaccumulation) affected by dissolved and dispersed hydrocarbons. Once background water quality conditions are re-established, plankton populations are expected to recover rapidly due to the recruitment of plankton from surrounding waters. Modelling predicts that low level surface hydrocarbon exposure may extend 48 km from the spill site. It is possible that plankton remaining in the current may suffer mortality due to the hydrocarbons. Low level exposure from entrained phase hydrocarbons may also produce the same fate. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations. Impact is assessed as NEGLIGIBLE with *recovery in the timescale of days to weeks.*		Not Applicable

Table 7-58: Potential impacts of hydrocarbons on benthic assemblages

General sensitivity to oiling – benthic assemblages (including inter-tidal shorelines)		
A description of benthic assemblages in the EMBA is provided in **Section 5.4.3**. Benthic species and communities have a 'Low' sensitivity rating. Surface Hydrocarbons Benthic species are generally protected from exposure to surface hydrocarbons. The primary modes of exposure for benthic communities in oil spills include: • Direct exposure to dispersed oil (e.g., physical smothering) from seabed discharges which 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 such as lobsters) will reduce the impact of hydrocarbon absorption through the surface membrane. Other invertebrates with no exoskeleton and larval forms may be more susceptible to impacts from water-column hydrocarbons. Water column Hydrocarbons Entrained and dissolved hydrocarbons can have negative impacts on marine invertebrates and associated larval forms, while impacts to adult species may be reduced due to the presence of an exoskeleton. Localised impacts to larval stages may occur which could impact on population recruitment that year (refer plankton). Sub-lethal effects of crude oil emulsions on lobster larvae (reduced metabolism and respiratory activity) occur down to 1 ppm and concentrations of 100 ppm are lethal (Kennish, 1996). Mortality impacts to crustacean larvae if present are considered unlikely however sub-lethal impacts may be expected 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 (2000) identifies the following 96 hr LC_{50} concentrations for naphthalene 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). Abalone is a gastropod (i.e. grazer) and not a filter-feeder which actively bioconcentrate hydrocarbon residues. Effect pathways include dissolved/entrained phase contact leading to toxic impacts to the species or direct impact to its food sources (i.e. algal communities). Sub-lethal hydrocarbon concentrations can lead to narcosis (death-like appearance when the organism has not actually died). The invertebrates often recover but are more vulnerable to predators or being swept away by currents. Other sub-lethal effects of oil on invertebrates include developmental problems such as slow growth and deformities (Fingas, 2001). Shoreline Hydrocarbons Mortality is a major impact from an oil spill through coating and toxicity of persistent residues. Sub-lethal impacts can result in altered respiration, growth, reproduction and behaviour to more specific processes such as calcification, moulting, ion transport and enzyme function to individual animals. Oil spill impacts also typically result in changes in abundance, density, reproduction and recruitment, age structure, tolerance and population genetic structures within the invertebrate community (McFarlane and Burchett, 2003). Studies undertaken following the Amoco Cadiz spill identified that the inter-tidal invertebrates suffered heavy initial mortalities with the near disappearance of some species. This was followed by an invasion of opportunistic species with species richness gradually increasing 2-3 years after the spill where most species had reappeared and were undergoing normal seasonal fluctuations (Seymour & Geyer, 1992). French-McCay (2009) predicts that benthic invertebrates in these environments impacted at thresholds above 100g/m^2 will undergo 99% recovery in approximately 3 years if impacted.		
Potential impacts from Dorrigo MSS		
Surface Oiling	**Water Column**	**Shoreline**

Modelling predicts no exposure from dissolved phase hydrocarbons from a surface spill of MDO. Low level entrained hydrocarbon exposure is possible within the top 10 m of the water column and has a low probability of entering Tasmanian state waters. Water depths within the Dorrigo MSS vary from 100 m to 1420 m. Water column impacts on larval stages are addressed under 'plankton'. Filter-feeding benthic invertebrates such as porifera, ascidians, bryozoans and commercial species such as lobster and deep-sea crab are present within the oil spill EMBA. Benthic invertebrates are generally protected from direct oiling by the buoyant nature of hydrocarbons, although the depth of oil penetration in the water column is dependent on turbulence (Jewett et al., 1999; cited in ECOS 2001). Given benthic species live on the seabed, contact with surface oils is not expected and species in waters (> 20 m) are not expected to be impacted from entrained phase hydrocarbons from a limited size, diesel surface spill. At locations closer to shore where abalone or rock lobster may be present on reefs in depths of <10m, low level entrained phase exposure (99% species protection) is possible. This exposure level is not expected to cause mortality impacts to the species, however sub-lethal impacts may be experienced over the short-term. Tissue taint may remain for several months in some species (e.g. lobster, abalone) (refer commercial fishing), however given the limited spill footprint and the rapid dilution of the plume, predicted exposure are localised and temporary with full recovery expected (MINOR impact).	Modelling predicts that shoreline oiling above 100g/m^2 may impact on King Island shorelines for a maximum distance of 6 km. Areas affected by shoreline residue are areas of mixed sand / shoreline platform/ cliff / rocky shoreline. Residues deposited on rocky shorelines are rapidly remobilised due to wave and tidal action. MDO residues on sandy shorelines, given the viscosity of weathered MDO permeate into the sand sub-strata. At 100 g/m^2, resident fauna such as worms, molluscs and crustaceans may suffer lethal impacts if hydrocarbons penetrate sediments, especially along sheltered shorelines where hydrocarbon is more likely to be retained (i.e. not reworked). Shorelines exposed to a MDO spill are not predicted to be sheltered given the exposed nature of the western King Island coastline. On this basis, impacts to shoreline assemblages are expected to be limited, localised, and if impacts occur, areas will be rapidly recolonised by adjacent species (MINOR impact).

Table 7-59: Potential impacts of hydrocarbons on fish (including sharks)

General sensitivity to oiling – fish
A description of fish in the EMBA is provided in **Section 5.4.4**. Fish have a low sensitivity rating to spilled hydrocarbons. Fish habitat preferences determine their potential for exposure to MDO residues. Pelagic species that occupy the water column are more susceptible to entrained and dissolved hydrocarbons, however generally these species are highly mobile and not likely to suffer extended exposure due to their patterns of movement. The exception would be reef areas and other seabed features where species are less likely to move away into open waters (i.e., site-attached). For surface oil spills shallow reef systems (i.e. < 20 m) are expected to have the potential for exposure. Demersal fish habitats are close to the seabed and are therefore unlikely to contact either surface oil or entrained phase spill residues. Fish are exposed to hydrocarbons through the following 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 has shown a range of impacts on fish 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 hydrocarbons, which reduces the risk of hydrocarbon bioaccumulation 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, pelagic fish are high mobile and unlikely to remain close to a spill long enough to be exposed to sub-lethal doses of hydrocarbons. As fish and sharks do not generally break the sea surface, impacts from surface oiling are unlikely to occur and wide-ranging pelagic fish in the open ocean generally are not highly susceptible to surface oil impacts. No reports of oil spills in open waters have been reported to cause fish kills. This may be because vertebrates can rapidly metabolise and excrete hydrocarbons (Hook *et al*., 2016) (*refer to commercial fishing*). Extended duration exposures (weeks to months) of entrained phase hydrocarbons can physically affect reef fish (i.e. with high site fidelity) 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). Effects will be greatest in the upper 10 m of the water column and close to the spill source where hydrocarbon concentrations are likely to be highest.

<table>
<tr><td colspan="3">Studies of oil impacts on bony fish report light, volatile oils are likely to be more toxic to fish. Many studies conclude that exposure to PAHs and soluble hydrocarbon compounds are responsible for most toxic impacts observed in fish (e.g., Carls et al., 2008; Ramachandran et al., 2004). The water-soluble fraction (dissolved phase) containing the aromatic fraction is the most important component when assessing impacts to fish. Benzene, the most toxic of the compounds, has a LC_{50} of approximately 10-200 ppm (CEDRE, 2000). It is noted that observed concentration of dissolved phase compounds below slicks typically range from a few ppm to less than 0.1 ppm (IPIECA, 2000). Marine diesel has low levels of aromatics which are rapidly lost from the spill (~24hrs), and fish species, if exposed, would need substantially long exposure times (e.g. 96 hrs) for impacts to be realise).

Davis et al (2002) also reported detectable tainting of fish flesh after a 24-hour exposure at diesel concentrations of 0.25 ppm. Most studies, either from laboratory trials or of fish collected after spill events (including the Hebei Spirit, Macondo, and Sea Empress spills) found evidence of PAH elimination 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 et al., 2011; Law et al., 1997; Rawson et al., 2011).</td></tr>
<tr><th colspan="3">Potential impacts from Dorrigo MSS</th></tr>
<tr><th>Surface Oiling</th><th>Water Column</th><th>Shoreline</th></tr>
<tr><td colspan="2">Modelling predicts that low level surface oils may extend up to 48 km from the spill location (i.e. limited areal extent) and may last for 1-5 days (temporary). There is a low probability (1%) that low exposure entrained hydrocarbons may extend into Tasmanian State waters.
• Pelagic free-swimming fish and sharks and reef-based fish are not expected to suffer long-term damage from oil spill exposure because entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2010). Given the limited areal and temporal presence of the spill and the limited numbers of fish potentially affected, impacts are assessed as NEGLIGIBLE – recovery in the timescale days to weeks.
• Demersal fish are not expected to be impacted by a surface spill of MDO.</td><td>Not Applicable</td></tr>
</table>

Table 7-60: Potential impacts of hydrocarbons on cetaceans

<table>
<tr><th>General sensitivity to oiling – cetaceans</th></tr>
<tr><td>A description of cetaceans in the EMBA is provided in Section 5.4.5. Cetaceans, given the presence of BIAs within the oil spill EMBA have a ‘high’ sensitivity rating.

Whales and dolphins can be exposed to oil via the following pathways:
• 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 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 change (NRDA, 2012; Hook et al., 2016).

French-McCay (2009) identifies that a oil thickness of 10-25μm 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 thicknesses 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, 1982). Cetaceans 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. However, cetaceans may be impacted by surface oil exposure during surfacing events leading to aspiration hazards which are present in fresh spills (GESAMP, 2002). Such exposure could damage mucous membranes or damage airways during surfacing (AMSA, 2011b).</td></tr>
</table>

The physical impacts from ingested hydrocarbon with subsequent lethal or sub-lethal impacts are both applicable to entrained oil. However, cetacean susceptibility 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 if they feed by skimming the surface. Oil may stick to the baleen while they 'filter feed' near slicks. Studies identify oil exposure through ingestion of tar-like residues may temporarily *inhibit* feeding baleen whales however for light/medium oils this inhibition is only predicted to occurred for 40 seconds, heavy oils for up to 15 minutes with total clearance of residues within 15-20 hrs (ECOS, 2001). As refined products, such as diesel, are not very sticky or viscous compared with black oils (some crude oils and heavy fuel oils) adhesion to baleen plates is not likely (AMSA, 2011). 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) leading to chronic toxicity effects. 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 spill (heavy oil) (Hook *et al*., 2016). Dolphin populations from Barataria Bay, Louisiana, 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).		
Potential impacts from Dorrigo MSS		
Surface Oiling	**Water Column**	**Shoreline**
Modelling predicts that surface oils in thicknesses of 10µm may extend up to 14 km from the spill location (i.e. limited areal extent) and may last for up to 2 days (temporary) from a surface spill of MDO. There is a low probability (2 %) that low exposure entrained hydrocarbons within the MSS area (location of the spill – worst case). Foraging baleen whales (blue, sei, fin) may encounter a diesel spill given the BIA overlap with MSS activities. Baleen whale foraging typically occurs as an individual or in groups of two. Given the limited sea surface area affected at ecological levels (~14km from spill site) and time where a diesel spill may be at thicknesses which are considered harmful (<48 hrs) it is possible that individual whales may be affected, however this is not expected to result in death of the animal. Foraging odontocetes are considered less likely to ingest surface or entrained hydrocarbons as they obtain their prey from deeper waters. Given this, based upon the assessment for baleen whales, impacts are not considered as great to this species type. From the above assessment, it is considered that impacts to whale species present in the survey area, based upon feeding impacts, is SIGNIFICANT – minor disruption to a small portion of population. Minor temporary effects on protected species critical habitat or activity. No threats to population viability.		Not Applicable

Table 7-61: Potential impacts of hydrocarbons on pinnipeds

General sensitivity to oiling – pinnipeds
A description of pinnipeds (Australian fur seal and Now Zealand fur seal) in the EMBA is provided in **Section 5.4.6**. Pinnipeds, widespread in the environment have a medium sensitivity rating. <u>Sea surface oil</u> Pinnipeds are vulnerable to sea surface exposures as they spend much of their time on or near the surface of the water as they need to surface every few minutes to breathe. French-McCay (2009) estimates encounter with a 10-25 µm oil thickness carries a 75% probability of mortality to the species based upon the proportion of time the species spends at the sea surface. 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 toxic impact 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. Fur seals possess only a thin subcutaneous fat layer instead having a thick pelage that thermally insulates the animal (Johnson & Ziccardi, 2006) and can suffer from hypothermia when oiled. Heavy oil coating and tar deposits on fur-seals may also 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.

<u>In-water hydrocarbons</u>

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) suggests that a small phocid weighing 50 kg might have to ingest approximately 1 litre of oil to be at risk.

Pinnipeds are 'gulp feeders' and as such will ingest water during prey capture. 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. Prey items consist of cephalopods and small fish. Entrained phase diesel within the upper water column is unlikely to impact on the species during foraging activities as the species is a benthic forager with food sources likely to be unaffected by entrained oil concentrations.

Entrained oil presents fewer impacts to pinnipeds. While fur contact with entrained oil may occur, the entrained hydrocarbons will be at lower concentrations, due to dilution with water in the water column, and oiling effects to the fur not expected to be significant.

<u>Shoreline Oil</u>

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 which released 550 tonnes of heavy fuel oil (in Tasmania, 1995) concluded that "The number of 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).

Potential impacts from Dorrigo MSS

Surface Oiling	Water Column	Shoreline
Modelling predicts that surface oils in thicknesses of 10µm may extend up to 14 km from the spill location (i.e. limited areal extent) and may last for 1-2 days (temporary). There is a low probability (2 %) that low exposure entrained hydrocarbons within the MSS area (location of the spill – worst case). Foraging pinnipeds are expected to be present in open waters during the survey. Exposure may range from no effect to corneal abrasions, conjunctivitis and ulcers or oiling of fur. Localised parts of the foraging range may also be temporarily exposed to low level surface oil concentrations. Given the rapid evaporation of diesel, the limited time of the surface slick at 10µm it is expected that that if present in the area, individual pinnipeds may be affected. From the above assessment, it is considered that impacts to pinniped species present in the survey area is MINOR – localised short-term effects, recovery in the timescale of months to < 5 years.		Modelling predicts that shoreline exposures are not expected to exceed 100 g/m^2 at Reid Rocks, the only seal colony in proximity to the Dorrigo MSS location. No impacts from shoreline hydrocarbon residues are expected.

Table 7-62: Potential impacts of hydrocarbons on marine turtles

<table>
<tr><th colspan="3">General sensitivity to oiling – marine turtles</th></tr>
<tr><td colspan="3">A description of marine turtles in the EMBA is provided in Section 5.4.7. Marine turtles have a 'medium' sensitivity rating due to their protected status.</td></tr>
<tr><td colspan="3">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. Turtles may be exposed to chemicals in oil (or used to treat oil spills like dispersants) in two ways:
• Internally – eating or swallowing oil, consuming prey containing oil-based chemicals, or inhaling of volatile oil related compounds; and
• Externally – swimming in oil with oil on skin and body.

Contact with hydrocarbons can have lethal or sub-lethal effects or may impair mobility. As per cetaceans, turtles through surfacing activities may contact a surface slick which may coat the species and allow for inhalation exposure. On contact with the slick, turtles may experience skin irritation and injury to airways or lungs, eyes and mucous membranes of the mouth and nasal cavities (AMSA, 2011b). Sea turtles' diving behaviour also puts them at risk. They rapidly inhale a large volume of air before diving and continually resurface over time, therefore turtles in an oil spill would experience both extended physical exposure to the oil and prolonged exposure to hydrocarbon vapours. Evidence from the Montara crude oil spill, identified that turtles also exhibit severe dermal pathologies (particularly in the softer skin of the neck) through surfacing behaviour (Gagnon & Rawson, 2011). A stress response associated with this exposure pathway includes an increase in the production of white blood cells, and even a short exposure to hydrocarbons, such as crude oil, may affect the functioning of their salt gland (Lutcavage et al., 1995).

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 Gulf of Mexico, although many of these animals did not show any sign of oil exposure (NOAA, 2011; 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.

Adult sea turtles spend 1-10% of their time at the surface with each dive lasting between 30-70 minutes (French-McCay, 2009). French-McCay (2009) identified that a 10-25µm oil thickness has the potential to impart a lethal dose to intersecting wildlife and estimates a probability of 5% mortality to turtle species, if they encounter surface oil more than 10µm thick, based on the proportion of the time turtles spend at surface.

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 water (AMSA, 2015c). 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 their internal organs. 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. Sea 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.</td></tr>
<tr><th colspan="3">Potential impacts from Dorrigo MSS</th></tr>
<tr><th>Surface Oiling</th><th>Water Column</th><th>Shoreline</th></tr>
</table>

Modelling predicts that surface oils in thicknesses of 10µm may extend up to 14 km from the spill location (i.e. limited areal extent) and may last for 1-2 days (temporary). There is a low probability (2 %) that low exposure entrained hydrocarbons within the MSS area (location of the spill – worst case). Marine turtles present in Victoria are rare vagrants except for the leatherback turtle which are deep-water species. The Dorrigo EMBA is not a recognised BIA and turtles are likely to occur in low numbers. Given the limited areas of surface sheen from a MDO spill in the Dorrigo MSS area, it is possible individual marine reptiles may come into contact with localised areas of low exposure hydrocarbons. Based on the literature review above, exposure may range from no effect to sub-lethal impacts such as irritation of skin or injury to airways, lungs, eyes or mucus membranes. From the above assessment, impacts to marine turtles present in the survey area is MINOR – Minor and temporary disruption to small portion of protected species population. No effects on critical habitats or activities.	Not Applicable. Marine turtles do not have a shoreline presence (i.e. nesting) within the Dorrigo MSS EMBA.

Table 7-63: Potential impacts of hydrocarbons on shorebirds and seabirds

General sensitivity to oiling – shorebirds and seabirds		
A description of shorebirds and seabirds in the EMBA is provided in **Section 5.4.8**. Shorebirds and seabirds, given the presence of BIAs within the oil spill EMBA have a 'high' sensitivity rating. 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). Birds foraging at sea have the potential to directly interact with oil on the sea surface during 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 feathers, which may result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair water-proofing. It may also result in impaired navigation and flight performance (Hook *et al*., 2016). Direct contact with surface hydrocarbons can result in dehydration, drowning and starvation (SEWPC, 2011c). Increased heat loss from a loss of water-proofing results in increased metabolism of food reserves in the body, which is not countered by a corresponding increase in food intake, and may lead to emaciation (SEPWC, 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 hydrocarbon is ingested as the bird attempts to preen its feathers. Whether this toxicity ultimately results in mortality will depend on the 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) indentified 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) indicated 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 of feeding, roosting or nesting 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/shorebirds 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 spill (325 tonnes of bunker fuel in Tasmania in 1995) is estimated to have resulted in the death of up to 20,000 penguins (Hook *et al*., 2016).		
Potential impacts from Dorrigo MSS		
Surface Oiling	**Water Column**	**Shoreline**

A significant number of albatross, petrel and shearwater bird species, together with the Australasian gannet, little penguin and black-faced cormorant have BIAs within the Dorrigo MSS EMBA. These threatened bird species (albatross, petrels) forage over an extensive area and are distributed over a wide geographic area. Modelling predicts that surface oiling in thicknesses > 10µm lie within 14 km of the spill site and is present for 24-48 hrs. Seabirds rafting, resting, diving or feeding at sea have the potential to contact with this localised and temporary area of low surface oil exposure. As such, acute or chronic toxicity impacts (death or long-term poor health) to bird species at the individual level is possible, however given the small area affected compared with their widespread BIA area for foraging and the timeframe of the Dorrigo MSS does not lie within upwelling areas/seasons where aggregations may occur, there may be a minor temporary distruption on protected species critical habitat or species. No threats to population viability (SIGNIFICANT consequence).	Impacts to birds from hydrocarbons in the water column are unlikely without first being exposure to surface oiling. This exposure route is not considered as significant as direct contact with hydrocarbons on the sea surface or at the shoreline. As oil spill risks present area surface related modelling predicts only low-level effect concentrations from a spill incident. Penguins present foraging in the 10 km BIA which extends from Christmas Island, may be exposed to very localised, temporary low-level entrained hydrocarbon exposures however, given their foraging range and their nightly return to burrows, the species is unlikely to remain within the entrained phase plumes for sufficient time to allow sub-lethal impacts to result. Penguin colonies are present along the west coast of King Island and at Christmas and New Year Island Reserves (all having a low probability of low-level entrained hydrocarbon exposure). As prey is caught with rapid jabs of the penguin's beak and swallowed whole, it is possible that the penguin may ingest small volumes of low-level entrained phase hydrocarbons, if feeding in the affected area. Prey (school fish, squid or krill) affected by the spill when ingested may lead to ingestion of hydrocarbons and have associated sub-lethal impacts. It is possible that individual birds may be affected by a MDO spill however given the spill's temporary nature, its localised footprint and the foraging range of the penguin, while it is possible individual birds may be affected, no population-level effects would be expected.	There is a 2% probability of shoreline exposure to >100 g/m^2 (but less than 1000 g/m^2) in isolated areas on the western coastline of King Island within a minimum timeframe of 39 hrs. The maximum length of shoreline affected in such a spill is 6 km (localised) and are predicted to affect New Year Island, Christmas Island and areas around Fitzmaurice Bay. The Island shorelines consists of sandy and rocky shorelines. Residues deposited on these areas are rapidly remobilised due to wave and tidal action so any accumulation is likely to be short-term and temporary (i.e. maximum of a couple of tides). For sand areas MDO residues are expected to percolate into the sub-strata of the beach (NOAA, 2016), limiting exposure to shoreline species. A variety of shorebirds and seabirds reside in these areas including hooded plovers (on sand during nesting period) and penguin colonies (Christmas Island). Shorebirds foraging for food in intertidal areas or along the high tide mark and splash zone may encounter weathered MDO that may be brought back to nests which may reduce the survivability of hatchlings. Any coating of feathers preened once onshore increases oil ingestion and may lead to acute or chronic toxicity depending on the amount ingested and the life stage of the bird. Shorebirds foraging for food may experience secondary impacts due to MDO residues impacting invertebrate prey within the sand column. Tidal washing within sand environments rapidly removes MDO residues allowing for rapid recolonization by adjacent invertebrate species. Areas affected are also be isolated in nature. For inter-tidal platforms/rocky shorelines, accumulation will be temporary given wave and tidal action remobilises and weathers MDO residues. Populations of most shorebird species within the EMBA (including plovers, penguins, terns) also have a wide geographic range, meaning that impacts to individuals at one location will not extend to other populations. Given the low levels of hydrocarbon accumulation predicted on these isolated sections of shoreline (912 g/m^2 (max)), the limited area and temporary nature of exposure, individual birds may be affected, however at a population level this is not significant (MINOR consequence – *Minor and disruption to a small portion of a protected species population. Localised and short-term impacts*).

Table 7-64: Potential impacts of hydrocarbons on sandy beaches

General sensitivity to oiling – sandy beaches
A description of shoreline types is presented in **Section 5.3**. Sandy beaches have a 'Low' sensitivity rating as they are regularly cleaned by wave action and have low sediment total organic carbon and therefore low abundance of marine life (Hook *et al*., 2016). A 100 g/m^2 threshold (considered a 'stain' or 'film', and equivalent to 0.1 mm) is assumed as the lethal threshold for invertebrates on hard substrates and sediments (mud, silt, sand, gravel) in intertidal habitats. A threshold of 100 g/m^2 oil thickness would be enough to coat the animal and likely impact its survival and reproductive capacity (French-McCay, 2009). Based on this, areas of heavy oiling would likely result in acute toxicity, and death, of many invertebrate communities, especially where oil penetrates into sediments through animal burrows (IPIECA, 1999). 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. Depth of penetration in sandy sediment is influenced by: • Particle size. Penetration is not generally as great on mud as on coarser sediments; • Oil viscosity. Viscous oils and mousse (water-in-oil emulsion) tend to penetrate less deeply than low-viscosity oils such as light crudes or diesel oil; • Drainage. If sediments are poorly drained (as is often the case with tidal flats remote from creeks or channels), the water content may prevent the oil from penetrating into the sediment. In contrast, oil 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. Sandy beaches support a variety of worms, molluscs and crustaceans. Because the sand retains oil, such animals may be killed if oil penetrates into the sediments. 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. Opportunistic species of worm may actually show a dramatic short-term increase following an oil spill (IPIECA, 1999). As a result of the Macondo well blowout, oil washed 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). 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 hydro-carbonoclastic consortium (petroleum hydrocarbon degrading microorganisms) (Lamendella *et al*., 2014)
Potential impacts from Dorrigo MSS
Shoreline
Modelling predicts there is a low probability (2%) of small areas (6km (max)) along Christmas and New Year Islands and the western side of King Island (Fitzmaurice Bay) where shoreline residues may exceed 100 g/m^2. No exceedances above 1000g/m^2 are predicted. These shorelines are dominated by cliffs, rocks, sand and inter-tidal platforms. The 100g/m^2 threshold is recommended in AMSA's foreshore assessment guide for sandy beaches, boulder shoreline, pebble shorelines, rock platforms and industry facility structures as the minimum thickness that does not inhibit the potential for recovery and is best remediated by natural processes alone (AMSA, 2007). With the shortest time to shore of 30 hours, the MDO residues will have weathered. As per shoreline bird section, sandy beach environments are not likely to accumulate MDO residue due to the viscosity of the hydrocarbon and its tendency to penetrate through the sand. Additionally, the constant wave action and tidal movements will naturally wash and degrade MDO residues which remain in the inter-tidal area. Sand environments recover rapidly and any residual shoreline MDO residues, based upon predicted levels, should not create visual aesthetic impacts to any visiting tourists. A threshold of 100 g/m^2 oil thickness is considered enough to coat animals living on or in the sand and may impact survival and reproductive capacity. Based on this, areas of oiling may result in acute toxicity, and death, of shoreline invertebrate communities, especially where oil penetrates into sediments through animal burrows. These communities would be expected to rapidly recover (recruitment from unaffected individuals and recruitment from nearby areas) as oil is removed with the tides (sediment reworking).
Given the MDO spill is localised, temporary and recoverable, invertebrate impacts at a population level are not considered to be significant (MINOR Consequence – localised short-term effects). Impacts to tourism and other human uses of the beach are unlikely. Visual impact through shoreline staining is unlikely to occur (MINOR consequence – public awareness but no public concern beyond local users).

Table 7-65: Potential impacts of hydrocarbons on rocky beaches/intertidal platforms

General sensitivity to oiling – rock beaches/ intertidal platforms
A description of shoreline types is presented in Section 5.3. Rocky shores have a 'Low' sensitivity rating as hydrocarbons are generally quickly removed by incoming tides and waves (Hook et al, 2016). Cracks and crevices, rock pools, overhangs and other shaded areas provide habitat for soft bodied animals such as sea anemones, sponges and sea-squirts, and become places where oil can become concentrated as it strands ashore (Hook *et al.*, 2016). Rich animal communities underneath the rocks are also the most vulnerable to oil pollution. The vulnerability of a rocky shoreline to oiling depends 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 oil, which may penetrate 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 hydrocarbons are 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, 2005). Waves and tides that carry the oil to shore gradually remove it again, but the rate of removal 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. Even where the immediate damage to rocky shores from oil spills has been considerable, it is unusual for this to result in long-term damage and the communities have often recovered within 2 or 3 years (IPIECA, 2005). This is because oil is not normally retained on rocky shores in a form or quantity that causes long-term impacts and because most rocky shore species re-establish populations rapidly. Brown seaweeds, for example, are relatively insensitive to oil due to the slimy mucilage that coats all their surfaces. Even after a heavy oiling, most of these seaweeds are washed clean by the next high tide and remain largely undamaged. Many rocky shore animals have been found to withstand heavy oiling, and it typically requires smothering by a viscous oil for a few tides to fatally impact barnacles and intertidal sea anemones. Limpets, littorinid snails and other grazing molluscs are usually more susceptible, and a particularly toxic oil may cause fatalities. This may be a direct effect or through the narcotic effect of the oil which causes the animals to lose their grip on the rock and become available to predators or die of desiccation (IPIECA, 2005). The extent of the effect on susceptible organisms is strongly related to the toxicity and freshness of the oil. A weathered hydrocarbon may have very limited effects, even if it is present on the shore for a long period, whereas a fresh hydrocarbon can cause acute toxic effects to molluscs and bleaching effects on red algae in the short time before it weathers away. The removal of large numbers of grazers is often followed by a rapid proliferation of microalgae covering the normally grazed rock in a 'green flush', which is a sign of a stressed environment, but also the first stage of recovery (IPIECA, 2005). If the shore is not contaminated by further oiling, the spores of macroalgae settle and grow resulting in an abnormally dense cover of seaweeds. At the same time, the juvenile limpets and snails, which settle and develop in damp and protected sub-habitats, move out onto the open rock to gradually repopulate the vacant areas. They grow quickly on the large quantities of food and gradually reduce the seaweed cover to normal levels. The whole process may take less than 2 or 3 years for the shore to look 'normal', although in some cases the balance between algae and grazers may take longer to stabilise (IPIECA, 2005). Given the timeframe to landfall of MDO residues associated with a Dorrigo oil will have undergone significant weathering and toxic impacts are expected to be slight.
Potential impacts from Dorrigo MSS
Shoreline
Modelling predicts there is a low probability (2%) of small areas (6km (max)) along Christmas and New Year Islands and the western side of King Island where shoreline residues may exceed 100 g/m^2. No exceedances above 1000g/m^2 are predicted. These shorelines are dominated by cliffs, rocks, sand and inter-tidal platforms. The 100g/m^2 threshold is recommended in AMSA's foreshore assessment guide for sandy beaches, boulder shoreline, pebble shorelines, rock platforms and industry facility structures as the minimum thickness that does not inhibit the potential for recovery and is best remediated by natural processes alone (AMSA, 2007). With the shortest time to shore of 30 hours, the MDO residues will have weathered. The action of reflected waves off rocky shores means it is unlikely that toxicity or smothering effects to exposed invertebrates will occur. The oil is likely to be continually washed off the substrate and into the water, leading to further weathering. Given the MDO spill is localised and temporary, ecological impacts to these areas are localised, temporary and undergo rapid recovery (MINOR consequence – localised short-term effects).

Table 7-66: Potential impacts of hydrocarbons on macro-algal communities (including seaweed aquaculture)

<table>
<tr><th colspan="3">General sensitivity to oiling – macroalgal communities</th></tr>
<tr><td colspan="3">A description of macroalgal communities in the EMBA is provided in Section 5.5.6. Macroalgal communities have a 'medium' sensitivity rating to hydrocarbons.

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 entrained hydrocarbons however are susceptible to surface hydrocarbons 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 carbon dioxide across cell walls (O'Brian & Dixon, 1976). The effect of hydrocarbons however is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to algae, which will vary depending on the oils physical state and relative 'stickiness'. The morphological features of macroalgae, such as the presence of a mucilage layer or the presence of fine 'hairs' will influence the amount of hydrocarbon that will adhere 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) 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). Hook et al (2016) on the other hand states that kelp is typically relatively resistant to oil, though the fauna associated with it may be more sensitive.

The toxicity of macroalgae to hydrocarbons varies for the different macroalgal life stages, with water-soluble hydrocarbons more toxic to macro-algae (Van Overbeek & Blondeau, 1954; Kauss et al., 1973; cited in O'Brien and Dixon, 1976). Toxic effect concentrations for hydrocarbons and algae have varied greatly among species and studies, ranging from 0.002–10,000 ppm (Lewis & Pryor, 2013). The sensitivity of gametes, larva and zygote stages however have all proven more responsive to hydrocarbon exposure than adult growth stages (Thursby & Steele, 2003; Lewis & Pryor, 2013).

Macrophytes, including seagrasses and macroalgae, require light to photosynthesise. In addition to the potential impacts from direct smothering or exposure to entrained and dissolved hydrocarbons, the presence of entrained hydrocarbon within the water column can affect light qualities and the ability of macrophytes to photosynthesise.</td></tr>
<tr><th colspan="3">Potential impacts from Dorrigo MSS</th></tr>
<tr><th>Surface Oiling</th><th>Water Column</th><th>Shoreline</th></tr>
<tr><td rowspan="2">Macroalgal communities are generally restricted close to shore (refer to shoreline).

Modelling predicts that surface oils in thicknesses of 10µm (g/m²) may extend up to 14 km from the spill location (i.e. limited areal extent) and may last for 1-2 days (temporary). Modelling predicts that an offshore release of MDO would not result in surface oiling in sufficient concentrations to have an impact on subsurface macroalgae.</td><td colspan="2"><u>Macroalgal Communities</u>: Giant Kelp Forest TEC areas have not been identified within the EMBA.

King Island coastal waters have a low probability of low-level entrained phase hydrocarbon exposure. The King Island coastline contains areas of subtidal rocky reef, where it is likely that macro-algal communities exist. This entrained phase exposure is expected to have limited impact to macroalgal communities over the shore period of exposure. From available literature, macroalgae regenerates quickly. Impacts to inter-tidal and shoreline macro-algal community's present in the EMBA are likely to reflect the general sensitivity observations (above) noting that the rough seas of the nearshore environment will result in rapid MDO weathering. Given the small length of shoreline affected by hydrocarbon residues above 100 g/m², the constant tidal and wave 'washing' of the macroalgae, impacts are expected to be localised, temporary and recoverable (MINOR Consequence – localised short-term effects).</td></tr>
<tr><td colspan="2"><u>Aquaculture</u>: Seaweed harvesting occurs along the west coast of King Island from Cape Wickham to 5km south of Ettrick Bay however is prohibited from September to March on sandy beach areas except the north end of Admiral Beach (immediately south of Currie) and other sandy beaches where it would not be detrimental to nesting hooded plovers (e.g. Fitzmaurice Bay (Tasmanian NVA, 2018). Modelling predicts that the shoreline area affected by MDO residues above 100 g/m² lies from Ettrick Bay to Cataraqui Point and therefore a minor spatial overlap where kelp harvesting and hydrocarbon residues may be present exists. Given the length of coastline available to kelp harvesting (~70 km) and the spatial overlap (~5 km) it is possible that 7% of the coastline available for kelp collection may be affected on a temporary basis (MINOR consequence (damages based)).</td></tr>
</table>

Table 7-67: Potential impacts of hydrocarbons on saltmarsh communities

General sensitivity to oiling – saltmarsh communities
A description of sub-tropical and temperate saltmarsh TEC is provided in **Section 5.5.6**. Saltmarsh is endangered and has a ‘high’ sensitivity rating. Saltmarsh is present in areas with some type of connectivity to saline tidal influences (surface or groundwater) and located in the upper inter-tidal environment. Oil can adhere readily to saltmarsh and recovery times are variable depending upon the level of impact. Saltmarsh are typically a nursery area for fish and invertebrate species and typically consist of fine grain often anoxic sediments held in place by the rhizomes of the plant. Damage and dieback of the plants often cause erosion of the habitat (Hook et al, 2016). Damage to saltmarsh is usually most severe in the areas close to the shoreline. It was observed from the Deepwater Horizon oil spill, oiling and plant stress where both highest within 14m of tidally inundated areas (Hook et al, 2016). For temperate species there is seasonal die back, and during spring and summer (growing season) the species are more susceptible (IPIECA, 2004). Impacts are related to oil toxicity (lighter, non weathered products causing more impacts such as MDO) or smothering (physical effect). Oil loading also determines recovery times. For light to moderate oiling with little penetration into the sediments, the plant may be killed in part, but recovery can take place from the underground systems – generally good recovery in 1 2years. Oiling of shoots with substantial penetration into the sediments with damage to underground systems may delay recovery (~7years). With thick deposits of oil, vegetation is likely to be killed by smothering and the recovery period for species can be significant (~20years) (IPIECA, 2004). Shoreline loadings of more than 1,000 g/m^2 of oil during the growing season would impact marsh plants according to observations by Lin and Mendelssohn (1996). Similar thresholds have been found in studies assessing oil impacts on mangroves. Thus 1,000 g/m^2 is representative of higher-level ecological impacts (i.e. ecosystem-based impacts).
Potential impacts from Dorrigo MSS
Water Column and Shoreline
Within the EMBA, saltmarsh is present in the estuary and lower reaches of the Yellow Rock River located on the north-west coast of King Island. Modelling predicts that this area may be affected by weathered low-level entrained hydrocarbon exposure which is not expected to have a significant impact on saltmarsh if exposure occurs (NEGLIGIBLE consequence – incidental effects locally within the environmental setting). No shoreline hydrocarbon residues are predicted to impact this estuary area.

Table 7-0-68: Potential impacts of hydrocarbons on commercial fishing

General sensitivity to oiling – commercial fishing
A description of commercial fishing in the EMBA is provided in **Section 5.7.5**. Commercial fishing has a ‘medium’ sensitivity rating. 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 risk of catch taint by oil. Concentrations of petroleum contaminants in fish and crustacean (i.e. lobster) and mollusc tissues (e.g. abalone) could pose a significant potential for adverse human health effects, and until products from nearshore fisheries have been cleared by the health authorities, could be restricted for sale and human consumption. Indirectly, the fisheries sector may suffer a heavy loss if consumers stop consuming or are unwilling to buy fish and shellfish from the region affected by the spill. 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.

<table>
<tr><td colspan="3">
The Montara spill (2009) 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) and 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), levels of oil contamination residue in seafood have consistently tested 100 to 1,000 times lower than safety thresholds established by the USA Food and Drug Administration (FDA), and every sample tested has been 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 have generally been 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 spill, a temporary fisheries closure may be put in place by the Victorian Fisheries Authority (or voluntarily by the fishers themselves). Oil may foul the hulls of fishing vessels and associated equipment, such as gill nets. A temporary (short- or long-term) fisheries closure, combined with oil tainting of target species (actual or perceived), would 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, etc.).
</td></tr>
<tr><th colspan="3">Potential impacts from Dorrigo MSS</th></tr>
<tr><th>Surface Oiling</th><th>Water Column</th><th>Shoreline</th></tr>
<tr><td>
Direct impact to demersal fisheries within the EMBA is not considered to be significant due to the large spatial extent of the fisheries and the localised exposure of MDO at the sea surface.
The level of commercial fishing activity within the EMBA during the MSS period is low.
Surface oiling may cause equipment fouling if fishing is undertaken within an oil slick. This may require equipment cleaning (NEGLIGIBLE impact (damages)).
</td><td>
Direct impact to the finfish fisheries is not considered to be significant due to the large spatial extent of the fisheries and the localised zone of low exposure to entrained hydrocarbons.
While tainting is considered possible from the MDO spill, entrained phase hydrocarbon levels in the environment is localised and at low levels and not considered sufficiently high to cause significant levels of tainting (~ 250 ppb) to fish stock, particularly for mobile pelagic species. Most fish & invertebrate stock caught within the Dorrigo EMBA are demersal and would not be exposure to entrained hydrocarbons present from a surface spill.
A possible exception to this is abalone found in inshore reef areas where isolated areas of low-level entrained phase MDO may occur. Exposures are localised and not considered sufficient to cause injury to the stock but may cause tainting in these isolated areas.
The value of the abalone in King Island (west coast) is approximately $2.3M (MINOR Consequence (damages)).
</td><td>Not Applicable</td></tr>
</table>

Table 7-69: Potential impacts of hydrocarbons on tourism

<table>
<tr><th colspan="3">General sensitivity to oiling – tourism</th></tr>
<tr><td colspan="3">A description of tourism activity in the EMBA is provided in Section 5.7.2. Tourism has a medium sensitivity rating with respect to hydrocarbon exposure.
During an oil spill event, not only are tourist destinations affected directly in areas where the spill has impacted upon the coastline, but it also faces significant reputational impacts, particularly in those areas which are considered to be 'unspoilt' by development. Public perception strongly influences people's decisions whether to visit a destination.</td></tr>
<tr><td colspan="3">For the Deep-water Horizon spill, which was a significantly larger oil spill with significantly higher spill impacts when compared with a MDO spill from Dorrigo MSS activities, a study commissioned by the Louisiana Office of Tourism two months after the Deepwater Horizon spill incident found (CRED, 2018):
• The spill had a negative impact on people's intentions to visit Louisiana. People who had previously intended to visit the state had postponed or cancelled their trips;
• Perception overshadowed actual impacts: a quarter of people thought that leisure activities (swamp tours, boating and hiking) were closed because of the spill when in fact this was not the case;
• The seafood industry was particularly impacted by perceptions: for example, over half of people surveyed thought that Louisiana oysters were unsafe to eat although evidence demonstrated otherwise.
This resulted in significant impacts on the hospitality sector and small businesses.</td></tr>
<tr><th colspan="3">Potential impacts from Dorrigo MSS</th></tr>
<tr><th>Surface Oiling</th><th>Water Column</th><th>Shoreline</th></tr>
<tr><td colspan="3">In the event of an MDO spill within the Dorrigo MSS area, it is possible that weathered oil spill sheens may enter Tasmanian State waters 1-5 days after the spill incident which may be observed by visiting tourists. It is possible that the 'unspoilt' perception of King Island may be compromised on a short-term basis and might reduce numbers visiting King Island. However, impacts associated with a spill event which is visible to the public would be limited in scale, very localised in impact and temporary in nature. The material released does not have a significant surface presence at shoreline locations. The impact to visitation is expected to be small on this basis (MINOR consequence – Public awareness but no public concern beyond local users).</td></tr>
</table>

Table 7-70: Potential impacts of hydrocarbons on commercial shipping

<table>
<tr><th>General sensitivity to oiling – tourism</th></tr>
<tr><td>A description of commercial shipping activity in the EMBA is provided in Section 5.7.3. Commercial shipping has a low sensitivity rating with respect to hydrocarbon exposure.
Oiling of commercial vessels is possible if transiting through surface oils during a spill event. This may lead to additional spread of oil contamination and dispersion of MDO into the water column by propeller action.</td></tr>
<tr><th>Potential impacts from Dorrigo MSS</th></tr>
<tr><th>Surface Oiling</th></tr>
<tr><td>In the event of an MDO spill within the Dorrigo MSS area, given the presence of a commercial shipping land in the northern section of the Dorrigo MSS area, oiling of vessels is possible. MDO is a light volatile oil and not viscous compared with other hydrocarbons (e.g. fuel oils) and are not expected to adhere to surfaces as readily. In addition, given the distance of the Dorrigo MSS from port, vessels intersection MDO residues will undergo water-washing prior to entry to port. Impact to commercial shipping on this basis are expected to be slight (NEGLIGIBLE consequence – incident effects contained within the local environment).</td></tr>
</table>

Impacts to Matters of National Environmental Significance:

An MDO spill is not likely to have a significant impact to any matters of NES applicable to this survey as outline below.

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Sub-Tropical and Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	✓	✓	✓
Significant impacts to populations of threatened species are remote as outlined in the preceding **Tables 7-56** to 7-**69.** .	Low level entrained MDO may occur within areas where giant kelp grows but impacts to this TEC are unlikely. If the TEC exists within the EMBA, the dynamic, turbulent environment in which it grows ensures high levels of water mixing and rapid weathering of MDO, thereby minimising any impacts associated with toxicity. Saltmarsh areas are protected in estuarine environments with a remote possibility of low-level entrained phase exposure. No significant impacts predicted.	Migration, feeding, resting or breeding activities of seabirds and shorebirds may be impacted by MDO on the sea surface or less likely by accumulated hydrocarbon on the shoreline. However, impacts at the population level are unlikely given the localised and temporary nature of the oiling and the widespread distribution of migratory species. .	The Commonwealth marine environment may be temporarily affected by MDO residues on a localised basis. This residue will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality adversely impacting on biodiversity or ecological integrity as the MDO degrades very rapidly.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:

Impacts to areas of conservation significance within the Dorrigo EMBA associated with a MDO spill is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and National Wetlands of Importance	Commonwealth Marine Reserves (CMR)	Coastal protected areas
X / X	X	✓	✓
These KEFs are located on the seabed and will not be affected by a surface release of MDO.	There are no nationally important wetlands within the EMBA.	The Apollo CMP and Zeehan CMP may be affected by surface hydrocarbons and low levels of entrained hydrocarbon in the upper levels of the water column. Reserve conservation values will not be impacted by the temporary and low-level exposures predicted (refer to assessments of conservation values (cetaceans and seabirds) in Tables 7-56 to 7-69) and an assessment of Management plan prescriptions in **Appendix** 7).	The following coastal reserve areas may be contacted with hydrocarbons (low level surface, entrained and beached hydrocarbons): • Christmas Island Nature Reserve; • New Year Island Game Reserve; • Seal Rocks State Reserve. Reserve conservation values will not be impacted by the temporary and low-level exposures predicted (refer to **Appendix** 7).

Spill Frequency

Vessel Collision: Analysis of oil spill frequency data for Bass Strait waters from vessel incidents (i.e. area coincident with the Dorrigo survey) identifies the following frequency of spills (all vessels from all causal pathways including collision) over 100 tonnes as low at 0.0001 to 0.001 (1 event every 1000 - 10,000years)[61] (DNV, 2011). While DNV (2011) compares the frequencies to

[61] Reference: DNV (2011) – Figure 3.2 (page 21)

Australian averages, the report states that in absolute terms, oil spill frequencies in all Australian sub-regions are considered low to very low. Additionally, based upon a review of the Australian Transport Safety Bureau's (ATSB) marine safety database[62], there have been no instances of collision, grounding or sinking of a petroleum activity related survey vessel in Australian waters for the past 30 years.

Refuelling Spill: DNV, in a review of spill frequencies for ship-to-ship transfers of hydrocarbons, identified that in the UK the spill frequency over 1 tonne was 1 incident in 2000 lightering operations or a frequency of 5×10^{-4} per transfer operation. This result was consistent with US data (DNV, 2011). Based on this data, the likelihood of a refuelling spill is assessed as highly unlikely.

Spill Mitigation
The survey vessels will operate under an approved SOPEP (or equivalent for class) in accordance with MARPOL 73/78 Annex I requirements and as required by the *Protection of the Sea (Prevention of Pollution by Ships) Act 1983* Section 11A. Information contained in the SOPEP includes personnel responsibilities for the deployment and maintenance of response equipment; the emergency plan in case of pollution; communications/contacts required in the event of a spill (i.e. AMSA or Tasmanian EPA details); measures to control and limit the oil flow; and the required forms to be completed and transmitted to regulatory authorities.

For a vessel collision incident resulting in a spill, the actions taken by the vessel master would typically include:

- Make safe the vessel and crew;
- Immediate notification to AMSA (in Commonwealth waters) and Tasmanian EPA (Level 2 or where the spill threatens coastal waters) in the event of a vessel collision and/or possible oil spill advising on location, oil spill volume, nearby sensitivities, etc;
- Implement SOPEP remedial measures to limit volumes spilt (i.e. close water tight doors, check bulkheads; assess damage; determine whether vessel separation will increase spillage; isolation of penetrated tanks; possible tank lightering, etc.);
- AMSA, as vessel-based marine oil spill Control Agency in Commonwealth marine waters activates the National Marine Oil Spill Contingency Plan (NATPLAN) (2019), or EPA Tasmania activates the Tasmanian Marine Oil Spill Contingency Plan (TASPlan) if oil spill threatens Tasmanian State waters. AMSA/EPA (Tas.) will determine the appropriate response strategy for the spill type, location and environmental sensitivities which are threatened via a Net Environmental Benefits Assessment (NEBA).

All vessels (according to class) are required to undertake routine SOPEP testing/drills to ensure all crew are trained in the response requirements. The SOPEP is routinely reviewed and updated such that the document remains relevant and current.

AMSA in Commonwealth waters and EPA (Tas.) in Tasmanian waters are the responsible agencies for operational monitoring. 3D oil will implement scientific monitoring as described in **Section 8.12** (Scientific Monitoring).

[62] http://www.atsb.gov.au/publications/safety-investigation-reports.aspx?s=1&mode=Marine&sort=OccurrenceReleaseDate&sortAscending=descending&occurrenceClass=&typeOfOperation=&initialTab=

7.12.4 Environmental Risk Assessment

Table 7-70 provides the ERA for a and MDO spill incident.

Table 7-71: ERA for MDO Spill.

Aspect	Release of MDO to the marine environment
Impact Summary	• Pollution of waters and/or shoreline. • Injury or death of marine fauna and seabirds through ingestion or contact. • Visual impacts to other marine users.
Extent of Impact	In general, if incident occurs this will generally result in localised impacts around point of discharge. Surface oiling may extend 48 km from the spill location (predominantly in a southerly direction consistent with current direction) and low-level entrained phase exposures maty be experienced within the MSS area and along the western coastline of King Island.
Duration of Impact	Short-term and recoverable
Level of Certainty of Impact	HIGH. All parameters provided for spill modelling have been conservatively estimated to provide the largest credible spill footprint. Conservative thresholds have also been utilised to define this footprint. Modelling parameters are also conservative on the following basis: • Models used are best practice and industry standard conforming to quality standards (ASTM Standard F267-07); • Modelled tides and currents have been validated against actual tides and currents; • Weathering characteristics of MDO have been based upon scientific studies and the degree of confidence is high; • Sample size has been studied by RPS-APASA and shown that variation can occur between 50 and 100 simulation runs however the variation between 100 and 200 simulations results in minimal variation.
Species possibly affected within survey environment:	○ For water quality impacts: Plankton, pelagic fish (not protected), cetaceans, pinnipeds, seabirds, turtles (protected). ○ For shoreline residues: Marine seabirds / shorebirds (protected); sand/rock coastlines, bull kelp farming (not protected).
Impact Decision Framework Context	**Decision Context A** The potential for a vessel collision is is possible within the Dorrigo MSS. The management of offshore vessels is well regulated and understood. Risk are well understood and managed. No objections or concerns were raised by relevant stakeholders regarding vessel collisions or resulting spill events. A MDO refuelling spill has an inherently low risk that it would occur. Offshore refuelling (bunkering) of vessels is a frequently practiced activity with the causes of spills well understood and managed. Although there is the potential for sensitive receptors to be present within the Dorrigo MSS area, exposure to surface hydrocarbons would be low due to the dispersive nature of MDO. No objections or concerns were raised by relevant stakeholders regarding potential spills from refuelling. Decision context A will be applied to this aspect

Impact with controls failure (Inherent) (Based upon largest consequence for animal class)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Plankton/Fish Larvae	NEGLIGIBLE	POSSIBLE	LOW
Benthic Assemblages	MINOR	POSSIBLE	MEDIUM
Fish	NEGLIGIBLE	POSSIBLE	LOW
Cetaceans	SIGNIFICANT	POSSIBLE	MEDIUM
Pinnipeds	MINOR	POSSIBLE	MEDIUM
Turtles	MINOR	POSSIBLE	MEDIUM

Shorebirds/Seabirds	SIGNIFICANT	POSSIBLE	MEDIUM
Sandy Beaches	MINOR	POSSIBLE	MEDIUM
Rocky Beaches	MINOR	POSSIBLE	MEDIUM
Macro-algae	MINOR	POSSIBLE	MEDIUM
Saltmarsh	NEGLIGIBLE	POSSIBLE	LOW
Commercial Fishing	MINOR	POSSIBLE	MEDIUM
Commercial Shipping	NEGLIGIBLE	POSSIBLE	LOW
Tourism	MINOR	POSSIBLE	MEDIUM

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
*Controls assessment for the prevention of commercial shipping spatial conflicts (refer **Table 7-46**) also apply to vessel collision with significant diesel spill and should be read in conjunction with this table*			
Survey and support vessels used approved navigation systems	Prevent	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. *Environmental benefit outweighs costs.* **Control adopted.**
Survey vessel has an implemented and tested SOPEP	Administrative	YES	Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. *Environmental benefit outweighs costs.* **Control adopted.**
Fuel used will be MDO (alternates such as HFO are more persistent in a spill event)	Reduce	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. MDO evaporates rapidly leaving little residue after 24 hrs which is of benefit to sea surface species vulnerable to oil spills such as seabirds. *Environmental benefit outweighs costs.* **Control adopted.**
Crew have been drilled in shipboard oil response	Mitigate	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. *Environmental benefit outweighs costs.* **Control adopted.**
Titleholder OPEP in place and implemented	Mitigate	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. *Environmental benefit outweighs costs.* **Control adopted.**
MSS activity will occur outside protected areas	Eliminate	NO	This would leave large gaps in survey data coverage and would not meet data objectives. *Cost outweighs environmental benefit given the risk of large spill is low.* **Control not adopted.**

No refuelling within CMP areas	Eliminate	YES	Good practice. *Environmental benefit outweighs costs.* **Control adopted.**
Use vessels with smaller tank size	Reduce	NO	May lead to more refuelling events leading to additional risk. *Cost outweighs environmental benefit given the risk of large spill is low.* **Control not adopted**
MSS vessel could consider carrying less fuel in each tank.	Reduce	NO	May lead to more refuelling events leading to additional risk. *Cost outweighs environmental benefit given the risk of large spill is low.* **Control not adopted**
Use of alternate fuels (solar, wind, biofuels)	Eliminate	NO	Alternate fuel sources have not been commercially proven for use in large vessels. **Control not practicable.**
Refuelling is subject to bunkering procedures	Prevent	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. *Cost outweighs environmental benefit given the risk of large spill is low.* **Control not adopted**
No at-sea refuelling	Eliminate	YES	Vessel contact will specify that the vessel will be sufficiently fuelled for the duration of the survey upon commencement of activity. **Control adopted**
Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Plankton/Fish Larvae	NEGLIGIBLE	VERY UNLIKELY	LOW
Benthic Assemblages	MINOR	VERY UNLIKELY	LOW
Fish	NEGLIGIBLE	VERY UNLIKELY	LOW
Cetaceans	SIGNIFICANT	VERY UNLIKELY	LOW
Pinnipeds	MINOR	VERY UNLIKELY	LOW
Turtles	MINOR	VERY UNLIKELY	LOW
Shorebirds/Seabirds	SIGNIFICANT	VERY UNLIKELY	LOW
Sandy Beaches	MINOR	VERY UNLIKELY	LOW
Rocky Beaches	MINOR	VERY UNLIKELY	LOW
Macro-algae	MINOR	VERY UNLIKELY	LOW
Saltmarsh	NEGLIGIBLE	VERY UNLIKELY	LOW
Commercial Fishing	MINOR	VERY UNLIKELY	LOW
Commercial Shipping	NEGLIGIBLE	VERY UNLIKELY	LOW
Tourism	MINOR	VERY UNLIKELY	LOW
ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS			
EPO	**EPS**	**MEASUREMENT CRITERIA**	

To protect marine sensitivities no spill of MDO to the marine environment from vessels during Dorrigo MSS activity.	*Vessel Fuel* MDO will be used to fuel the vessels.	Bunker records verify marine diesel is utilised as fuel on-board the vessels. Responsibility: Vessel Master
	Bunkering Activities • No refuelling at sea will take place during the Dorrigo survey.	Vessel contact will specify that the vessel will be sufficiently fuelled for the duration of the survey upon commencement of activity. Responsibility: 3D Oil Project Manager
	Spatial restrictions on Refuelling Refuelling activities will not occur within the Zeehan CMP.	Records verify that spatial buffer are maintained during survey operations. Responsibility: Vessel Master
To protect marine sensitivities, vessels are prepared for an oil spill and implement arrangements should a spill occur.	*Vessel Integrity & Crew Trainging* Vessels selected for the MSS activity will have: • Class certification requirements under the Navigation Act 2012; • Relevant crew shall hold valid STCW certification (or equivalent to class).	Contractor selection records verify these specifications were met. Responsibility: 3D Oil Project Manager
	Vessel SOPEP Vessels have a current approved SOPEP (appropriate to class) consistent with the *IMO Guideline for the Development of Shipboard Marine Pollution Emergency Plans (or equivalent according to class)*.	Current and MARPOL-certified SOPEP (or equivalent to class) available on-board survey vessels. Responsibility: Vessel Masters
	Spill Cleanup Equipment Spill response equipment (spill kits) located in proximity to at-risk spill areas and replenished as required.	Inspection records verify kits are positioned in accordance with the SOPEP and checked for contents routinely. Responsibility: Vessel Master
	Crew Spill Training Crew are trained and competent in spill response procedures.	Training records demonstrate personnel are trained and competent. Responsibility: Vessel Master
To protect marine sensitivities, vessels are prepared for an oil spill and implement arrangements should a spill occur (Con't)	*Crew Environmental Induction* Crew (including MFOs) must attend an environmental induction containing basic information on spill response measures.	Induction material includes responsibilities for response and notification protocols. Induction attendance sheet. Responsibility: 3D Oil Project Manager
	Spill Response Exercise Prior to MSS activities an oil spill response exercise will be conducted to test interfaces between the SOPEP, OPEP, NATPLAN and TasPlan. The test will involve a vessel-based drill and testing of communications for notifying the RCC, at or near the survey location prior to the activity.	Records verify drills have been undertaken in accordance with the vessel's drills matrix. Record of OPEP/SOPEP test prior op survey commencement. Responsibility: Vessel Master & 3D Oil Project Manager
	SOPEP/OPEP Implementation In the event of an oil spill the SOPEP/OPEP are activated to mitigate the effects of the spill.	Incident log verifies SOPEP/OPEP were implemented for spill incidents. Responsibility: Vessel Master & 3D Oil Project Manager

	Spill Notification 3D Oil will report to spill to NOPSEMA within 2 hours of becoming aware of the spill. 3D Oil notifies the DNP as soon as possible if the spill is within or threatens a marine park. 3D Oil notifies marine stakeholders of spill include to prevent impacts to their activities within 4 hours of the event.	Incident log verifies contact was made with NOPSEMA and stakeholders within the timeframes noted. <u>Responsibility:</u> 3D Oil Project Manager
3D Oil to initiate operational and scientific monitoring to establish environmental impacts from the spill and inform mitigation and remediation activities.	*Operational/Scientific Monitoring Initiation* 3D Oil will undertake operational/scientific monitoring in accordance with the Dorrigo MSS OSMP (refer **Appendix 3**). *(Refer also to Oil Spill Response Option assessment – Section 7-14).*	Daily operation report and overall study reports verify the scientific monitoring plan has been implemented. <u>Responsibility</u>: 3D Oil Project Manager

Demonstration of ALARP	
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).
ALARP Statement	No reasonably practical additional, alternative, and/or improved control measures exist.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The risk management strategy for prevention of significant oil spills from vessel collision reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.5**); • Training and Awareness (**Section 8.4**); and • Emergency Response (**Section 8.6**) & **Appendix 2** (OPEP). • Environmental Performance Monitoring & Reporting (**Section 8.12**) & **Appendix 3** (OSMP)
External Context: Natural Environment	<u>Environmental Significance:</u> As per NES assessment above, the Dorrigo MSS area contains a number of environmental sensitivities which include: • Migrating and foraging cetaceans (the latter exposure reduced as a result of the MSS timeframe). SRW aggregation areas are outside the oil spill EMBA; • Transiting pinnipeds with nearby pinniped colonies located at distances which are not affected by spill residues; • Transiting turtle species (low densities); • Seabird BIAs consisting of widely dispersed albatross/petrel species and shearwaters which nest on adjacent coastlines; • Shoreline species on adjacent coastlines (Christmas Island Nature Reserve, New Year Game Reserve) which are sensitive to oil spills but also to anthropogenic impacts associated with cleanup activities. An MDO spill does not result in significant impacts to matters of NES (refer **Table 7-56 to 7-69**). <u>Key Ecological Features</u>: An MDO spill (surface spill) does not result in significant impacts to KEFs present in the Dorrigo MSS area. <u>Zeehan CMP</u>: Conservation values for the Zeehan CMP include migrating whales (humpback and blue) and foraging seabird BIAs (petrels/albatross/shearwaters). MDO spill residues may have localised impacts to these conservation values, however spill impacts are localised, short-term and recoverable, with no significant population exposure. <u>Commercial Fisheries:</u> SRL/giant crab and trawl fisheries are present within the Dorrigo MSS. These fisheries are all demersal so spill residue impacts to fish species are expected to be incidental.

External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with routine contact to spill response authorities. No issues raised with respect to MDO spills from vessels. Given the controls adopted and the lack of feedback from stakeholders, 3D Oil considers that there is broad acceptability of MDO spill risk associated with this activity.
Legislation & Conventions	The controls adopted to prevent spills from the Dorrigo MSS activity comply with the following legislative provisions: <u>Act/Statutes</u>: • *Navigation Act 2012* • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* • Marine Order 91 (Marine Pollution Prevention – Oil) • Marine Order 21 (Safe Navigation and Emergency Procedures) • Marine Order 27 (Safe Navigation and Radio Equipment) • Marine Order 30 (Prevention of Collisions) <u>International Conventions</u>: • International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78) • Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) <u>SE Marine Reserves Network Management Plan</u>: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMP in accordance with conditions of class approval (refer Management Plan Section 5.1). • Spill preparedness and response meet the requirements of MARPOL (refer Management Plan Section 5.3.3) <u>South-east Marine Region Profile:</u> No specific references in plan which relate to oil spill impact.
Legislation and Conventions	<u>Recovery/Conservation Plans & Advices</u>: • Marine pollution is a threat identified for marine turtles and their habitats particularly slow to recover habitats such as nesting habitats, seagrass meadows or coral reefs (*not present in the Dorrigo MSS EMBA*). • Marine pollution is a threat to albatross and giant-petrels in the National recovery plan for threatened albatross and giant petrels 2011-2016 (DSEWPC, 2011). Population monitoring is the suggested action to deal with marine pollution at nesting locations. *No nesting locations are within the oil spill EMBA.* • Marine pollution <u>and</u> human interference is a key threat to shoreline species (Australian fairy tern (TSSC, 2011); Curlew samdpiper (TSSC, 2015d); Eastern Curlew (TSSC, 2015f); Red Knot (TSSC, 2016a); Hooded Plover (TSSC, 2015); Lesser Sand Plover (TSSC, 2016b); bar-tailed godwit (TSSC, 2016c, TSSC, 2016d)). These species are rcognised in the oil spill response strategies (Section 7.14). • A key threat to Saltmarsh TEC (TSSC, 2013) is oil spill. This TEC is not affected by spill residues which contact the west King Island coastline. <u>Threat Abatement Plans</u>: No threat abatement plans are applicable.
Industry Standards	Compliance with industry standards: APPEA CoEP & IAGC Environment Manual.
Good Industry Practice/Industry Standard	Oil Spill Response Arrangements align with the following industry standards: • National Plan for Maritime Environmental Emerencies (AMSA, 2019 (NATPLAN); • Tasmanian Oil Spill Contingency Plan (TASPLAN). Other Codes adopted in the assessment of oil spill requirements include**:** **APPEA CoEP:** Objectives met for MSS with respect to reducing the risk of release of substances into the marine environment to a level which is ALARP and acceptable by: • Demonstrating appropriate management measures are in place and implemented in accordance with legislative requirements/guidelines; and • Having an appropriate emergency response plan. **IAGC:** The stated controls are compliant with the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.3 Prestart Operations) and for spill leak response (Section 8.6 – Hazardous Materials).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with a MDO spill during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)

Acceptability Assessment:	With controls adopted, to prevent MDO spills & respond to spills as quickly and efficiently as possible, 3D Oil will: • Prevent/minimise injury to marine fauna sensitive to oil spills (seabirds, pinnipeds); • Prevent/mimise impacts to other marine user activities; • Prevent/minimise impacts to shoreline fauna sensitive to oil spills (shoreline birds); and • Preserves the conservation values in the Zeehan CMP consistent with the IUCN principles which provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species.
Environmental Monitoring	
Operational/Scientific monitoring (**Appendix 3**)	
Record Keeping	
Records relevant to Commercial Shipping (refer **Section 7.8**). Vessel Class Certification SOPEP and SOPEP Drill Records Campaign-specific Exercise Report Crew induction and induction records Inspection records (spill kit replenishment) Bunkering Procedures Vessel Log Equipment PMS Records Incident Records (notification and investigation)	

7.13 RISK: Deck Spill to Marine Environment

7.13.1 Hazard

Packaged chemicals/oils used on-board during seismic operations are limited to small quantities of cleaning products, solvents, cable fluid, hydraulic oils, paints and primers, and lithium batteries. It is possible these chemicals/oils could leak during storage and/or handling and enter the marine environment through the deck drainage system. Chemicals (e.g. solvents and detergents) are typically be stored in small containers between 5 to 25 litres and stored/used in internal areas where leaks/spills are retained on-board and cleaned-up in accordance with the SOPEP (or equivalent for vessels< 400 GRT) and associated spill clean-up procedures. Some spills may occur when small containers of chemicals are being used in open areas, where there is a risk of entering the sea if spilled. The realistic worst-case spill volume is assessed at 25 litres.

7.13.2 Known and Potential Impacts

Potential impacts associated with the accidental release of chemical/oil releases include:

- Pollution of surrounding surface waters; and
- Toxicity to marine biota (fish, plankton).

Area affected by impact: The area which could be affected by package chemical/oil releases is limited to the Dorrigo MSS area immediately around the vessel. The Dorrigo MSS area is located within Commonwealth waters.

Possible environment/receptors affected by impact:
Receptors which may occur within this area and are at risk from the accidental release of packaged oil/chemicals are:

- Pelagic fish;
- Marine mammals;
- Marine turtles; and
- Seabirds.

7.13.3 Evaluation of Environmental Risk

On-board drainage consists of two distinct areas:

- Drainage from bunded areas which are isolated from the open deck; and
- Open deck areas which handle 'uncontaminated' water runoff (wash-down water, rainwater and sea-spray) and drain directly to the marine environment.

Decks are maintained clean and free from oil and grease, with all hazardous materials stored in bunded areas and drip trays under any potential leakage points. Uncontaminated deck drainage from rain, sea splash and wash down water is channeled via scuppers directly into the sea. Impacts from desk drainage can only occur from minor spills that are not appropriately responded to and clean-up. These spills can potentially be discharged into the marine environment via deck drainage

Vessels operate with Safety Data Sheets (SDS) available for chemicals on-board which detail the clean-up requirements for any spills. Crew are trained in spill clean-up requirements. For infrequent activities (e.g. vessel refuelling) temporary bunding is put in place to prevent spills from entering the marine environment (refer **Section 7.12**).

Extent and duration of exposure and identified potential impact: Given the small volumes of deck drainage, the low concentration of chemicals or hydrocarbons that it could contain, any release to the sea would be expected to result in a change to water quality that is highly localised and temporary in nature. Impacts would be limited to the immediate area surrounding the release point, prior to rapidly dilution and dispersal by currents. Therefore any pollution would be temporary and localised ('Negligible' consequence). With the on-board controls implemented (e.g. inspection, bunding, spill clean-up procedures) such incidents are considered unlikely and the residual risk is assessed as LOW.

Impacts to Matters of National Environmental Significance:
The accidental release of deck spills to the marine environment will not have a 'significant' impact to any of the matters of NES, as outlined in the box below:

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Sub-Tropical and Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Small quantities of oil/chemicals released to the marine environment will affect waters on a localised basis before rapidly diluting. This will not result in any 'significant impacts' to populations of threatened fauna.	The TEC is not located in the area which is affected by the spill residues.	Migration, feeding, resting or breeding activities will not be impacted by small quantities of oil/chemical within the water column.	Given the small volume of material released the localised discharge will not result in disturbance to an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality adversely impacting on biodiversity or ecological integrity.

'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance associated with a deck spill are outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and Nationally Important Wetlands	Commonwealth Marine Park (CMP)	Coastal protected areas
X / X	X	✓	X
As the oil/chemical impacts will be restricted to the upper water column, these KEFs remain unaffected by the spill material. The small localised area of impact, this release is not expected to result in disturbance to a substantial area of habitat such that an adverse impact on ecosystem functioning or integrity occurs. Nor does it result in a substantial change in water quality which would adversely impacting on biodiversity or ecological integrity.	There are no nationally important wetlands within the spill residue area.	Temporary and localised reduction in water quality is possible within the upper water column within the Zeehan CMR if waste is accidently released. This localised, temporary and recoverable release will not result in impacts to conservation values within the CMR.	Coastal protected areas are outside the area affected by a package oil/ chemical spill to the marine environment.

7.9.4 Environmental Risk Assessment

Table 7-71 provides the ERA for a packaged oil/chemical spill overboard incident.

Table 7-72: ERA for release of packaged oil/chemical overboard spill

Aspect	Release of package-volumes of oil/chemical overboard to the marine environment		
Impact Summary	• Pollution of surrounding surface waters; and • Toxicity to marine biota (fish, plankton).		
Extent of Impact	In general, if incident occurs this will generally result in localised impacts around point of discharge. Materials will be rapidly dispersed by local currents and volumes will be small.		
Duration of Impact	Short-term (water quality impact) and recoverable (due to rapid dispersion and dilution).		
Level of Certainty of Impact	HIGH. Impacts from deck spills of limited volume are known.		
Species possibly affected within survey environment:	○ For water quality impacts: Plankton and Fish (not protected), marine mammals, seabirds (protected).		
Impact Decision Framework Context	**Decision Context A** The use of vessels and potential for deck spills from vessel activities is normal during offshore operations. Impacts are well understood and the management of spills waters is well practiced and understood. There is little uncertainty associated with this aspect. The offshore management of spills and deck discharges is well regulated. There have been no issues or concerns raised by relevant stakeholders regarding deck discharge management, decision context A will be applied to this aspect.		
Impact with controls failure (Inherent)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Fauna Impact (Ingestion)	MINOR	POSSIBLE	MEDIUM

ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Compliance with Protection of the Seas (Prevention of Pollution from Ships) Act 1983 and Marine Order – Part 94 – Packages Harmful Substances	Prevent (engineering/ administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**
All storages designed to contain spillage. This includes scupper plugs beside all deck drainage points leading overboard so drains can be blocked in the event of a spill.	Prevent (isolation control)	YES	Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. **Control adopted**
SDSs are available for all hazardous materials aboard the survey and support vessels.	Mitigate (administrative)	YES	Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. **Control adopted**
Storage areas shall be routinely inspected, and high levels of housekeeping maintained.	Prevent (Administrative/ control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**
Implemented and tested SOPEP for both survey and support vessels.	Administrative	YES	Good Practice – well defined and established standard practices adopted by offshore petroleum sector. **Control adopted**
Spill response bins/kits located in close proximity to storage areas from prompt response in the event of a spill or leak	Mitigate (administrative)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**
All crew participate in an environmental induction prior to survey commencement to understand their responsibility with respect to chemical handling and spill clean-up.	Prevent (Administrative control)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector. **Control adopted**
No hazardous materials will be used aboard either the survey or support vessel.	Eliminate	NO	Hazardous materials (e.g. hydraulic fluid, lubricating oils, cleaning chemical, paints, solvents, batteries, etc.) are required for the safe and efficient operation of the survey and support vessels. Suitable chemicals which fulfil the required performance characteristics of these chemicals are required.

Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Fauna Impact (Ingestion)	MINOR	VERY UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**

To protect marine sensitivities, no release of chemicals/oils will occur through the deck drainage system from Vessel during the Dorrigo MSS to the marine environment.	*Chemical/Oil Storage Facilities* All storage facilities are designed so to contain spillages. Any hydrocarbon storage or equipment located on-deck utilising hydrocarbons must be designed and maintained to have at least one barrier (i.e. deck edge lips or upstands) to contain and prevent deck spills.	Inspection ensures hazardous materials are stored and handled in accordance with these requirements. Responsibility: Vessel Master/Chief Engineer
To protect marine sensitivities, vessels are prepared for a spill and implement arrangements should a spill occur.	*SDS Availability* All hazardous substances (as defined in NOHSC: 1008 [2004] - Approved Criteria for Classifying Hazardous Substances) aboard the survey and support vessels will have SDSs that are readily available on board	Records verify the SDSs are available and correct for all hazardous materials on-board. Responsibility: Vessel Master/Party Chief
	Spill Kits Available Spill response bins/kits are located in close proximity to storage areas for prompt response in the event of a spill or leak. The kits will be checked for their adequacy and replenished as necessary prior to the commencement of activities and on a regular basis thereafter.	Spill kits will be checked prior to commencement of activities (pre-mobilisation audit. Responsibility: Vessel Master Inspection records verify that spill response kits are close to storage areas and are checked/ replenished on a regular basis. Responsibility: Vessel Master
	Crew Environmental Induction All crew participate in an environmental induction prior to survey commencement to understand their responsibilities with respect to chemical handling and spill clean-up	Induction records verify that the deck crew have undertaken chemical handling and spill response training. Responsibility: Vessel Master
	SOPEP Availability The survey vessel/support vessel over 400GT must have an implemented and tested SOPEP in place that complies with the requirements of: • MARPOL Annex I (Regulation 37) • Marine Order 91 (Marine Pollution Prevention – Oil) 2014 Other vessels will have a SOPEP-equivalent document for spills to deck.	Records demonstrate that the vessel has a SOPEP (or equivalent) in place Responsibility: Vessel Master
	SOPEP Drills SOPEP drills are undertaken in accordance with the Vessel Drills Matrix (or equivalent) to ensure personnel is familiar with their role during an oil/chemical spill event	Record verify SOPEP (or equivalent) drills have been undertaken. Responsibility: Vessel Master
	SOPEP/OPEP Implementation In the event of an oil spill the SOPEP/OPEP are activated to mitigate the effects of the spill.	Incident log verifies SOPEP/OPEP were implemented for spill incidents. Responsibility: Vessel Master & 3D Oil Project Manager

Demonstration of ALARP	
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).
ALARP Statement	No reasonably practical additional, alternate and/or improved control measures exist.

Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The risk management strategy for deck spills reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** details the relevant management system processes adopted to implement and manage hazards to ALARP: • Contractor and Supplier Management (**Section 8.5**); • Training and Awareness (**Section 8.4**); and • Emergency Response (**Section 8.6**) & **Appendix 2** (OPEP).
External Context: Natural Environment	Environmental Significance: As per NES assessment above, the Dorrigo MSS area contains a number of environmental sensitivities which if a deck spilloccurs, due to the local and transite nature of the spill will not affect matters of NES. These include include: • Migrating and foraging cetaceans (the latter exposure reduced as a result of the MSS timeframe). • Transiting pinnipeds and turtle species; and • Seabird BIAs consisting of widely dispersed albatross/petrel species and shearwaters. Key Ecological Features: A deck spill will not affect KEFs present in the Dorrigo MSS area. Zeehan CMP: Conservation values for the Zeehan CMP include migrating whales (humpback and blue) and foraging seabird BIAs (petrels/albatross/shearwaters) will not be affected by a deck spill given their very localised, short-term and recoverable impacts with no significant population exposure. Commercial Fisheries: SRL/giant crab and trawl fisheries are present within the Dorrigo MSS. These fisheries will not be affected bya a deck spill.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with no issues raised with respect to deck spills from vessels. Given the controls adopted and the lack of feedback from stakeholders, 3D Oil considers that there is broad acceptability of the accidental release risk associated with this activity.
Legislation and Conventions	The controls adopted to prevent spills from the Dorrigo MSS activity comply with the following legislative provisions: Act/Statutes: • *Navigation Act 2012* • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* • Marine Order 94 (Marine Pollution Prevention – Packaged Harmful Substances) • Marine Order 91 (Marine Pollution Prevention – Oil) International Conventions: • International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78) SE Marine Reserves Network Management Plan: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1). • Oil/Chemical management during the survey meets the requirements of MARPOL (refer Management Plan Section 5.3.3) South-east Marine Region Profile: No specific references in plan which relate to waste disposal. Recovery/Conservation Plans & Advices: • 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, 2011). Population monitoring at breeding locations is the suggested action to deal with marine pollution. The risks posed by MSS activities do not impact on breeding locations. • Shoreline birds will not be affected by deck spill residues. Threat Abatement Plans: Threat abatement plans not triggered.
Good Industry Practice	**APPEA CoEP:** Objectives met for MSS with respect to reducing the risk of release of substances into the marine environment to a level which is ALARP and acceptable by: • Demonstrating appropriate management measures are in place and implemented; and • An appropriate spill response plan is in place for the activity. **IAGC:** The stated controls for oil/chemical management and spill response for deck spills conform with the requirements detailed in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.6 Hazardous Materials).

Industry Standards	Compliance with industry standards: APPEA CoEP & IAGC Environment Manual.
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with accidental release of package oil/chemicals during the Dorrigo MSS. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted, to prevent deck spills 3D Oil will: • Prevent/minimise injury to marine fauna; and • Preserve the conservation values in the Zeehan CMP consistent with the IUCN principles which provide for the ecologically sustainable use and conservation of ecosystems, habitats and native species.
Environmental Monitoring	
Nil	
Record Keeping	
Incident Records Crew induction and attendance records Vessel Housekeeping Inspections SOPEP SOPEP Drill Records Chemical/Oil SDSs	

7.14 RISK: Oil Spill Response Strategies

This section represents the risk assessment for oil spill response options as required by the Commonwealth OPGGSER Regulations 13(6)(b) and NOPSEMA Oil Pollution Risk Management Guideline (GN1488, Rev 2).

7.14.1 Oil Spill Arrangements in Tasmanian and Commonwealth Waters

Table 7-72 details the control agency (CA) arrangements for oil spill by location for Commonwealth and Tasmanian waters.

Table 7-73: Control Agency arrangements for Commonwealth and Tasmanian State Waters

Location	Release Source	Statutory Authority	Applicable Plan	Applicable Legislation	Control Agency: Level 1	Control Agency: Level 2
Commonwealth waters (> 3nm from the coast baseline)	Survey Vessel	AMSA	NATPLAN	Australian Maritime Safety Authority Act 1990	AMSA	AMSA
Spill threatening or occurring in State Waters (< 3nm from coast baseline)	Survey Vessel	State Marine Pollution Committee (SMPC)	TASPLAN	Emergency Response Act 2005	EPA Tasmania	EPA Tasmania

National Plan for Maritime Environmental Emergencies: All vessel-based spill incidents within Commonwealth waters are controlled by AMSA as the designated CA. Upon notification of an incident involving a ship AMSA will assume control of the incident in accordance with the National Plan for Maritime Environmental Emergencies (AMSA, 2019) (NATPLAN). NATPLAN sets the framework for spill response activities according to the resources at risk, the type of incident (duration and size) and the resources required to respond (AMSA, 2019). NATPLAN is supported by the National Response Team (NRT) consisting of qualified, trained and experienced state/territory resources which can be activated by AMSA, as necessary, in the event of a spill incident.

The oil industry also has a ready response group ('Core Group') which operates under AMOSPlan to support Level 2 or Level 3 spill responses. These responders have minimum core competencies and operate together during regular training and exercises. The Core Group is available to AMSA to support NATPLAN in vessel-based spill responses.

AMSA maintains equipment at nine strategic locations around the Australian coastline, which includes Melbourne and Devonport. This equipment supplements local and regional resources within states/territories. Additional stockpiles of equipment are accessible under AMOSPlan (AMSA, 2019). AMOSC holds stockpiles of equipment at various locations with its largest stockpile in Geelong. These resources are accessed through AMSA (AMSA, 2017; DPIPWE, 2011).

Tasmanian Marine Oil Spill Contingency Plan: TASPLAN applies to actual or potential oil spills in Tasmanian state waters and adjacent shorelines. Tasmania is also the designated CA where oil spilled outside Tasmanian State waters impacts or has the potential to impact on Tasmanian shorelines under NATPLAN arrangements (DPIPWE, 2011). TASPLAN is supported by trained resources and exercises are held annually to test arrangements (DPIPWE, 2011).

TASPLAN operates within the framework of NATPLAN and complements NATPLAN arrangements providing the interface between NATPLAN and regional, local port and facility plans. This includes the Tasmanian Oiled Wildlife Response Plan (WildPlan) administered by DPIPWE which outlines priorities and procedures for the rescue and rehabilitation of oiled wildlife (DPIPWE, 2011).

TASPLAN equipment is located at Burnie, Devonport, Bell Bay and Hobart and under TASPLAN arrangements, local government may be requested to supply earth-moving, amenities, storage and transport equipment. Local government may take on the responsibility for the cleanup of shoreline for minor impacts of oil (DPIPWE, 2011). Access to other state and national equipment stockpiles is made via AMSA.

7.14.2 Oil Spill Risks Associated with Dorrigo MSS

Oil Spill Risks associated with the Dorrigo MSS activity include:

- Vessel collision (fuel tank rupture);
- Refuelling spill;
- Deck Spill;
- Failure of bilge water treatment system.

These scenarios and initial actions/responsibilities to be taken is contained in the vessel SOPEP (summary provided in OPEP (**Appendix 2**)).

7.14.3 Assessment of Response Options

Table 7-73 provides an assessment of the available oil spill response options, their suitability to MDO and their possible adoption during Dorrigo MSS activities.

Table 7-74: Suitability of Response Options for MDO

Response Option	Description	MDO Assessment	Suitability
Source Control	Limit flow of oil to environment	Achieved by vessel SOPEP	✓
Monitor and Evaluate	Direct Observation – Aerial or Marine; vector calculations; oil spill trajectory modelling; satellite tracking buoys.	MDO spreads rapidly to thin layers. To maintain situational awareness all monitor and evaluate options are suitable. Aerial is more effective than vessel surveillance to inform spill response.	✓
Natural Degradation	This response option is adopted with a monitor and evaluate surveillance strategy when sensitive environmental resources are not considered 'at risk' from a marine oil spill.	MDO evaporates rapidly leaving only small levels of persistent residues after 24-48 hrs of weathering. No toxic components are predicted to be present in concentrations which would affect marine fauna after approximately 24 hours. Predictive modelling identifies that sea surface spill residues > 10µm are unlikely to enter state waters or encroach on the west King Island coastline. Response option is preferred for MDO spills as it avoids other additional hazards associated with intervention.	✓
Dispersant Application	Breakdown surface spill and draw droplets into upper layers of water column. Increases biodegradation and weathering.	MDO, while having a small persistent fraction, spreads rapidly to thin layers. Dispersant application can result in punch-through where dispersant passes into the water column without breaking oil layer down. This response option is unsuitable to MDO.	X
In-situ burning	Controlled in-situ burning involves the controlled burning of hydrocarbons in order to rapidly reduce the volume of oil on the water's surface, thereby reducing its spread to sensitive receptors.	In-situ burning is only suitable for use on hydrocarbons >1-2 mm think with calm sea and light winds. It also requires fire-resistent booming. MDO spreads rapidly to lea than 10µm (0.01mm) which makes this response option unsuitable for a MDO spill in the Dorrigo MSS area.	X
Contain and Recover	Booms and skimmers to contain surface oil. Relies on calm conditions and thicknesses > 10µm to collect.	MDO spreads rapidly to less than 10µm thicknesses which are present for only 24-28 hours for a 400 m^3 MDO spill. Given the time to mobilise resources to the spill site (> 48hrs), this response option is unsuitable for an MDO spill in the Dorrigo MSS area.	X

Response Option	Description	MDO Assessment	Suitability
Protect & Deflect	Booms and skimmers deployed to protect environmental sensitivities. Environmental conditions (e.g. currents, waves limit application)	MDO has persistent components and can only reach the shoreline in thicknesses of 0.5µm. Normally open estuaries (still water with no significant tidal flows) with environmental sensitivities (aquatic vegetation, recreational users) may benefit, however predictive modelling indicates only surface sheens will be present along the west King Island coastline. Net environmental benefits to open shorelines with wave action are unlikely given the required conditions for protect and deflect to be effective (limited currents, low waves). The west King Island shoreline is a high-energy coastline	✓ (estuaries) X (Open beaches)
Shoreline Cleanup	Where shoreline impact is predicted, initiate a shoreline clean-up assessment technique (SCAT) assessment where safe to undertake. Note SCAT assessments will depend on the personnel safety factors and for high energy environments such as rocky inter-tidal shelf/cliffs (not considered a sensitive environment (Hook et al, 2016)), SCAT resources may not be deployed for assessment. If SCAT and NEBA assess clean-up is of net benefit, initiate clean-up.	MDO residues are known to infiltrate sand where it will be susceptible to remobilisation by wave action (reworking) until it has naturally degraded. MDO does not discolour shoreline as much as other hydrocarbon types. Manual collection techniques likely to have limited effectiveness. Use of sediment reworking is possible but highly disruptive to beaches and carries a significant health and safety hazard if undertaken by hand. Sediment reworking is only considered a suitable technique if undertaken by equipment eliminating personnel exposure. This may be suitable for the limited number of beaches along the west coast of King Island affected by hydrocarbon loadinsg > 100 g/m^2.	✓ (mechanical reworking only)
Oiled Wildlife Response	Consists of capture, cleaning and rehabilitation of oiled wildlife. May include hazing or pre-spill captive management. In Tasmania this is managed by DPIPWE.	Given size and spreading, large scale wildlife response is not predicted. Potential for individual birds to be affected in the vicinity of spill or potentially along adjacent shorelines where residue may accumulate. Considered a suitable response for MDO spill type.	✓

Protection Priorities

Table 7-74 provides an assessment of the shoreline sensitivities (refer **Table 7-55**) within the EMBA and response options which could be considered for MDO spills from the Dorrigo MSS area. Response options assessed as unsuitable in **Table 7-73** have not been considered further.

The EMBA is defined as the area within the sea surface oil footprint of > 0.5µm[63] (visible sheen) and where shoreline residues > 100 g/m^2 based upon the largest credible oil spill for the Dorrigo MSS activity. The Dorrigo MSS OSTM report contained in **Appendix 6** identifies that only Christmas Island Nature Reserve, New Years Island Game Reserve and Fitzmaurice Bay may be affected by spill residue accumulation in thresholds > 100 g/m^2. Oil spill residues > 0.5µm have been assumed to enter state waters along the entire west coast of King Island.

Table 7-75: Protection Priorities within the Dorrigo MSS 400m^3 MDO EMBA

[63] Visible sheen threshold is selected for tourism related impacts.

Conservation Area/ Sensitive Area	Oil Spill Sensitivities (Protection priorities)	Shortest Timeframe to Impact	Response Options				
			Source Control	Monitor & Evaluate	Natural Degradation	Shoreline Cleanup	Oiled Wildlife Response
Zeehan CMR	Cetaceans Pinnipeds Seabirds	Immediate (all surface oil threshold thicknesses)	✓	✓	✓	X	✓
Apollo CMR	Cetaceans Pinnipeds Seabirds	Sheen (0.5µm): ~ hrs Surface Oil Ecological (10µm+): NA	✓	✓	✓	X	X
Christmas Island Nature Reserve	Sea/shorebird colonies (breeding incl. hooded plover, penguin, terns) Sandy Beaches Sub-tidal Reefs Rocky Shorelines Cobble beaches	Sheen (0.5µm): ~ 30 hrs Shoreline (> 100g/m^2): 39 hrs	✓	✓	✓	X[64]	✓
New Year Island Game Reserve	Sea/shorebird colonies Sandy Beaches Sub-tidal Reefs Rocky Shorelines Cobble beaches	Sheen (0.5µm): ~ 30 hrs Shoreline (> 100g/m^2): 39 hrs	✓	✓	✓	X[65]	✓
Seal Rocks State Reserve	Bird Colonies Sub-tidal Reefs Rocky shorelines/cliffs	Sheen (0.5µm): ~ 30 hrs	✓	✓	✓	X	✓
Cape Wickham Conservation Area (Victoria Cove)	Hooded Plovers Seabirds Sandy Beach Kelp Farming	Sheen (0.5µm): ~ 30 hrs Shoreline (> 100g/m^2): 39 hrs	✓	✓	✓	✓[66]	✓
Porky Beach Conservation Area (Sandy Bays)	Red-capped Plover Hooded Plover Mixed sand/shoreline Kelp Farming	Sheen (0.5µm): ~ 30 hrs Shoreline (> 100g/m^2): 39 hrs	✓	✓	✓	✓[67]	✓
Currie Harbour	Sand Beaches Hooded Plover Tourism Harbour Facilities	Sheen (0.5µm): ~ 30 hrs Shoreline (> 100g/m^2): 39 hrs	✓	✓	✓	✓[68]	✓
Cataraqui Point Conservation Area (Sandy Bays)	Hooded Plover Red-capped Plover Seabirds Sand Beaches Kelp Farming	Sheen (0.5µm): ~ 30 hrs Shoreline (> 100g/m^2): 39 hrs	✓	✓	✓	✓[69]	✓
Stokes Point Conservation Area (Sandy Bays)	Hooded Plover Red-capped Plover Seabirds Sand Beaches	Sheen (0.5µm): ~ 30 hrs Shoreline (> 100g/m^2): 39 hrs	✓	✓	✓	✓[70]	✓

In accordance with NOPSEMA Oil Pollution Risk Management Guidance (GN1488, Rev 2, Feb 2018), each of the identified suitable response options identified in **Table 7-74** are assessed for

64 No mechanical equipment available on Christmas Island Nature Reserve. Manual sediment reworking not effective or safe.

65 No mechanical equipment available on New Year Island Game Reserve. Manual sediment reworking not effective or safe.

66 Dependent on equipment access availability. Manual sediment reworking not effective or safe.

67 Dependent on equipment access availability. Manual sediment reworking not effective or safe.

68 Dependent on equipment access availability. Manual sediment reworking not effective or safe.

69 Dependent on equipment access availability. Manual sediment reworking not effective or safe.

70 Dependent on equipment access availability. Manual sediment reworking not effective or safe.

effectiveness in protecting the identified sensitivities and also for reducing response activity impacts to demonstrate collectively these control measures reduce the oil spill risks to ALARP and acceptable levels.

Note that natural degradation is not assessed here, as the response option doses not introduce any additional risks as a result of the activity. Natural degradation is a natural process which takes place regardless of human intervention.

Response: Source Control
Source control actions for the Dorrigo MSS oil spill risks have been discussed in **Section 7.12** and **Section 7.13**.

Response: Monitor & Evaluate
Overview of Strategy: Ongoing monitoring and assessment of the oil spill is a key strategy and critical for maintaining situational awareness and to complement and support the success of other response activities. In some situations, monitoring and evaluation may be the primary response strategy where the spill volume/risk reduction through dispersion and weathering processes is considered the most appropriate response strategy.

It is the responsibility of the Control Agency (CA) to undertake operational monitoring during the spill event to inform the operational response. Operational response includes the following:

- Aerial observation;
- Vessel-based observation;
- Predictive tools:
  - Oil spill trajectory modelling;
  - Vector analysis (manual calculation); and
  - Automated Data Inquiry for Oil Spills (ADIOS) (a spill weathering model).

For Commonwealth vessel-based spills, the responsibility for operational monitoring lies with the CA, AMSA. AMSA as nominated in the National Plan for Maritime Environmental Emergencies (AMSA, 2019) undertakes:

- Regular drills to test response capability;
- Maintains 'on-call' listing of trained personnel to undertake operational monitoring;
- Regular inspection and testing of its oil spill response equipment; and
- Maintains an agreement with RPS-APASA for OSTM services.

Under these arrangements, operational monitoring will be undertaken in a timely manner to identify and mitigate oil spill risks with trained and expert resources.

Resource Availability: In accordance with the National Plan for Maritime Environmental Emergencies (AMSA, 2019), AMSA coordinates the national arrangements with respect to trajectory modelling, remote sensing and aerial surveillance associated with a vessel-related spill in Commonwealth waters. These arrangements are contracted with external parties where required (including response times), trained and available to attend to an emergency.

Resources used in a Level 2 'monitor and evaluate' response include:

- Aerial observation: Aircraft and trained observers (AMSA resources);
- Vessel Observation: Vessels and spill observers (AMSA resources with backup by 3D Oil vessel resources);
- Oil Spill Trajectory Modelling (AMSA with backup by 3D Oil).

3D Oil will have capability to assist with operational monitoring during the Dorrigo MSS via available marine vessels. 3D Oil also has a relationship with RPS for spill modelling suppory (not emergency call-out). 3D Oil would initiate Type II (scientific monitoring) in the event of a Level 2 spill incident from a Dorrigo MSS vessel spill. This would utilise the Dorrigo MSS support vessels and MFOs present on those vessels. This resourcing is provided in the Dorrigo MSS OPEP (refer **Appendix 2**).

Monitor and Evaluate 'Activity' Impact/Risk Evaluation:

Environmental Hazard:
The following activities associated with operational monitoring have the potential to interfere with marine fauna:

- Additional vessel activity (over a greater area); and
- Aircraft[71] use for aerial surveillance.

This activity may be undertaken in Commonwealth or Tasmanian state waters.

Known and Potential Impacts:
The known and potential impacts of vessel and aircraft (helicopter or fixed wing) noise in the environment is:

- Potential behavioural impacts/damage to whale and pinniped species.

Assessment of Environmental Impacts & Risks:
Aircraft: The behavioural reaction of cetaceans to circling aircraft (fixed wing or helicopter) is sometimes conspicuous if the aircraft is below an altitude of 300m, uncommon at 460m and generally undetectable at 600m (NMFS, 2001; cited in Santos 2004; Richardson et al, 1995). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animals. The effect on whales seems transient, and occasional over-flights probably have no long-term consequences (NMFS, 2001; cited in Santos, 2004).

Richardson et al. (1995) identifies for Californian sea lions (an Octariid similar to fur seals) the following behaviours to flight sound:

- Jets above an altitude of 305 m produced no reaction and below that height caused limited movement but no major reaction;
- Light aircraft directly overhead at altitudes of < 150-180 m elicited alert reactions and in sea lion's movement;
- Helicopters above 305 m usually caused no observable response while those below caused the pinnipeds to raise their heads, often causing some movement and occasionally caused rushes by some animals into the water.

[71] Helicopters are assessed as part of Section 7.2 (Acoustic Noise)

Aerial surveillance platforms will operate at between 300 – 500 m altitudes when undertaking observation activities (AMSA, 2003). In accordance with the EPBC Regulations (Part 8) a fixed wing aircraft will maintain a buffer of 300 m from a cetacean and a helicopter will maintain 500m from a cetacean. Note that any noise produced by surveillance aircraft is localised and temporary as the platform is in constant movement. On this basis impact to cetaceans is expected to be temporary, localised and recoverable (negligible consequence);

Vessels: Disturbances/damage to cetaceans in open ocean habitats has been assessed in **Section 7.2** (vessel sound). Vessel movement near seal colonies can also cause disturbance particularly during breeding periods (November to December), however there are no colonies within the MDO response footprint nor does it temporally overlap the breeding period of fur seals. Sea lions in the water tolerate close and frequent approaches by vessels and if on land, rarely react unless the boat approaches within 100-200m (Richardson et al, 1995).

Impacts to Matters of National Environmental Significance:
A 'monitor and evaluate' response strategy is not likely to have a significant impact to any matters of NES as outlined below. Note this covers aerial surveillance only, as vessel disturbance activities are covered in **Section 7.2** (sound impacts) and **Section 7.11** (vessel impact/disturbance).

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Sub-Tropical and Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	✓
Significant impacts to populations of threatened species from aerial surveillance is remote as outlined above. Dorrigo MSS timeframe avoids most threatened cetacean presence in the area, and the location does not overlap cetacean (southern right whale) aggregation areas – a species which may be present in the area at the time of the survey.	Aerial surveillance does not impact on TECs.	Significant impacts to populations of migratory species from aerial surveillance is remote as outlined above.	The Commonwealth marine environment is not affected by aerial surveillance activities.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo EMBA associated with a 'monitor and evaluate' response strategy is detailed below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and National Wetlands of Importance	Commonwealth Marine Parks (CMP)	Coastal protected areas
X / X	X	✓	✓

These KEFs are located on the seabed and will not be affected by aerial surveillance.	There are no nationally important wetlands within the EMBA.	The Apollo CMP and Zeehan CMP may be overflown by aircraft however conservation values will not be impacted by the activity.	The following coastal reserve areas may be overflown by aerial surveillance aircraft: • Christmas Island Nature Reserve; • New Year Island Game Reserve; • Seal Rocks State Reserve; Reserve conservation values will not by aerial surveillance activities (refer to **Appendix** 7).

Environmental Impact/Risk Assessment summary:

Table 7-75 provides a summary of the EIA/ERA for monitor and evaluate activities.

Table 7-76: Oil Spill Response – Monitor and Evaluate EIA.ERA

Aspect	Response – Operational Monitoring		
Impact Summary	Impact to marine fauna due to increased vessel activity or aircraft surveillance.		
Extent of Impact	Localised (immediately around vessel or aircraft)		
Duration of Impact	Temporary (duration of surveillance) and recoverable.		
Level of Certainty of Impact	HIGH. Impacts from sound disturbance to marine fauna is well understood and controls documented in legislation.		
Species possibly affected within survey environment:	Marine mammals and seabirds (protected).		
Impact Decision Framework Context	**Decision Context A** The use of aircraft offshore during spill response activities is understood and well practiced and potential impacts well studied and understood. Sound levels associated with aircraft are not large enough to result in significant impacts. No objections or concerns were raised by relevant stakeholders regarding the generation of noise from aircraft. 3D Oil believes that decision context A is applied to this hazard.		
Impact with controls failure (Inherent)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Fauna Disturbance	MINOR	POSSIBLE	MEDIUM
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION

Use of aerial/vessel surveillance to verify and monitor spill residue locations for a Level 2 MDO spill.	Mitigative surveillance method (administrative)	YES	Good Practice – well defined and established standard practice by the offshore petroleum sector during spill incidents. Improves situlational awareness. This capability is covered by AMSA together with trained observers for slick monitoring. As spill residues > 10µm remain in the environment for 1-2 days (& more probably < 24 hrs) and within 14 km of the spill site (i.e. in Commonwealth waters), 3D Oil considers that the more immediate 'vessel' platform to offer more immediate benefits to track and verify oil spill trajectory. 3D Oil does not consider it is necessary to duplicate AMSA's aerial observation capability for effective spill monitoring. Control is effective depending upon weather conditions**. Adopted in NATPLAN arrangements.**
Utilise OSTM, vector calculation, to determine where oil spill residues may impact	Preventative surveillance method (administrative)	YES	Good Practice – well defined and established standard procedures adopted by the offshore petroleum industry. AMSA has a standing contract with RPS to initiate OSTM when authorised by the Incident Controller. Technique offers benefits in predicting where impacts may arise and pre-emptive initiation of actions to prevent impacts. **Control is effective and adopted in NATPLAN arrangements**
Oil Spill Tracking Buoy	Preventative surveillance method (administrative)	YES	Good-practice. Assists in informing the spill direction and speed in the event of an incident. **Control adopted.**
Remote sensing techniques (satellite)	Preventative surveillance method (administrative)	Possible	Remote sensing methods are used to survey large areas of open ocean and provide images on the extent of slicks (Hook et al, 2016). Technique has some limitations - requires specialised training to interpret images and environmental conditions (cloud, wind) can complicate interpretation (Hook et al, 2016). For the size and duration of a potential Dorrigo MSS oil spill and its potential impacts, 3D Oil does not consider this surveillance technique is warranted or as reliable as vessel-based/aerial surveillance. **Control is available in NATPLAN arrangements. AMSA will determine whether this technology is used.**

Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Fauna Disturbance	NEGLIGIBLE	VERY UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
Preparedness Controls		

<table>
<tr><td rowspan="4">To inform spill response strategies and mitigate environmental impacts, 3D Oil maintains the capability to undertake vessel-based monitoring during the Dorrigo MSS.</td><td>Support Vessel Availability
The Dorrigo MSS will have two support vessels which (as practicable/ required) have the capability of being deployed to assist with oil spill surveillance.</td><td>Records verify two support vessels are engaged for the Dorrigo MSS activity.
<u>Responsibility</u>: 3D Oil Project Manager</td></tr>
<tr><td>Oil Spill Slick Estimation
Crew members are provided with basic training in oil spill surveillance and estimation techniques in accordance with the Bonn Agreement Oil Apperarence Code (BAOAC).</td><td>Training records verify that crew have been trained in surveillance and estimation techniques.
<u>Responsibility</u>: 3D Oil Offshore Representative.</td></tr>
<tr><td>Oil Spil Tracking buoys
An oil spill tracking buoy is available and maintained in an operational condition on-board the MSS vessel.</td><td>Vessel Manifest
Responsibility: 3D Oil Project Manager</td></tr>
<tr><td>OSTM
3D Oil OPEP includes contact details for OSTM initiation.</td><td>OPEP includes RPS contact details
<u>Responsibility</u>: 3D oil Project Manager</td></tr>
<tr><td colspan="3">Response Controls</td></tr>
<tr><td rowspan="2">To inform spill response strategies and mitigate environmental impacts, 3D Oil initiates vessel-based oil spill surveillance in the event of a Level 2 spill incident to inform response activities.</td><td>Operational Monitoring
Operational monitoring from support vessels is initiated (as practicable considering safety requirements) immediately following a spill (during daylight hours). Information is provided to AMSA (as required).</td><td>Incident records verify AMSA requests are met.
<u>Responsibility</u>: Support Vessel Master</td></tr>
<tr><td>Oil Spill Tracking Buoy Deployment
The MSS vessel deploys oil spill tracking buoys in the event of a Level 2 spill as soon as possible, but within 30 minutes of the spill.</td><td>Incident log/Oil spill tracking buoy stallite readouts.
<u>Responsibility</u>: 3D Oil Offshore Representative.</td></tr>
<tr><td colspan="3">Activity Controls
Note: Controls identified in Section 7.11 to prevent interference with marine mammals are relevant and applicable to this activity.</td></tr>
<tr><td>Any aerial surveillance activities are undertaken to prevent interference with, or disturbance to, marine fauna.</td><td>Spatial Buffers
Surveilllance aircraft will ensure buffer distances of 500 m (helicopters) and 300 m (fixed wing) are maintained in accordance with EPBC Regulations 2000 (Part 8) to whales and dolphins.</td><td>Flight instructions document these constraints.
<u>Responsibility</u>: Pilot/AMSA</td></tr>
<tr><td colspan="3">Demonstration of ALARP</td></tr>
<tr><td>Hazard Consequence Criteria</td><td colspan="2">A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).</td></tr>
<tr><td>ALARP Statement</td><td colspan="2">No reasonably practical, alternative and/or improved control measures exist</td></tr>
<tr><td colspan="3">Demonstration of Acceptability</td></tr>
<tr><td>Internal Context: 3D Oil Policy compliance</td><td colspan="2">The risk management strategy for the ‘monitor and evaluate’ response option reflects 3D Oil’s HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.</td></tr>
</table>

Internal Context: 3D Oil Management System	**Section 8** describes the relevant management system processes adopted to manage the hazards to ALARP: • Emergency Response (**Section 8.6**) • Dorrigo MSS OPEP is provided in **Appendix 2** • Dorrigo MSS OSMP provided in **Appendix 3**. • Notification and Reporting (**Section 8.11**).
External Context: Natural Environment	Environmental Significance: The Dorrigio MSS area include marine fauna (wide-ranging seabirds, cetaceans, pinnipeds, fish, turtles) which are not expected to significantly impacts by aerial operations. Key Ecological Features: KEFs are located on the seabed. No impacts from monitor and evaluate activities predicted. Commonwealth Marine Park/State Reserve Management Plans: Impact is localised and temporary not affecting conservation values and management objectives.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with no issues raised with respect to operational spill monitoring. 3D Oil's OPEP arrangements reflect and integrate with NATPLAN as required by Commonwealth legislation. As such, 3D Oil considers that there is broad acceptance of the controls associated with this activity.
Compliance with International Conventions, Legislation, Codes and Standards	The controls adopted to undertake aerial surveillance from a Dorrigo MSS MDO activity comply with the following legislative provisions: Act/Statutes: • Offshore Petroleum & Greenhouse Gas Storage Act 2006 (& associated regulations) • Environment Protection & Biodiversity Conservation Act 1999 (& EPBC Regulations 2000) • Australian Maritime Safety Authority Act 1990 • Navigation Act 2012 • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 International Conventions: • 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 SE Marine Reserves Network Management Plan: • MSS activity is permissible in the 'multiple use zone' of the Zeehan CMR in accordance with conditions of class approval (refer Management Plan Section 5.1). South-east Marine Region Profile: No specific references in plan which relate to waste disposal. Recovery/Conservation Plans & Advices: No criteria relates to aerial surveillance activities Threat Abatement Plans: Threat abatement plans not triggered.
Good Industry Practice/Industry Guidelines	The controls adopted to undertake aerial surveillance from a Dorrigo MSS MDO activity comply with the following legislative provisions: • National Plan for Maritime Environmental Emergencies (AMSA, 2017) • Bonn Agreement Oil Appearance Code **APPEA CoEP:** Objectives met for MSS with respect to reducing the risk of release of substances into the marine environment to a level which is ALARP and acceptable by: • Demonstrating appropriate management measures are in place and implemented; and • An appropriate spill response plan is in place for the activity. **IAGC:** The stated controls for oil/chemical management and spill response conform with the requirements detailed in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.6 Hazardous Materials). **CSIRO Oil Spill Monitoring Handbook** (Hook et al, 2016) **Aerial Observation of oil spills at sea** (OGP, 2015)
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with a 'monitoring and evaluation' response during a Dorrigo MSS oil spill. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)

Acceptability Assessment:	With controls adopted and implemented to prevent fauna impacts for aerial surveillance activities: • 3D Oil's oil spill response strategy aligns with and integrates into NATPLAN requirements; and • Prevent/minimise injury to marine fauna.
Environmental Monitoring	
Operational Monitoring (Refer Appendix 3)	
Record Keeping	
Incident Records Crew induction and attendance records (spill observation) Support Vessel Contracts (Dorrigo MSS) Aviation Flight Instructions Dorrigo MSS OPEP and OPEP Contact List OSMP Records (**Appendix 3**)	

Response : Shoreline Assessment and Cleanup

Overview of Strategy: As identified in **Table 7-74**, shoreline assessment and minor levels of shoreline clean-up are possible for sandy beach areas where MDO residues are predicted to be > 100 g/m^2 (e.g. Fitzmaurice Bay, Christmas Island Nature Reserve and New Year Island Game Reserve). Note that MDO residues reaching shorelines will be weathered (> 39 hrs) with reduced toxicity. Diesel oils are not sticky or viscous. When small spills do strand on the shoreline, the oil tends to penetrate the porous sediments quickly, but also wash off quickly by waves and tidal flushing with shoreline cleanup not usually needed (NOAA, 2018). Diesel oil is readily and completely degraded by naturally occurring microbes, under time frames of one to two months (NOAA, 2018).

For vessel-related MDO releases in Commonwealth waters where spill residues impact or have the potential to impact on state waters/coastal areas, the CA is the Tasmanian EPA within Tasmanian waters. Cleanup activities will be undertaken in accordance with the Tasmanian Marine Oil Spill Contingency Plan (TasPlan) (DPIPWE, 2011) and may request assistance from AMSA for expert advice on clean-up options and the supply of additional NATPLAN personnel, equipment and resources (including AMOSC personnel and equipment). Any shoreline response will be controlled by the Tasmanian IC under TASPLAN utilising available local government resources (DPIPWE, 2011).

While spill response from a vessel MDO spill is the responsibility of EPA Tasmania, this information has been provided to demonstrate that shoreline clean-up activities performed by TASPLAN resources hav considered all appropriate sensitivities and will reduce the risk to ALARP and acceptable levels as required by the NOPSEMA Oil Pollution Risk Management Guideline (2018).

Based upon 'monitor and evaluate' information, the Tasmanian CA will identify areas of environmental impact, shorelines at risk and protection priorities. Protection priorities will be evaluated against available response options to determine effectiveness (sea state, daylight hours, weather) to establish environmental benefit over leaving the MDO to degrade naturally (i.e. a net environmental benefits assessment (NEBA)) (AMSA, 2015). This assessment will include the potential for shoreline impacts associated with cleanup and the development of a shoreline strategy to protect high priority areas and cleaning of impacted shorelines. If operational monitoring predicts or observations verify that MDO residue has reached shorelines, the following shoreline assessment is adopted:

- Initiate a Shoreline Contamination Assessment Technique (SCAT) survey;
- With information supplied by the SCAT survey undertake a NEBA assessment and determine if a net environmental benefit exists;
- If a benefit exists develop shoreline strategy, protecting sensitive resources from damage; and
- Deploy shoreline cleanup resources.

SCAT Survey: Any cleanup response will be preceeded by a SCAT survey. This process systematically collects data on shoreline oiling conditions using the following steps (NOAA, 2013):

- Undertake a reconnaissance survey;
- Segment the shoreline;
- Assign teams and conduct survey;
- Develop cleanup guidelines and endpoints;
- Submit reports to the CA (planning section);
- Monitor effectiveness of the cleanup;
- Conduct post-cleanup inspections; and
- Undertake final evaluation of the cleanup activities.

A trained SCAT team will be deployed by the Tasmanian CA (Planning Section) at the time of, or prior to shoreline stranding, informed by monitoring and evaluation activities to provide best methods for cleanup.

Shoreline Cleanup: Shoreline cleanup can consist of different manual and mechanical recovery techniques to remove the oil from the shoreline and reduce ongoing environmental contamination and impact. It may include the following techniques:

- Natural recovery – allowing the shoreline to self-clean (no intervention);
- Manual collection of oil and debris – use of personnel to collect oil from the shoreline (limited effectiveness for MDO residues given percolation characteristics and little visible shoreline residue);
- Mechanical collection – use of machinery to collect and remove stranded oil (as above – not considered effective for MDO residues);
- Sorbents – use of sorbent padding to remove stranded oil (as above – not considered effective);
- Vacuum recovery, flushing, washing – the use of high volumes of low-pressure water, pumping and/or vacuuming to remove floating oil accumulated at the shoreline (as above – not considered effective);
- Sediment reworking – move sediment to the surf to allow oil to be removed from the sediment by heavy machinery; and
- Cleaning agents – application of chemicals such as dispersants to remove oil (not considered warranted given the tidal flushing which occurs).

Given the shorelines predicted to be affected by MDO residues, natural recovery or sediment reworking are considered the clean-up options most likely to be deployed. Note no mechanical equipment is present on nature/game reserve areas.

Resource Availability: In accordance with the Tasmanian Marine Oil Spill Contingency Plan (DPIPWE, 2011) and supported by NATPLAN resources, EPA Tasmania maintains shoreline clean-up capabilities and is the CA in Tasmania for vessel-based incidents.

Shoreline Survey & Cleanup 'Activity' Impact/Risk Evaluation:

Environmental Hazard:
The following environmental hazards associated with SCAT and shoreline cleanup have been identified based on the environment which may be affected by spill residues:

- Additional human activity on beaches;
- Loss for shoreline sediment; and
- Waste collection and transport.

Known and Potential Impacts:
The known and potential impacts of these activities are:

- Loss of vegetation;
- Fauna habitat interference;
- Aboriginal cultural habitat interference;
- Spread of contamination from equipment; and
- Restricted access to beaches for recreational users.

This impact affects Tasmanian terrestrial areas only.

Assessment of Environmental Impacts & Risks:

Damage to foreshore and backshore environments: The noise and general disturbance created by shoreline clean-up activities are likely to disturb the feeding, breeding, nesting or resting activities of resident and migratory fauna species that may be present (such as hooded plovers, penguins). For 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, 2015). Any erosion caused by responder access to sandy beaches, or the removal of sand, may also bury nests. In isolated instances, this is unlikely to have impacts at the population level. Disturbance or damage to such sites will be minimised by ensuring shoreline access is undertaken via established pathways and shoreline activities are undertaken in the inter-tidal zone.

Disturbance to Aboriginal Cultural Heritage: The movement of people through backshore areas may disturb cultural heritage artefacts that occur at the surface or are buried. The most likely cultural heritage artefacts to be present are Aboriginal stone artefacts and shell middens, especially where freshwater and brackish water sources occur nearby (refer **Section 5.6.2** – Aboriginal Heritage). Disturbance or damage to such sites will be minimised by ensuring shoreline access is undertaken via established pathways.

Temporary exclusion of the public from amenity beaches: The presence of any visible stranded oil and clean-up operations may necessitate temporary beach closures (~ days to weeks). This means recreational activities (such as swimming, walking, fishing, boating) in affected areas will be excluded until access is again granted by local authorities. Effects for west King Island beaches is localised and temporary with not many people affected given the time of the year (September-October). Note that both Christmas Island and New Year Island are not inhabited so this impact is unlikely to arise in those locations.

Secondary contamination of the shoreline: Untreated, secondary contamination of the environment (e.g., oil released into sand dunes/along roadsides from equipment) may cause chronic toxicity impacts to any flora and fauna directly contacted. Habitat degradation or loss may occur as a result of soil pollution (that may result in temporary or permanent soil sterilisation, thereby inhibiting or reducing plant growth). The degree to which these impacts occur is a function of the volume of oil spilled and how long it remains in the environment before being cleaned.

Impacts to Matters of National Environmental Significance:
A 'shoreline cleanup' response strategy is not likely to have a significant impact to any matters of NES if controls are adopted as per **Table 7-76** to prevent possible impacts.

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Sub-Tropical and Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	X	✓	X
Christmas Island Nature Reserve and New Year Island Game Reserve contains seabird rookeries and important nesting areas for terns, hooded plovers, penguins and short-tailed shearwaters. Hooded plovers and fairy terns are threatened by human disturbance causing destruction to eggs and oil spills which may threaten breeding habitats. Cleanup activities will only occur if there is a Net Environmental Benefit with controls implemented (refer **Table 7-76**) to prevent interference to the species. **No significant impacts predicted**.	Shoreline assessment and cleanup does not impact on TECs.	Migratory bird species including the breeding short-tailed shearwater are present at New Year Island Reserve. No threats are identified for this bird species. Controls (refer **Table 7-76**) are adopted to prevent interference to the species. **No significant impacts predicted**.	The Commonwealth marine environment is not affected by shoreline cleanup activities.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo EMBA associated with a 'monitor and evaluate' response strategy is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and National Wetlands of Importance	Commonwealth Marine Parks (CMP)	Coastal protected areas
X / X	X	X	✓
These KEFs are not relevant to shoreline cleanup activities.	There are no nationally important wetlands within the EMBA.	CMPs are not affected by shoreline cleanup activities.	The following coastal reserve areas may be considered for shoreline cleanup based upon predictive modelling: • Christmas Island Nature Reserve; • New Year Island Game Reserve; • Cape Wickham Conservation Area; • Porky Beach Conservation Area; Cataraqui Point Conservation Area; • Stokes Point Conservation Area. Reserve conservation values have been assessed (refer to **Appendix** 7).

Environmental Impact/Risk Assessment summary:

Table 7-76 provides a summary of the EIA/ERA for SCAT and shoreline cleanup activities.

Table 7-77: Oil Spill Response – SCAT & Shoreline Cleanup EIA/ERA

Aspect	Response – Shoreline Assessment & Cleanup		
Impact Summary	Potential impact to protected shoreline bird species, coastal vegetation, aboriginal cultural heritage, recreational beach users and contamination of soilds through transfer of spill residues.		
Extent of Impact	Localised (MDO spill volume is limited over a short duration)		
Duration of Impact	Temporary and recoverable.		
Level of Certainty of Impact	MEDIUM. Impacts associated with shoreline assessment and cleanup have been assessed on available information, however an operational NEBA between state authorities and land managers will identify all potential impacts.		
Species possibly affected within survey environment:	Shoreline and seabird species (protected).		
Impact Decision Framework Context	**Impact Decision Context B** This activity is an infrequent and non-standard activity which will have a nu,ber of stakeholders requiring input. The assessment methodology (SCAT and NEBA) are well established and shoreline risks are amenable to this risk assessment methodology. The exercise is also likely to attract local medial attention. This activity will be undertaken by State authorities with 3D Oil providing support where practical and possible. Impact Decision B framework is appropriate to this hazard.		
Impact with controls failure (Inherent)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Shoreline Bird Habitat Interference	SIGNIFICANT	POSSIBLE	MEDIUM
Vegetation/Cultural Heritage Disturbance	SIGNIFICANT	POSSIBLE	MEDIUM
Recreational shoreline users	MINOR	POSSIBLE	MEDIUM
Spill Contamination Spread	MINOR	POSSIBLE	MEDIUM
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			

CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION
Maintain capability to implement SCAT and shoreline cleanup resources appropriate to the nature and scale of shoreline impacts	Mitigative (administrative)	YES	This capability is available through the TASPLAN and NATPLAN resources as a preparedness preasure. Likelihood of shoreline residues exceeding 100 mg/m^2 is 2% and timeframe for residues to accumulate is 39 hrs (min). Response timeframes are achievable with State and Commonwealth resources. 3D Oil will have access to scientific resources for Type II (scientific) monitoring who may supplement standard TASPLAN/NATPLAN resources as necessary. *Control is considered effective based on trained Tasmanian and Commonwealth resources allocated to response activities.*
NEBA is undertaken prior to undertaking shoreline assessment activities	Preventative	YES	Good Practice – well defined and established standard procedures adopted by oil spill response organisations. Will be implemented in accordance with Commonwealth/State response plans and in consultation with local authorities (including councils). *Control is considered effective based on trained Tasmanian and Commonwealth resources allocated to response activities.*
Recreational user impacts are managed to ALARP (elimination from cleanup areas)	Mitigative (administrative)	YES	Removal of recreational users from beach during any cleanup activity is considered prudent to prevent possible health and safety impacts and the potential for increased spread of contamination. Displacement, given the small quantities of oil ashore, is expected to be localised, short-term and fully recoverable. Will be implemented in accordance with Commonwealth/State response plans and in consultation with local authorities (including councils). *Control is considered effective based on trained Tasmanian and Commonwealth resources allocated to response activities.*
Spill residue collection is managed to prevent increased and secondary contamination.	Preventative (administrative)	YES	Responders adopt standard waste management and waste minimisation techniques including the selection of clean-up methods which minimise waste generation. Will be implemented in accordance with Commonwealth/State response plans and in consultation with local authorities (including councils). *Control is considered effective based on trained Tasmanian and Commonwealth resources allocated to response activities.*

Aboriginal heritage is protected from damage during cleanup/SCAT activities	Preventative (administrative)	YES	Responders as a result of the NEBA identify possible impacts of response and establish controls to protect aboriginal resources. Will be implemented in accordance with TASPLAN and in consultation with aboriginal stakeholders identified in that plan. *Control is considered effective based on trained Tasmanian resources allocated to response activities.*
Shoreline and seabird habitats are protected from damage during cleanup/ SCAT activities	Preventative (administrative)	YES	Responders as a result of the NEBA identify possible impacts of response and establish controls to protect protected species. Will be implemented in accordance with State response plans and in consultation with state conservation authorities. *Control is considered effective based on trained Tasmanian and Commonwealth resources allocated to response activities.*

Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Shoreline Bird Habitat Interference	SIGNIFICANT	VERY UNLIKELY	LOW
Vegetation/Cultural Heritage Disturbance	SIGNIFICANT	VERY UNLIKELY	LOW
Recreational shoreline users	MINOR	VERY UNLIKELY	LOW
Spill Contamination Spread	MINOR	UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
Preparedness Controls		
Shoreline response capability is available to prevent and mitigate shoreline impacts from vessel-based oil spill impacts if required.	*Shoreline Response Capability* Access to shoreline response capability is maintained through trained and experienced TASPLAN and NATPLAN resources.	NATPLAN Governance Records TASPLAN Training/Response Exercises Database of equipment and service provided is readily available Responsibility: AMSA/EPA Tasmania
	Planning – Predictive Modelling Outcomes 3D Oil consults with EPA Tasmania to advise of predictive modelling outcomes and possible shoreline response from a significant oil spill.	Consultation Records Responsibility: 3D Oil Project Manager
Response Controls		
Operational monitoring is provided to shoreline response CA to ensure that the potential for shoreline impacts are identified at early stages to inform a fast and effective response to shoreline impacts where net benefits can be gained.	*Oil Spill Notification* 3D Oil provides EPA Tasmania with notification of a Level 2 spill incident event within 2 hours of the spill occurring.	Incident Log/Notification Records Responsibility: 3D Oil Project Manager

Operational monitoring is provided to shoreline response CA to ensure that the potential for shoreline impacts are identified at early stages to inform a fast and effective response to shoreline impacts where net benefits can be gained.	*Provision of Operational Monitoring Data* 3D Oil provides vessel-based operational monitoring to EPA Tasmania within 2 hours of monitoring information receipt to inform EPA Tasmania of possible shoreline impacts.	Incident Log/Monitoring Records Responsibility: 3D Oil Project Manager
	SCAT Deployment EPA Tasmania deploys SCAT resources to shorelines where operational monitoring identifies possible shoreline impacts (daylight hours permitting).	Incident Log Responsibility: Tasmanian CA (EPA Tasmania)
	Operational NEBA An operational NEBA is undertaken to determine net benefit of shoreline clean-up.	Incident Log/NEBA Record Responsibility: Tasmanian CA (EPA Tasmania)
Activity Controls *Note: Controls identified in this section are expected to be outcomes of the risk assessment performed as part of the NEBA for shoreline response (if undertaken).*		
Shoreline cleanup activities are undertaken so distruption to recreational beach users are minimised however, maintaining safe outcomes to public	*Beach Restiction Controls* Tamanian CA in consultation with King Island Council and relevant additional Land Managers identify controls to protect public from harm of spill response activities. Agreed controls are documented in the Incident Action Plan.	Incident log/Consultation Records/IAP Records. Responsibility: Tasmanian CA (EPA Tasmania)
If shoreline cleanup activities are undertaken, impacts to native vegetation, aboriginal cultutal heritage and fauna habitats are prevented.	*Shoreline Access* Access to shoreline is via existing tracks and roads. Access outside existing tracks and pathways is determined in consultation with DPIPWE and Aboriginal stakeholders. Any areas of sensitivity are flagged/fenced for avoidance. Along shorelines, cleanup activities will keep to the inter-tidal zone to prevent damage to nesting hooded plovers, terns and other shoreline species.	Incident log/Consultation Records/IAP Records. Responsibility: Tasmanian CA (EPA Tasmania)
	Wildlife Handling Only Parks and Wildlife Service (PWS) or DPIPWE trained officers will approach and handle oiled fauna.	Shoreline induction reinforces this constraint. Induction records. Responsibility: Tasmanian CA (EPA Tasmania)
	Waste Containment & Spill Prevention Any waste materials generated from shoreline cleanup activities are contained and stored within an impervious area. This area is under supervision and secured from the public.	Incident log/IAP Records. Responsibility: Tasmanian CA (EPA Tasmania)
	Waste Disposal Oiled waste is disposed in accordance with EPA Tasmanina disposal requirements.	Waste Disposal Certificates Responsibility: Tasmanian CA (EPA Tasmania)

If shoreline cleanup activities are undertaken, secondary contamination from personnel and equipment is prevented (Con't).	*Beach access controls* All access points (personnel and equipment) will be controlled via designated access points through decontamination facilities.	Shoreline induction reinforces this constraint. Induction records. Responsibility: Tasmanian CA (EPA Tasmania)

Demonstration of ALARP	
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).
ALARP Statement	No reasonably practicable additional, alternative and/or improved control measures can be identified until situational awareness and operational NEBA is undertaken in a spill event.
Demonstration of Acceptability	
Internal Context: 3D Oil Policy compliance	The risk management strategy for deck spills reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.
Internal Context: 3D Oil Management System	**Section 8** describes the relevant management system processes adopted to manage the hazards to ALARP: • Emergency Response (**Section 8.6**) • Dorrigo MSS OPEP is provided in **Appendix 2**. • Notification and Reporting (**Section 8.11**).
External Context: Natural Environment	Environmental Significance: Shorelines present that may be affected by oil spill residues contain significant colonies of shoreline birds which are threatened, sensitive to oil spill residues and anthropogenic interference. These details are documented in TSSC advices for the species and must be observed undertaken the operational NEBA, and when developing controls for undertaking SCAT and shoreline cleanup activities. Note: Impacts predictive modelleing does not identify significant levels of shoreline residue and MDO rapidly degrades. Natural degradation and monitoring offers benefits when determining NEBA Key Ecological Features: KEFs are located on the seabed. No impacts predicted. Commonwealth Marine Reserve Management Plans: Impacts are shoreline related – no impact to Commonwealth CMPs. State Nature Conservation Plans: An assessment of shoreline cleanup activities against the management objectives of the IUCN classification for conservation areas is provided in **Appendix 7**. As identified with assessment techniques adopted and controls applied, conservation values and management objectives are not compromised. Note that activities are controlled by EPA Tasmania.
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with no issues raised with respect to shoreline response activities. 3D Oil has consulted with EPA Tasmania to advise of predictive modelling and possible responses from a significant oil spill. All feedback from the authority has been incorporated into this section. As such, 3D Oil considers that there is broad acceptance of the controls associated with this activity.

Compliance with International Conventions, Legislation, Codes and Standards	The controls adopted to undertake SCAT/shoreline assessment from a Dorrigo MSS MDO activity comply with the following legislative provisions: Acts/Statutes: • Environment Protection & Biodiversity Conservation Act 1999 (& EPBC Regulations 2000) • Emergency Management Act 2006 (Tasmania) • Nature Conservation Act 2002 (Tas) • National Parks and Reserves Management Act 2002 (Tas) • Threatened Species Protection Act 1995 (Tas) International Conventions: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range) SE Marine Reserves Network Management Plan: Not Applicable South-east Marine Region Profile: Not Applicable. Tasmanian Nature Reserve Management Plan: No management plans available. IUCN management principles apply. Species Conservation/Recovery Plans & Conservation Advices: Review and assessment of threatened species recovery plans and conservation advices have identified human disturbance and oil spills as threats to the species. This information has informed the control measures developed for shoreline cleanup in this section. Threat Abatement Plans: Threat Abatement Plans not triggered by this activity.
Good Industry Practice	The controls adopted to undertake SCAT/Shoreline Cleanup from a Dorrigo MSS MDO activity comply with the following: • Tasmanian Marine Oil Spill Contingency Plan (DPIPWE, 2011) • Tasmanian Oiled Wildlife Response Plan (DPIWE, 2006) **APPEA CoEP:** Objectives met for MSS with respect to reducing the risk of release of substances into the marine environment to a level which is ALARP and acceptable by: • Demonstrating appropriate management measures are in place and implemented; and • An appropriate spill response plan is in place for the activity. **IAGC:** The stated controls for oil/chemical management and spill response conform with the requirements detailed in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.6 Hazardous Materials). **Other:** Adopted methodologies to assess for risk conform to: • Guide to Oiled Shoreline Assessment Surveys (IPIECA, 2014) • Recognition of oil on shorelines (ITOPF, 2011) • Response strategy development using net environmental benefit analysis (IPIECA/OGP, 2015); • Shoreline Cleanup and Assessment Technique (NOAA, 2013).
ESD principles	There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with the 'shoreline cleanup' response during a Dorrigo MSS oil spill. This response option will be assessed for net environmental benefit prior to activity commencement to ensure suitability. The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer **Section 2.2**)
Acceptability Assessment:	With controls adopted and implemented to prevent shoreline impacts from SCAT/Shoreline Cleanup activities: • 3D Oil's oil spill response strategy aligns with and integrates into NATPLAN, TASPLAN and WILDPLAN requirements; and • Strategies are adopted which prevent anthropogenic impacts to shoreline birds in the affected spill area.
Environmental Monitoring	
Operational Monitoring Records – Oil Spill Tracking Buoy, Vessel Surveillance Records	
Record Keeping	

Incident Records Notification Records Monitoring Records Dorrigo MSS OPEP and OPEP Contact List OSMP Records (**Appendix 3**)

Response: Oiled Wildlife Response

Overview of Strategy: In the event of a spill , the impacts on wildlife are determine by the types of fauna present, the type of oil spill and the extent of exposure. A review of the species likely to be present within the oil spill EMBA includes marine birds (albatross, petrels, penguins, short-tailed shearwaters, fairy prion) and shorebirds (hooded plovers, little terns and fairy terns) (refer **Section 5.4.8**). **Table 7-74** provides the protection priorities at locations which may be affected by oil spill residues > 100 g/m^2 (i.e. Fitzmaurice Bay, Christmas Island Nature Reserve and New Year Island Game Reserve). The reserves form part of the King Island IBA (DPIPWE, 2012) with the Christmas Island Nature Reserve identified as constining habitat for ~11,900 penguins (DoEE, 2018b).

Note that MDO residues reaching shorelines will be:
- Weathered (> 30 hrs) with reduced toxicity and are not sticky or viscous (NOAA, 2018);
- Tends to penetrate the porous sediments quickly, but also wash off quickly by waves and tidal flushing with shoreline cleanup not usually needed (NOAA, 2018);
- Diesel oil is readily and completely degraded by naturally occurring microbes, under time frames of one to two months (NOAA, 2018).

The inter-tidal zone is therefore expected to be impacted at depth with remobilisation of residues during subsequent tidal flushing. This will limit direct residues exposure to shoreline bird species at these locations. Individual birds may be impacted if they overfly areas where sea surface oil residues > 10µm.

Oiled wildlife response consists of a three-tiered approach involving:
- Primary Response: Situational understanding of the species/populations potentially affected (ground-truth species presence and distribution by foot/aerial observations). This involves oil recovery and removing the threat of oil to wildlife (e.g. protect and deflect, shoreline clean-up);
- Secondary Response: Deterrence or displacement strategies (e.g. hazing by auditory bird scarers, visual flags or balloons, barricade fences; or pre-emptive capture which involved a PWS/DPIPWE wildlife response, capture of wildlife and transfer or holding while the contamination threat remains); and
- Tertiary: Capturing, field stabilisation, transport, veterinary examination, triage, stabilisation, cleaning, rehabilitation and release. Because of the light nature of the MDO, its rapid weathering and evaporation and the lack of shoreline exposure at significant levels, wildlife oiling impacts are expected to be very low (if any) and tertiary response is unlikely to be required.

Resource Availability: In accordance with the Tasmanian Marine Oil Spill Contingency Plan (DPIPWE, 2011) and supported by NATPLAN resources, DPIPWE (Resource Management & Conservation Division) is responsible for responding to wildlife affected by marine pollution emergencies in Tasmanian waters in accordance with the Tasmanian Oiled Wildlife Response Plan (WildPlan) (DPIW, 2006). DPIPWE manages the rescue and rehabilitation of oiled fauna with the assistance of the Tasmanian Parks and Wildlife Service (PWS) by trained DPIPWE/PWS officers. Regional specialists such as Phillip Island Nature Park; Melbourne Zoo and Tooronga Park Zoo are all available under NATPLAN arrangements.

DPIPWE wildlife rescue kits are held at Hobart and Launceston DPIW offices (DPIW, 2006). Through NATPLAN arrangements DPIPWE also has access to AMOSC resources located in Geelong.

Oiled Wildlife Response 'Activity' Impact/Risk Evaluation:

Environmental Hazard:
The environmental hazards associated with oiled wildlife response (OWR) are:

- Hazing of target fauna may deter non-target species from their normal activities (resting, feeding, breeding, etc);
- Distress injury or death of target fauna from inappropriate handling and treatment;
- Euthanasia of target individual animals that cannot be treated or have no chance of rehabilitation; and'Damage to shoreline sensitivities from the establishment of OWR centres.

Known and Potential Impacts:
The known and potential impacts of these activities are disturbance, injury or death of fauna. This impact affects Tasmanian terrestrial areas only.

Assessment of Environmental Impacts & Risks:
Euthanasia: Oil-affected animals with no prospect of surviving or being successfully rehabilitated and then released to the environment are humanely euthanased rather than allowed to undergo prolonged suffering. Removal of these individual animals from the environment provides benefits in that they are not consumed by predators/scavengers, avoiding secondary contamination of the foodweb. There are no species within the EMBA with such a small or geographically-restricted population range that the death of a low number of individuals would result in population-wide impacts.

Hazing: Hazing and exclusion of wildlife from known congregation, resting, feeding, breeding or nesting areas may have a short- or long-term impacts on the survival of that group if cannot access preferred resources. These effects may be experienced by target and non-target species. For example, shoreline booming or ditches dug to contain oil may prevent penguins from reaching their burrows after exiting the water, or low helicopter passes flown regularly over an beach to deter coastal birds from feeding in an oil-affected area may also deter penguins from leaving their burrows to feed at sea, which may impact on their health.

Untrained Handlers: Untrained resources capturing and handling native fauna may cause distress, injury and death of the fauna. To prevent these impacts only DPIPWE/PWS trained oiled wildlife responders will approach or handle any fauna. This will eliminate any handling impacts to fauna from untrained personnel and reduce the potential for distress, injury or death of a species associated with handling.

<u>OWR Centres</u>: The establishment of OWR centres will preferentially avoid locating infrastructure on or in close proximity to native habitat, thereby avoiding impacts associated with vegetation clearing (such as loss of habitat, reduction in local native species diversity and abundance). Facilities such as portable toilets and showers will be established to deal with day-to-day requirements of first responders so wastes are not discharged to the environment. Similarly, facilities will be supplied for the collection and/or treatment of oily water and detergents associated with the treatment of oiled wildlife so these wastes are not inappropriately discharged to the environment. A licensed waste management contractor will coordinate the supply of waste facilities and regular removal of wastes (including animal carcasses) to licensed facilities for disposal and/or treatment. Accordingly, locating an OWR centre on Christmas Island Nature Reserve or New Year Game Reserve is not expected to be practicable given the potential impact to island habitats and waste generation. Note that given the properties of MDO residues contacting the shoreline, oil residue exposure is not expected to be significant to the bird population present.

Impacts to Matters of National Environmental Significance:
An oiled wildlife response strategy is not likely to have a significant impact to any matters of NES if controls are adopted as per **Table 7-77** to prevent possible impacts.

Nationally threatened species	Nationally threatened ecological communities (Giant Kelp Marine Forests of SE Australia & Sub-Tropical and Temperate Saltmarsh)	Migratory species	Commonwealth Marine Area
✓	x	✓	x
Christmas Island Nature Reserve and New Year Island Game Reserve contains seabird rookeries and important nesting areas for terns, hooded plovers, penguins and short-tailed shearwaters. Hooded plovers and fairy terns are threatened by human disturbance causing destruction to eggs and oil spills which may threaten breeding habitats. MDO residues are predicted along shorelines are low level, weathered with low levels of toxic compounds, and are expectd to permeate into the sand environment. No significant exposure is predicted for species at these locations. **NEBA will consider this when determining OWR requirements.**	OWR activity does not impact on TECs.	Migratory bird species including the breeding short-tailed shearwater are present at New Year Island Reserve. No significant exposure is predicted for species at these locations. No significant OWR activities are predicted for locations affected with residues > 100 g/m². **NEBA will consider this when determining OWR requirements.**	The Commonwealth marine environment is not affected by OWR activities.
'Significant impact' is defined in DoE (2013) as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value and quality of the environment which is impacted, and upon the sensitivity, duration, magnitude and geographic extent of the impacts.' 'Likely' is defined in DoE (2013) as 'it is not necessary for a significant impact to have a greater than 50% chance of it happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility.'			

Impacts to other areas of conservation significance:
Impacts to areas of conservation significance within the Dorrigo EMBA associated with a 'monitor and evaluate' response strategy is outlined in the box below.

KEFs (West Tasmanian Canyons/ Shelf Rocky reef and hard Substrate)	International and National Wetlands of Importance	Commonwealth Marine Parks (CMP)	Coastal protected areas

X / X	X	X	✓
These KEFs are not relevant to OWR activities.	There are no nationally important wetlands within the EMBA.	CMPs are not affected by OWR activities.	The following coastal reserve areas may be considered for shoreline cleanup based upon predictive modelling: • Christmas Island Nature Reserve; • New Year Island Game Reserve; • Cape Wickham Conservation Area; • Porky Beach Conservation Area; Cataraqui Point Conservation Area; • Stokes Point Conservation Area. Reserve conservation values have been assessed (refer to **Appendix** 7).

Environmental Impact/Risk Assessment summary:

Table 7-77 provides a summary of the EIA/ERA for OWR activities.

Table 7-78: Oil Spill Response – OWR EIA/ERA

Aspect	Response – OWR		
Impact Summary	Potential impact to protected shoreline bird species, through inappropriate handling, setup of response facilities, hazing or euthaniasia of individual birds.		
Extent of Impact	Localised and low-level residues ar identified shoreline bird nesting areas		
Duration of Impact	Temporary and recoverable.		
Level of Certainty of Impact	HIGH. Impacts from oil to shoreline bird species has been extensively studied. Wildlife capture and rehabilitation techniques are documented and adopted by trained DPIPWE/PWS personnel. Given the low level MDO residues predicted along the shorelines, it is expected that very small numbers of bird species may be affected.		
Species possibly affected within survey environment:	Shoreline and seabird species (protected).		
Impact Decision Framework Context	**Impact Decision Context B** This activity is an infrequent and non-standard activity which will have a number of stakeholders requiring input. The activity will utilise NEBA which is well established and implement WILDPLAN (OWR Plan) to respond to impacts. The exercise is also likely to attract local medial attention. This activity will be undertaken by State authorities with 3D Oil providing support where practical and possible. Impact Decision B framework is appropriate to this hazard.		
Impact with controls failure (Inherent)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Shoreline Bird Habitat	SIGNIFICANT	POSSIBLE	MEDIUM
ASSESSMENT OF PROPOSED CONTROL MEASURES (INCLUDING NON-ADOPTED CONTROLS)			
CONTROL MEASURE	CONTROL TYPE	PRACTICABLE AND IMPLEMENTED	JUSTIFICATION

Maintain capability to implement OWR appropriate to the nature and scale of impacts	Mitigative (administrative)	YES	This capability is available through the TASPLAN and NATPLAN resources as a preparedness preasure. Likelihood of shoreline residues exceeding 100 mg/m^2 is 2% and timeframe for residues to accumulate is 39 hrs (min). Response timeframes are achievable with TASPLAN and NATPLAN resources. *Control is considered effective based on trained Tasmanian and Commonwealth resources allocated to response activities.*
Notification of Level 2 spill provide to EPA Tasmania to respond in a timely manner	Preventative	YES	Good Practice – well defined and established standard procedures. 3D oil will notify Tasmanian EPA of a Level 2 oil spill so that DPIPWE/PWS can be alterted to possible fauna impacts. **Control adopted.**
Notification of oiled wildlife provided to Tasmanian CA during operational monitoring	Mitigative (administrative)	YES	Good practice – 3D Oil will advise the Tasmanian CA of any oiled fauna as a result of a Dorrigo MSS spill. This will assist in establishing possible numbers of oiled wildlife which may be returning to coastal areas. **Control adopted.**
Wildlife is only approached or handled by trained resources	Preventative (administrative)	YES	Good practice - only trained responders involved in OWR handling activities. **Control adopted.**
Deploy OWR resources to shoreline areas which are predicted to exceed shoreline concentrations > 100 g/m^2.	Preventative (administrative)	NO	Control is considered to carry too much environmental impact risk for the low level of exposure predicted by modelling. The Christmas Island Nature Reserve and New Year Game Reserve do not have any support infrastructure, so cleaning of birds in this location would create significant environmental impacts needing to be managed. **Control not adopted.**

Impact consequence with controls (residual)			
Hazard	**Consequence**	**Likelihood:**	**Risk:**
Shoreline Bird Habitat Oiling	SIGNIFICANT	VERY UNLIKELY	LOW

ENVIRONMENTAL OUTCOMES AND PERFORMANCE STANDARDS		
EPO	**EPS**	**MEASUREMENT CRITERIA**
Preparedness Controls		
OWR response capability is available to ensure response is rapid and effective.	*Oiled Wildlife Response Capability* Access to OWR capability is maintained through trained and experienced TASPLAN and NATPLAN resources.	NATPLAN Governance Records TASPLAN Training/Response Exercises Database of equipment and service provided is readily available <u>Responsibility</u>: AMSA/EPA Tasmania
Response Controls (Same as controls listed in Table 7-76 – not repeated)		
Activity Controls		

Response is undertaken in a manner which prevents further damage or impact to oiled species.	*Oiled Wildife Handling* Personnel are advised though site safety induction of wildlife handling restrictions (i.e. Trained DPIPWE/PWS resources can handle wildlife).	Induction Records <u>Responsibility</u>: Tasmanian CA (EPA Tasmania)
Demonstration of ALARP		
Hazard Consequence Criteria	A LOW risk ranking is considered sufficiently low to be acceptable (i.e. at ALARP). The hazard will be managed for continuous improvement by application of good industry practice (detailed below).	
ALARP Statement	No reasonably practicable additional, alternative and/or improved control measures can be identified until situational awareness and operational NEBA is undertaken in a spill event.	
Demonstration of Acceptability		
Internal Context: 3D Oil Policy compliance	The risk management strategy for deck spills reflects 3D Oil's HSE policy goals of proactively identifying hazards, eliminating impacts where possible and where this is not possible managing the risk to ALARP.	
Internal Context: 3D Oil Management System	**Section 8** describes the relevant management system processes adopted to manage the hazards to ALARP: • Emergency Response (**Section 8.6**) • Dorrigo MSS OPEP is provided in **Appendix 2**. • Dorrigo MSS OSMP is provided in **Appendix 3**. • Notification & Reporting Requirements (**Section 8.11**).	
External Context: Natural Environment	<u>Environmental Significance:</u> Shorelines present that may be affected by oil spill residues contain significant colonies of shoreline birds which are threatened, sensitive to oil spill residues and anthropogenic interference. These details are documented in TSSC advices for the species and must be observed undertaken the operational NEBA, and when developing controls for undertaking OWR activities. Note: Impacts predictive modelleing does not identify significant levels of shoreline residue and MDO rapidly degrades. Natural degradation and monitoring offers benefits when determining NEBA responses. With controls adopted, no significant impacts predicted. <u>Key Ecological Features</u>: KEFs are located on the seabed. No impacts predicted. <u>Commonwealth Marine Reserve Management Plans</u>: Impacts are shoreline related – no impact to Commonwealth CMPs. <u>State Nature Conservation Plans</u>: An assessment of OWR activities against the management objectives of the IUCN classification for conservation areas is provided in **Appendix 7**. As identified with assessment techniques adopted and controls applied, conservation values and management objectives are not compromised. Note that activities are controlled by EPA Tasmania under TASPLAN. <u>Species Conservation/Recovery Plans & Conservation Advices</u>: Review and assessment of threatened species recovery plans and conservation advices have included provisions for the Fairy Tern, Hooded Plover and Lesser Sand Plover which identify human disturbance and oil spill as threats to the species. This information has informed the spcies which may require OWR measures in this section. <u>Threat Abatement Plans</u>: Threat Abatament Plans not triggered by this activity.	
External Context: Stakeholder Expectations	Stakeholder consultation has been undertaken (refer **Section 4**) with no issues raised with respect to shoreline response activities. 3D Oil has consulted with EPA Tasmania to advise of predictive modelling and possible responses from a significant oil spill. All feedback from the authority has been incorporated into this section. As such, 3D Oil considers that there is broad acceptance of the controls associated with this activity.	

<table>
<tr><td>Compliance with International Conventions, Legislation, Codes and Standards</td><td>The controls adopted to undertake OWR from a Dorrigo MSS MDO activity comply with the following legislative provisions:
<u>Acts/Statutes</u>:
• Environment Protection & Biodiversity Conservation Act 1999 (& EPBC Regulations 2000)
• Emergency Management Act 2006 (Tasmania)
• Nature Conservation Act 2002 (Tas)
• National Parks and Reserves Management Act 2002 (Tas)
• Threatened Species Protection Act 1995 (Tas)
<u>International Conventions</u>: Convention on the Migratory Species of Wild Animals (Bonn Convention) 1979 (Conserve terrestrial, marine and avian species over their whole range)
<u>SE Marine Reserves Network Management Plan</u>: Not Applicable
<u>South-east Marine Region Profile:</u> Not Applicable.
<u>Tasmanian Nature Reserve Management Plan</u>: No Management Plan available.
<u>Species Conservation/Recovery Plans & Conservation Advices</u>: Review and assessment of threatened species recovery plans and conservation advices have identified human disturbance and oil spills as threats to the species. This information has informed the control measures developed for shoreline cleanup in this section.
<u>Threat Abatement Plans</u>: Threat Abatement Plans not triggered by this activity.</td></tr>
<tr><td>Good Industry Practice</td><td>The controls adopted to undertake SCAT/Shoreline Cleanup from a Dorrigo MSS MDO activity comply with the following:
• Tasmanian Marine Oil Spill Contingency Plan (DPIPWE, 2011)
• Tasmanian Oiled Wildlife Response Plan (DPIWE, 2006)
APPEA CoEP: Objectives met for MSS with respect to reducing the risk of release of substances into the marine environment to a level which is ALARP and acceptable by:
• Demonstrating appropriate management measures are in place and implemented; and
• An appropriate spill response plan is in place for the activity.
IAGC: The stated controls for oil/chemical management and spill response conform with the requirements detailed in the Environmental Manual for Worldwide Geophysical Operations (IAGC, 2013) (Section 8.6 Hazardous Materials).
Other: Adopted methodologies to assess for risk conform to:
• Wildlife Response Preparedness (IPIECA/OGP, 2014)</td></tr>
<tr><td>ESD principles</td><td>There is no threat of serious or irreversible environmental damage or significant impact to biological diversity and ecological integrity associated with OWR response during a Dorrigo MSS oil spill. This response option will be assessed for net environmental benefit prior to activity commencement to ensure suitability.

The EIA presented throughout this EP demonstrates compliance with APPEA Code of Conduct Principles and adopts the principles of ESD via all government policy frameworks (refer Section 2.2)</td></tr>
<tr><td>Acceptability Assessment:</td><td>The OWR Response outlined above is:
• Consistent with NATPLAN, TASPLAN and WILDPLAN response requirements;
• Complies with Commonwealth and Tasmanian legislative requirements (including oiled wildlife reporting);
• OWR will not trigger EPBC matters of NES criteria (SEWPC, 2013);
• Hooded plover is identified in oil spill response plans as requiring rehabilitation (TSSC, 2014).</td></tr>
<tr><td colspan="2" align="center">Environmental Monitoring</td></tr>
<tr><td colspan="2">Scientific Monitoring – Shoreline Bird Assessment

Operational Monitoring Records – Oil Spill Tracking Buoy, Vessel Surveillance Records</td></tr>
<tr><td colspan="2" align="center">Record Keeping</td></tr>
</table>

Incident Records
Notification Records
Monitoring Records
Dorrigo MSS OPEP and OPEP Contact List
OSMP Records (**Appendix 3**)

8.0 IMPLEMENTATION

8.1 Environmental Management System

8.1.1 Management System Arrangements

The design and execution of the Dorrigo MSS will be conducted under the framework of the 3D Oil HSE Policy. As part of contract award, 3D Oil will review the management system of the Seismic/Vessel Contractor against ISO14001 requirements as it relates to the implementation of EP commitments for the Dorrigo MSS (i.e. a gap assessment). Key components of the system which will be assessed will include:

- Planning:
  - Contractor HSE Policy;
  - Contractor organisation including roles, responsibilities and resourcing levels (particularly with respect to EP control measure implementation);
  - Environmental hazard & risk assessment process;
  - Emergency Response (including oil spill) preparedness and response arrangements;
- Implementation:
  - Operational procedures available to support environmental management of hazards (including equipment specifications and preventative maintenance system);
  - Management of change procedures;
  - Crew training needs analysis requirements and training records[72];
  - Vessel induction requirements;
  - Work activity assessment (e.g. JSEA) and management (e.g. Permit-to-Work, Toolbox Meeting, standard operating procedures);
- Monitoring and measuring:
  - Incident reporting, investigation and corrective action management process;
  - HSE Inspection and corrective action management process;
  - Emission/discharge monitoring process;
- Review:
  - Audit procedures/schedule and corrective action management;
  - HSE Review and continuous improvement action items.

Both marine and seismic crews operate under a campaign-specific HSEQ plan which details the relevant procedures which address environmental management elements detailed above. 3D Oil recognises that due to the short duration of this survey activity and the crew familiarity with the ship-based systems, contractor processes should be utilised wherever possible. However, to ensure that the specific requirements of the Dorrigo MSS EP are integrated and implemented into contractor systems, gaps identified during the assessment of the contractor's management system, will be documented and implemented via a bridging document, the Dorrigo Project Specific HSEQ Plan, which will define the agreed procedures and additional/supplemental requirements to be adopted within the contractor system during Dorrigo survey activities. This document will be agreed and endorsed by 3D Oil and the seismic/vessel Contractor. Particular attention will be paid in the bridging document to:

72 Particular emphasis will be placed on those positions responsible for implementing critical control measures to manage environmental impact/risk (e.g. MFOs)

- The utilisation of the 3D Oil's Risk Management Framework as provided in **Section 6** for the assessment of environmental risk[73] and the use of this EP's Environmental Risk Register for the Dorrigo MSS;
- Identification of crew positions responsible/accountable for the implementation of control measures identified within this EP (i.e. control measure 'custodians'). Information provided to these positions will include the required control measure performance standard, notification requirements if standards are not maintained/met[74] and delivery of records to verify performance (and effectiveness);
- Identification of 'reportable incidents' to be observed for the Dorrigo MSS. This will include the required internal notification/reporting requirements to meet regulatory notification and reporting timeframes and incident investigation requirements;
- Identification of vessel inspection programs included as a 'control measure' in this EP, ensuring the scope of the inspection addresses the relevant performance standard requirement;
- Identification of EPSs for the Dorrigo MSS and the required reporting, via the vessel's incident management process, where EPSs are not achieved;
- Identification of crew positions who maintain records (e.g. oil record book, incident records) to quantify emissions and discharges (during normal and incident/emergency events) during the Dorrigo MSS and the requirement to provide these records to the Offshore 3D Oil Representative;
- Ensuring all corrective actions/opportunities for improvement arising from incidents, audits, inspections, monitoring events are documented in the Vessel's on-board Vessel Action Tracking System and monitored for closure by the Party Chief and 3D Oil Offshore Representative in accordance with the vessel's corrective action close-out procedure;
- Events associated with the survey which may result in a *change in the activity scope (e.g. geographical or timing change); an observed significant new environmental impact/risk or significant increase in existing environmental impact/risk not provided in this EP; or a series of new environmental impacts/risk which when taken together results in a significant new, or increase in existing, environmental impact/risk* may trigger a revision to the NOPSEMA-accepted EP. Any change to the Dorrigo MSS program shall be directed to the 3D Oil Offshore Representative for initial assessment. The change shall be assessed for environmental impact/risk in accordance with the 3D Oil risk methodology and any implications determined for the environment and associated regulatory document revisions. Any confirmed change event shall be managed and documented via the Contractor's change management procedure, utilising the 3D Oil risk methodology; and
- Oil spill response arrangement for the Dorrigo MSS which must be observed (refer **Section 8.6**) and the pre-survey exercise activities to be conducted.

8.1.2 Implementation Strategy Methodology

3D Oil shall adopt the following methodology to ensure compliance with this EP:

- Pre-survey audits and information provision from the seismic contractor will determine 'hardware' and procedural compliance of the seismic contractor and vessels engaged to the EP requirements (refer **Section 8.12**) prior to survey;

[73] Safety and health aspects of the project will be assessed in accordance with the Contractor's risk framework.

[74] Crew position will be advised that this is a 'recordable incident' with required notification to the 3D Oil Offshore Representative.

- The vessel contractor management systems will be bridged with specific Dorrigo EP requirements. Control measure 'custodians' will be identified for relevant control measure implementation and a daily report provided to the 3D Oil Offshore Representative on compliance and effectiveness (as relevant);
- An environmental induction program will advise all survey personnel of relevant environmental sensitivities; identified environmental hazards, their EPOs/EPSs and relevant incident reporting requirements if not achieved; and 'reportable incidents' (refer **Section 8.4.1);**
- The 3D Oil Offshore Representative shall collate daily environmental parameters (e.g. waste streams, maritime compliance, cetacean mitigation and incident reporting outcomes) to determine EPO/EPS attainment and control measure implementation;
- The 3D Oil Offshore Representative will undertake an EP Compliance Audit and an EP implementation review against the Dorrigo Project Specific HSE Plan to determine the effectiveness of the 'bridged' 3D Oil requirements into the Contractor's management system;
- The 3D Oil Offshore Representative will obtain all relevant records to provide verification of discharges, incidents, etc. at the completion of the survey.

A Master Listing of Commitments will be generated from this EP on acceptance and refined as part of the review of the selected Contractor's management system, identifying the responsible person for implementing the requirement; when the requirement shall be implemented or information obtained; and whether the requirement requires ongoing monitoring by the 3D Oil Offshore Representative during the survey. Ongoing monitoring tasks will form the basis of a daily checklist for collation by the 3D Oil Offshore Representative.

8.2 Organisation Structure

3D Oil is responsible for ensuring that the proposed Dorrigo MSS is managed in accordance with this EP. The selected seismic/vessel contractor will undertake MSS operations under contractual arrangement with 3D Oil and is required to implement and comply with all environmental commitments contained within this EP.

The organisation reporting structure for the MSS is provided in **Figure 8-1.**

The Master/Officer of the Watch on-board the MSS vessel is responsible for maintaining control of all vessel operations (including support, scout vessels) associated with the MSS and for establishing/maintaining communication with other vessels and marine traffic during the survey. The support and scout vessel shall abide by all instruction from the MSS vessel and communicate with other marine traffic during the MSS.

All vessels will be capable of communicating and operating on both dedicated UHF working channels and maritime VHF working channels.

The personnel on-board the MSS vessel consists of the following crews:

- The **Marine crew** operate the vessel performing duties in the engine room, galley and accommodation services, internal/external decks, small boats and bridge. The bridge watch offices and crew are responsible for safe navigation; 360^{o} watch/lookout; radar monitoring;

AIS monitoring; electronic chart, radio and telephone communication. In addition to navigation safety, the bridge is also responsible for the monitoring of all vessel internal communications, integrated safety and emergency alarm systems and indicators;

- The **Seismic crew** operate and run the survey equipment; are responsible for the deployment and recovery of all equipment and data acquisition throughout the survey. This crew is responsible for the planned and continued maintenance of all towed equipment to ensure there is minimum risk of electrical/mechanical failure which might result in the loss of equipment during deployment, acquisition and recovery.
  The seismic crew also form the small workboat crew to conduct the in-water maintenance on the streamer spread and the streamer depth control, steering, position and emergency recovery units, also clearing any debris entanglements with the streamers. All workboat operations are conducted during appropriate weather conditions; have appropriate lighting; and the boat complies with all international requirements for small boat operations for safety, navigation and lighting. The small workboat, when not utilised for these operations is located on-board the seismic vessel.

The seismic crew consists of four departments:

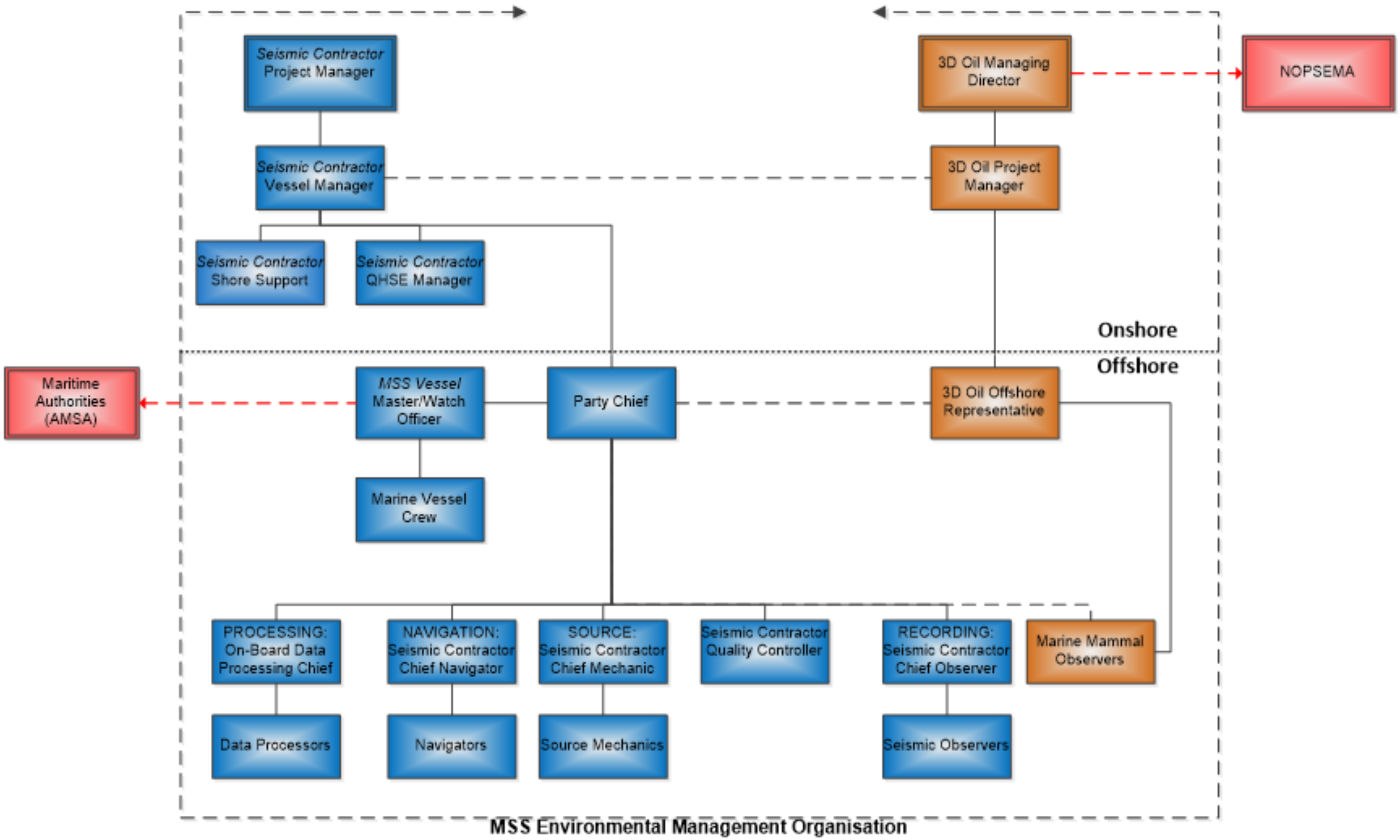
- **Navigation**: Responsible for the surface and sub-surface positioning of equipment, survey planning and execution. They are the communication hub during all operations for acquisition, deployment, recovery, in water maintenance or emergency. The department minimises the amount of time in acquiring survey data;
- **Recording:** Responsible for the safe deployment and recovery of the streamer spread and all streamer units controlling depth, steering, positioning and emergency recovery. This department is also responsible for the streamer and towing harness integrity and the planned maintenance of these items;
- **Source:** Responsible for the safe deployment, recovery, planned maintenance and operation of the acoustic source. This department maintains, deploys and recovers the barovane doors used to separate the streamers and assists with the operation during the deployment and recovery of streamers; and
- **Processing:** Responsible for the quality control of the seismic data acquired and are able to quantify in near real-time whether the data is achieving the objective negating the need for additional work in the same area.

8.3 Roles and Responsibilities

*Roles and responsibilities as they relate to Oil Spill Response are detailed in **Appendix 2.***

General accountabilities are provided in the section below. During contract award and on evaluation of the Contractor's management system, specific on-board positions will be identified who are responsible for specific control measure implementation.

Figure 8-1: Dorrigo MSS Organisation Structure



8.3.1 3D Oil Limited

The **3D Oil Managing Director (MD)** has overall accountability for the implementation of this MSS EP and the delivery of environmental performance outcomes for the MSS. This person is accountable for the:

- Seismic contractor and vessel selections which meets the requirements of this EP;
- All statutory approvals have been obtained for the activity; and
- All relevant reporting and notification activities are undertaken for the Dorrigo MSS.

The **3D Oil Project Manager** oversees the routine operation of the vessel, including the operations of the contractors and has overall responsibility for ensuring that all policies/procedures are implemented and the scope of the seismic survey is completed. This position ensures that:

- Regulatory approvals obtained for this activity are distributed to appropriate project personnel and relevant authorities (as identified in this EP);
- The petroleum activity is monitored for change which may trigger an Environment Plan revision;
- Appropriately qualified and experienced MFOs are engaged for the activity;
- All seismic activity incident notification(s) and associated reports to NOPSEMA, NOPTA, Tasmanian MET and Director of National Parks (DNP) (including reportable environmental incidents and environmental performance close-out report) are fulfilled;
- Provision of weekly seismic activity reports to NOPTA;
- A full briefing and induction of project personnel is undertaken to ensure an understanding of the environmental sensitivities of the survey area, the environmental management procedures and commitments detailed in the EP and individual responsibilities;
- Consultation activities associated with the seismic program to relevant government agencies and marine stakeholders in advance of operations commencing, during and after the completion of the MSS;
- All necessary program-specific procedures are developed and implemented prior to the commencement of the MSS;
- Monitors for legislative or environmental change which affects the impact and risk assessment associated with the Dorigo MSS activity;
- Coordinates necessary management of change (MoC) activities and associated risk assessments;
- Ensures a pre-mobilisation vessel inspection, oil spill response exercise and oil spill response capability audit is undertaken prior to MSS commencement;
- Implements a monitoring program (scientific) (as necessary) to monitor oil impacts to environmental sensitivities (wildlife, water quality) in the event of a Level 2 spill if oil is detected at levels which may cause environmental impact to the particular sensitivity; and
- Undertakes HSE review at the completion of the program and develops a ‘lessons-learnt’ listing.

The **3D Oil Offshore Representative** will be located on the vessel and is responsible for the oversight and reporting on the day-to-day conduct of the program by the seismic contractor. The 3D Oil Offshore Representative verifies that the seismic contractor is undertaking operations in a manner consistent with the performance outcomes and environmental management procedures detailed in this EP. This position ensures that:

- Day-to-day activities are monitored for compliance against this EP and the outcomes reported to the 3D Oil Project Manager;

- The 3D Oil Project Manager is immediately alerted to any changes in operations which could impact negatively on environmental performance or for changes in operation which alter the environmental risk profile of the activity;
- Maintains full awareness of ongoing operations, including status of EPOs/EPSs and control measure performance providing the necessary reports to the 3D Oil Project Manager;
- Data and records are collected for the Environmental Performance Close-out Report;
- Monitors for control measure implementation and associated 'performance standard' compliance;
- Collates information for monthly recordable incident report and provides information to the 3D Oil Project Manager;
- All on-board personnel have had a program environmental induction;
- All reportable incidents are reported to the 3D Oil Project Manager;
- An EP compliance audit is conducted during the MSS;
- A review of the effectiveness of the 'bridged' Contractor management system with Dorrigo MSS Environment Plan requirements (i.e. delivering EPOs and environmental performance standards) identifying opportunities for improvement.

The **Marine Fauna Observer(s)** (MFOs) act as 3D Oil's environmental representative on-board the vessel with respect to marine fauna interactions. This includes:

- Ensuring approval requirements with regard to minimising disturbance to fauna are adhered to on-board the vessel;
- Reporting on fauna sightings; and
- Submitting daily reports to the 3D Oil Project Manager.

8.3.2 Seismic Contractor

The Seismic Vessel's **Vessel Master** has ultimate responsibility for the safe execution of all vessel operations including:

- Compliance of the vessel with all regulatory (international and local) requirements;
- Notification of vessel movements to AMSA RCC;
- AMSA notifications associated with vessel or streamer (loss) incidents;
- Notifications to other marine users associated with incidents;
- All vessel-related emergency drills and training are undertaken;
- Auditing is undertaken as required by vessel procedures;
- Equipment is maintained to statutory requirements or better;
- All statutory records (oil record book, garbage record book, ODS Book, etc.) are maintained;
- All HSE related procedures and work instructions are known, understood and followed;
- All new employees are provided with induction, job familiarisation and specific obligations with respect to HSE participation;
- All marine crew have minimum HSE training and are competent in marine activities; and
- Safe working codes and practices are implemented for all vessel operations in accordance with recognised standards and policies.

The **Party Chief** is responsible to the Vessel Manager for strict observance of the Health, Safety and Environmental Management System (HSEMS) on-board the vessel and supports the Master in the following aspects of the operation:

- Implements the vessel HSEMS on-board;
- Reports all incidents and near-misses, recording the details and taking initial actions to render the situation safe;
- Ensures the procedures and work instructions required for seismic operations are known, understood and followed;
- Ensures tool-box meetings area carried out;
- Ensures new employees receive inductions, training and are appropriately supervised;
- Ensures HSE inspections are undertaken;
- Ensures that all working codes and practices are implemented for all survey operations in accordance with recognised standards;
- Ensures that prompt action is taken in order to rectify any deficiencies in working practices or conditions;
- Ensures active participation in HSE meetings by survey crew;
- Communicates all deficiencies of operation with the 3D Oil Offshore Representative; and
- Investigates all incidents along with the Safety Officer, Master and 3D Oil Offshore Representative.

8.4 Training and Awareness

The seismic contractor will be experienced with regard to the proposed seismic activity and their suitability to undertake the proposed works will be evaluated as part of the project planning phase (contract award).

8.4.1 Induction

In addition to the vessel induction, all personnel on-board the survey vessels will be made aware of relevant environmental matters to achieve the required Dorrigo MSS EPOs by a program environmental induction prior to their commencement on the MSS. Induction material will include:

- Importance of conforming with the EP and associated regulatory requirements;
- The location of environmentally sensitive areas (e.g. west Tasmania canyons) in proximity to the MSS area (including the conditions for operating in the Zeehan CMP);
- Conditions around undertaking MSS activity in a CMP;
- Potential MSS environmental hazards and required controls to minimise impacts associated with MSS activities in the area;
- EPOs, management measures, performance standards and requirements contained within this EP;
- Reportable and recordable incidents associated with the Dorrigo MSS;
- Personnel roles and responsibilities with respect to implementation of nominated controls in this EP; and
- The emergency and oil spill response arrangements for the Dorrigo MSS.

A record of induction will be maintained with endorsement of personnel who attended. These records shall be provided to 3D Oil Offshore Representative as soon as possible after induction activities.

Note all scout and support vessel crews will be provided with awareness training particularly with respect to their role, and requirements for, marine fauna observation as outlined in this EP.

8.4.2 Competency & Ongoing Awareness

3D Oil will ensure that all MMOs engaged for the survey have appropriate qualifications and experience to undertake reliable marine mammal observation activities.

The Seismic Contractor will provide offshore personnel that are trained and competent to undertake their respective activities on-board the seismic vessel. All marine personnel will be qualified, as required, in accordance with the International Convention on Standards of Training Certification and Watch Keeping for Seafarers (STCW95).

All seismic contractor employees will be inducted into the Vessel's HSEMS and specific responsibilities will be detailed in position job descriptions. Appropriate training is provided to individuals with specific environmental responsibilities).

The following ongoing activities serve to reinforce environmental awareness during the seismic program:

- *Project Kick-off Meeting* which is held at the start of each project and reviews the contractual and HSE specifications for the activity, scope of work, Dorrigo specific HSE/Project Plan, survey hazards and risks. This meeting is attended by the 3D Oil Project Manager, 3D Oil Offshore Representative, contractors and sub-contractor's representatives, Vessel Master, Party Chief and marine/survey crews;
- *On-board Daily Meeting* which reviews all survey operations and reviews incidents of the previous day. This meeting is attended by the 3D Oil Offshore Representative, Party Chief, Vessel master and relevant marine/survey crews;
- *On-board HSE Committee Meetings* attended by all on-board management positions and held each five weeks. In addition two full crew safety meetings and one departmental meeting (per department) is held within this period. These meetings review all HSE issues against plan requirements, review the Action Point list arising from incidents and inspections and prepare, in close liaison with all relevant parties, an action plan to facilitate continuous improvement in performance;
- *Toolbox Meetings* attended by all personnel involved in a specific operation's (before mobilisation, operations involving major hazards and operations involving more than one person). This meeting reviews the activity and reinforces appropriate measures to be adopted to prevent environmental and safety impacts.

Records are produced for each of these meetings.

8.5 Communication and Consultation

The Seismic Contractor will be responsible for keeping its workforce informed about environmental issues. The Party Chief acts as a focal point for personnel to raise environmental issues, and consults/involves all personnel in the following:

- Issues associated with the implementation of the EP
- Any proposed changes to equipment, systems, or methods of operation of plant, where these may have environmental implications; and

- Any proposals associated with continuous improvement of environmental protection, including the setting of environmental objectives and training schemes.

Regular HSE meetings will be held on the seismic vessel. The issues discussed and actions taken will be recorded. The minutes of each meeting, including action items from the meetings, will be made available to all personnel.

Other forms of internal communication include toolbox meetings which occur before every critical or unfamiliar job. This meeting includes all personnel involved in the task and will include aspects such as spill prevention requirements, etc.

*Consultation with third party stakeholders is provided in **Section 4**.*

8.6 Emergency Response

8.6.1 General Arrangements

Prior to the commencement of the Dorrigo MSS, 3D Oil and the Vessel Contractor shall develop the Dorrigo MSS (campaign-based) HSEQ Plan which will review and bridge the emergency response arrangements between the Vessel Contractor and 3D Oil. The Dorrigo MSS HSEQ Plan contains instructions for vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification and contact information.

In the event of an emergency of any type the survey vessel Master will assume overall onsite command and act as the Emergency Response Team (ERT) Coordinator (ERC). All persons aboard the vessel/s will be required to act under the ERC's directions. The MSS vessel will maintain communications with the Vessel Manager and/or other emergency services in the event of an emergency. Emergency response support will be provided by the contracted Vessel Manager (VM) if requested by the ERC.

In any incident, the:

- Vessel Party Chief will notify the contracted Vessel Manager of any vessel-based incidents. The vessel contractors' ERG Leader (typically the shore-based Vessel Manager) will make an initial assessment and take actions in accordance with the vessel's Emergency Response Plan (ERP). The ERG Leader will notify the contractor organisation (as required), take appropriate action to control the situation and activate the ERG to provide emergency support (as required) to the vessel.
- 3D Oil Offshore Representative will contact the 3D Oil Project Manager, who will make contact with the contracted Vessel Manager, to confirm situational awareness and actions being taken to manage the emergency. 3D Oil will provide support to the shore-based contractor ERG where required.

The Vessel Master is responsible for notifying maritime safety authorities (i.e. AMSA) in the event of a maritime safety/environmental emergency (e.g. oil spill). The 3D Oil Project Manager is responsible for notifying NOPSEMA, MRT, NOPTA and DNP of any reportable environmental incidents. As courtesy, 3D Oil will also notify EPA Tasmania in the instance of a Level 2 oil spill incident.

8.6.2 Oil Pollution Emergency Plan (OPEP)

The Dorrigo MSS OPEP, considering the nature and scale of the activity and the potential spill risks involved (refer **Section 7-12**), consists of the:

- Survey vessel(s) SOPEP (for vessels over 400 GRT involved in the survey or equivalent for lesser tonnage vessels) that manage the environmental impacts of a spill and vessel-based operational monitoring; and
- 3D Oil Dorrigo MSS OPEP which supports the individual vessel-based SOPEPs, details the interaction between contractor-related spill response plans and 3D Oil response arrangements. The 3D Oil Dorrigo MSS OPEP is provided in **Appendix 2**.

These response arrangements are consistent with, and supported by, the:

- *National Plan for Maritime Environmental Emergencies (NATPLAN*): Australian Maritime Safety Authority (AMSA) – has jurisdiction and is the Control Agency (CA) for vessel spills which affect Commonwealth waters, i.e. outside 3 nm from the SA state boundary (AMSA, 2019);
- *Tasmanian Marine Oil Spill Contingency Plan (TASPLAN):* The Tasmanian Environment Protection Authority (EPA) is the Control Agency for marine oil spills in Tasmanian state waters.

The seismic and support vessels (if > 400 GRT) IMO-accepted SOPEPs, prepared in accordance with IMO guidelines for the development of shipboard oil pollution emergency plans (resolution MEPC.54 (32) as amended by resolution MEPC.86 (44)), include oil spill response arrangements and provisions for testing the SOPEP (oil pollution emergency drills), as required under Regulations 14(8AA), 14(8A) and 14(8B) to 14(8E) of the OPGGER. Typical oil spill response actions for shipboard oil spills are contained in the 3D Oil Dorrigo OPEP (refer **Appendix 2**).

3D Oil will ensure that support/chase vessels <400 GRT that are not obligated legislatively to have a SOPEP, do have spill response plans (to an equivalent standard) that cover spill response arrangements and spill monitoring. The SOPEP is designed to ensure a rapid and appropriate response to any oil spill and provide practical information required to undertake a rapid, effective response; and reporting procedures in the event of a spill.

Initial actions undertaken by the vessel in the event of a spill to limit environmental impacts, is detailed in the Dorrigo MSS OPEP.

8.6.3 Drills and Training (OPEP/SOPEP)

Vessel-based SOPEP drills tests are undertaken by vessels routinely as per MARPOL Annex I (Regulation 15) requirements, and drill outcomes reviewed as part of the ongoing monitoring and improvement of emergency response control measures.

A desktop drill of the Dorrigo MSS OPEP, including the vessel SOPEP, will be conducted to assess the effectiveness of the arrangements, taking into account the nature and scale of the risk of a hydrocarbon prior to survey commencement. Specifically, the drill will test the following:

- Roles and responsibilities of those involved in oil spill response are clear and understood;

- Communication sequence from the vessel master to vessel-contractor onshore management and the CA, including notification of the AMSA RCC is adequate, current and includes all relevant details;
- Communication between the 3D Oil offshore representative and 3D Oil Project Manager and subsequent notification authorities is adequate and timely;
- Ensures Type 1 operational monitoring such as spill surveillance and tracking is appropriate, understood and practiced; and
- Equipment and procedures intended for source control onboard the vessel are available for use as outlined in the vessel SOPEP.

The outcomes of the Dorrigo MSS OPEP drill will be documented, reviewed and improvements identified (as needed). Should any inadequacies, altered contractual arrangements or improvements to arrangements be identified via testing, these corrective actions will be registered as a non-conformance (refer to **Section 8.11**) and the EP/OPEP will be amended for these items via a Management of Change process (refer **Section 8.9**). This is the responsibility of the 3D Oil Project Manager. The 3D Oil Project Manager is responsible for assessing any changes to the OPEP against the criteria in OPGGSER Regulation 17 (refer **Section 1.6**) and where necessary, the EP/OPEP submitted to NOPSEMA as a formal revision.

The OPEP will be tested on the following triggers:

- Prior to the survey commencing; and
- Following any significant amendment of the arrangements.

These arrangements for testing the OPEP are commensurate with the nature and scale of the worst-case oil spill scenario and the short duration of the MSS activity.

8.6.4 Maintaining Currency

3D Oil will monitor AMSA and EPA Tasmania's published plans and should the plans change, 3D Oil will assess the implications of any changes on the OPEP arrangements as described in this EP. Any change to the activity itself, or the potential and risks associated with it, will result in a review of the EP (including the OPEP) to ensure the measures in place remain suitable and there is not a significant increase in impact or risk (refer **Section 8.8**).

8.7 Contractor & Supplier Management

Seismic contractors considered for the Dorrigo MSS activity will be assessed against, and meet the following criteria:

- Compliance with all statutory requirements;
- Have an acceptable HSEC performance record in undertaking MSS activities;
- Provide evidence of resources and competency in the services to be provided;
- Services, procedures and vessel hardware comply with the requirements of this EP; and
- Any equipment to be used in the provision of MSS services meets regulatory requirements, is fit-for-purpose and has all equipment, testing and verification certificates.

Specific requirements which needs to be assessed at tender evaluation stage includes:

- Acoustic source verification ensuring it meets with the requirements of the JASCO Applied Science Acoustic modelling (refer **Section 7.2.1**);

Specific requirements which needs to be assessed prior to vessel mobilisation include:

- All vessels proposed for international or national transit must be assessed for biofouling risk (refer **Section 7.7**).

EP implementation activities with the selected MSS contractor have been described in **Section 8.1**.

8.8 Impact and Risk Management

The 3D Oil Project Manager (as per **Section 8.3**) will ensure an internal risk assessment is conducted for the following trigger events associated with the Dorrigo MSS:

- Non-conformances suggest the specified control measures no longer adequately demonstrate that the environmental impact/risk of the activity is managed to ALARP;
- New developments in the scientific understanding of impacts and risks suggest the risks and impacts are no longer acceptable;
- New information regarding the receiving environment relevant to Dorrigo activities identifies a potential new or increase in potential impact or risk;
- Any stakeholder claims, or concerns received during consultation associated with the survey activity (refer **Section 4);**
- EP changes as identified in **Section 8.9.**

Participants in the risk assessment workshop will be determined by the 3D Oil Project Manager based upon the scope of the review. The risk assessment methodology outlined in **Section 5** of this EP will be adopted for risk assessment activities. This methodology includes the steps to identify, analyse and evaluate the risks and impacts of the activities being undertaken within the Dorrigo MSS area. The decision-making framework is designed to ensure that activities do not pose an unacceptable environmental risk and are ALARP and acceptable in accordance with AS/ANZ ISO 31000 Risk Management (Principles and Guidelines) and Oil and Gas UK Guidance on Risk Related Decision Making (2014). The process for identifying additional controls will follow the risk assessment methodology outlined in **Section 6**. Any opportunities for improvement identified in the internal risk assessment (i.e. new controls to be adopted) will be amended via Management of Change (refer **Section 8.9).**

All environmental impacts and risk assessments must include an ALARP and acceptability assessment against 3D Oil criteria. Risk assessments will be documented and approved by the 3D Oil Project Manager.

8.9 Management of Change

For the Dorrigo MSS, the following activities will trigger a Management of Change (MoC) process which may lead to regulator revision of the accepted Dorrigo MSS EP:

- A new scope (e.g. timing, location or changes to operational details such as vessel type, equipment, processes or procedures) which has the potential to impact on the environment not assessed for environmental impact previously or authorised in existing management plans and procedures (responsibility of the 3D Oil Project Manager);

- Change to the *existing* activity, scope, equipment, process or procedures which have the potential to impact on the environment or interface with an environmental receptor (responsibility of the 3D Oil Project Manager);
- Changes in the external environment (managed and monitored by the 3D Oil Project Manager (or delegate)):
  - Provision of new information that differs to that included in this EP (such as potential changes in science surrounding impacts and risks from seismic activities or new environmental sensitivities within or adjacent to the survey area);
  - Issue of new regulatory requirements (e.g. revised CMP Management Plan arrangements, new species Conservation Management Plans);
  - Identification of KEFs, threatened or migratory species or critical habitats/BIAs not identified in the EP;
  - Identification of issues and concerns through stakeholder consultation (refer **Section 4**).
- Non-conformances (audits, inspections, etc.) which identify control measures no longer manage environmental impact/risk to ALARP or acceptable criteria. Non-conformances are monitored by the 3D Oil Offshore representative;
- Incidents which identify new or increased impacts and risks arising from activities not previously identified in the accepted EP. Incidents are monitored by the 3D Oil Offshore representative.

A risk assessment will accompany any MoC with identified environmental impacts/risks in accordance with the 3D Oil Risk Management process (refer **Section 8.8).**

For changes (e.g. additional controls, etc.) identified in the risk assessment process, if stakeholder interests are affected by the change, stakeholders will be advised and feedback obtained on the proposed change (refer **Section 4**). All environmental risk assessments must include an ALARP and acceptability assessment against 3D Oil criteria which includes obtaining and responding to necessary stakeholder concerns associated with the change.

Additional controls identified as part of the MoC shall be effective in reducing the environmental impact and risk to a level which is ALARP and acceptable; and meet the nominated EPOs and EPSs set out in the accepted EP for the activity. *Note: EPOs and EPSs cannot be altered from those set out in the accepted EP. If EPOs/EPSs cannot be met, a recordable or reportable incident will be registered for the activity.*

Minor revisions to the Dorrigo MSS EP that do not require resubmission to NOPSEMA will be made when:

- Minor administrative changes are identified that do not impact on the environment (e.g. document references, contact details, etc
- A review of the activity/change and the environmental impacts and risks of the activity/change do not trigger a requirement for revision under the OPGGSER (Regulation 17 and Regulation 18) (refer **Section 1.6** for resubmission criteria).

Where amendments are made to the accepted EP/OPEP via the 3D Oil MoC process, revisions made will be justified, tracked and a comprehensive record of the revision made for each change. This includes all risk assessments associated with MoC activities.

8.10 Maintaining Environmental & Legislative Knowledge

General (monthly): Changes to the external environment will be identified by the 3D Oil Project Manager (or delegate) by subscribing to environmental websites such as the DoEE to obtain regular updates of Commonwealth environmental information (e.g. species listings, threat abatement/management plan issue and policy updates via RSS news feeds[75]) and monitoring other key research websites on a monthly basis such as the Fisheries Research and Development Corporation (FRDC) (fishery research) to establish research which may provide additional information on the Dorrigo MSS environment, or new science on species present which might affect this EP assessment.

Prior to Survey Season: At least eight weeks prior to the survey, the 3D Oil Project Manager shall undertake pre-survey planning that will review and consider the following at a minimum:

- Stakeholder consultation requirements as per Section 4;
- New issues or concerns raised by stakeholders;
- Changes to all relevant legislation or regulatory guidelines;
- Existing information in relation to any component of the receiving environment described in **Section 5** (including BIAs, CMPs);
- Search the NOPSEMA website and consult with geophysical companies and/or titleholders to determine the presence of other seismic operations overlapping the proposed Dorrigo MSS area;
- Changes to commercial fishery license areas, fishery status, current fishing effort and licence holders overlapping the Dorrigo MSS area based on:
    - Status reports and available data sources such as FRDC, IMAS for fisheries and aquatic resources;
    - Information provided directly by fishers, VFA, DPIPWE (Wild Fish Section) and AFMA through the stakeholder consultation process;
    - Fishing locations
    - Spawning areas
- Newly-available scientific literature;
- New acoustic source technology and justification for or against its implementation;
- Confirrmation of emergency (oil spill) contacts.

If new information regarding the receiving environment relevant to the Dorrigo MSS area is present, then an internal risk assessment will be conducted as described in **Section 8.8**.

8.11 Notification and Reporting Requirements

8.11.1 Internal Incident Notification and Reporting

Activity Reports and Key Performance Indicators:
The Daily Seismic Survey Report is distributed to 3D Oil by the seismic contractor.

[75] DoEE provides an RSS feed which lets people know when a certain website or part of a website is updated with new content.

The Weekly Seismic Survey Report will be submitted to NOPTA at reporting@nopta.gov.au by the 3D Oil Project Manager.

The 3D Oil Offshore Representative and the MFOs will be responsible for recording compliance against this EP and for sending daily HSE reports to 3D oil outlining the status of the survey as well as information against environmental performance as covered in this EP.

Incident Reporting & Investigation:

All environmental incidents (including any environmental incident and near miss) on-board the seismic or support/scout vessel is reported and investigated in accordance with the vessel's Incident Reporting and Investigation Procedure. The Party Chief is responsible for forwarding any incident to the 3D Oil Offshore Representative on-board. All environmental incidents, including non-compliances with the EPOs and EPSs, will be communicated immediately to 3D Oil's Project Manager to confirm external notification requirements.

Incident investigations will be undertaken commensurate with the significance of the incident. Incident investigations are initiated and closed-out in a timely manner; and learnings associated with incidents communicated to all parties on-board. The Party Chief and 3D Oil Offshore Representative (or delegate) will lead incident investigation activities into the cause of the incident/non-compliance.

All corrective actions arising from incidents, audits and inspections are recorded on the seismic vessel's on-board action tracking system and monitored for closure by the Party Chief and 3D Oil Offshore Representative. Corrective and preventative actions taken to eliminate the cause of potential incidents will be commensurate with the magnitude of the environmental risks. 3D Oil will carry forward the identified corrective/preventative actions from incidents for consideration in future MSS campaigns to ensure 'lessons learnt' are captured and assist with continuous improvement in environmental management or to provide frequency data (i.e. likelihood determination) associated with MSS operations.

8.11.2 External Incident Notification and Reporting

Recordable Incidents:

The Commonwealth OPGGSER Regulation 4 defines the following incident types:

- **Recordable incident**: An incident arising from the activity that breaches an EPO or EPS in the EP that applies to the activity that is not a reportable incident;
- **Reportable Incident:** An incident arising from the activity that has caused, or has the potential to cause, moderate to significant environmental damage.

The requirements for notifying environmental incidents to external agencies are listed in **Table 8.1**. These will be reported to the regulator by the 3D Oil Project Manager.

Table 8-1: External Notification and Reporting Requirement

REQUIREMENTS	TIMING	CONTACT
RECORDABLE INCIDENTS		
As a minimum, the written monthly recordable report must include a description of: • All recordable incidents which occurred during the calendar month; • All material facts and circumstances concerning the incidents that the operator knows or is able to reasonably find out. • Any actions taken to avoid or mitigate any adverse environmental impacts of the incident; and • Corrective actions that have been taken, or may be taken, to prevent a repeat of similar incidents occurring	As soon as possible but before the 15th day of the following calendar month.	NOPSEMA - submissions@nopsema.gov.au
REPORTABLE INCIDENT		
Verbal Notification		
Any ship-sources spill in Commonwealth waters must be reported to AMSA within one hour via the national 24 hr emergency notification contact by the vessel master.	Within 1 hour	Rescue Co-ordination Centre Australia (RCC Australia): Phone: +61 2 6230 6811 or 1800 641 792 Facsimile: 1800 622 153 Telex: 62349 AFTN: YSARYCYX

REQUIREMENTS	TIMING	CONTACT
Reportable incidents include, but are not limited to, those that have been identified through the risk assessment process as having an inherent impact consequence of 'significant', 'major' or 'critical'; or at a minimum, the following incidents: • A level 2 spill incident; • Vessel strike to a cetacean; • Waste incident overboard; • IMS Introduction. The notification must contain: • All material fact and circumstances concerning the incident; • Any action taken to avoid or mitigate the adverse environmental impact of the incident; and • The corrective action that has been taken or is proposed to be taken to stop control or remedy the reportable incident. *This must be followed by a written record of notification ASAP after notification.* *This written notification must also be supplied to the Tasmanian MRT and NOPTA for Commonwealth water incidents.*	Within 2 hrs of becoming aware of the incident	Verbal: NOPSEMA – Phone 08 6461 7090. Director of Marine Parks (if in Zeehan CMP) - 0419 293 465 (24hr Marine Compliance Officer) Written Notification: NOPSEMA - submissions@nopsema.gov.au NOPTA – reporting@nopta.gov.au Tasmanian MRT – [redacted]
Notify EPA Tasmanian of Level 2 vessel spill. Notification must include: • Full name, address and telephone contact details; • Date, time and duration of incident • Type of pollutant or description of the incident, discharge or emission • Location of the incident, being as specific as possible • The source and cause of pollution if known • The extent or size of the area where the pollution is visible • Anything else relevant to the incident	Within 2 hours of spill event	Director, EPA Tasmania – 1800 005 171 (24 hrs) Email: incidentresponse@environment.tas.gov.au (non-urgent complaints only via this channel)
If the oil pollution occurs in the Zeehan CMP or threatends the Apollo CMP, the Director of National Parks must be contacted immediately. Information which must be provided withinthat notification includes: • Titleholder details; • Time and location of the incident (including CMP likely to be affected) • Proposed response arrangements as per OPEP; and • Contact details of the emergency coordinator.	Immediately	Telephone: 0419 293 465 (24hr Marine Compliance Officer)
Notify DoEE of any death or injury of a listed threatened species; all cetacean species; listed migratory species or listed marine species.	Within 7 days	Phone: +61 2 6274 111 Email: EPBC.Permits@environment.gov.au
Notify DoEE of death or injury to a cetacean in or beyond the Australian Whale Sanctuary	Within 7 days	Phone: 1800 803 772 Email: protected.species@environment.gov.au
Written Incident Report		

REQUIREMENTS	TIMING	CONTACT
Verbal notification of a reportable incident to NOPSEMA (Commonwealth waters) must be followed by a written report. As a minimum, the written incident report will include: • The incident and all material facts and circumstances concerning the incident; • Actions taken to avoid or mitigate any adverse environmental impacts; • The corrective actions that have been taken, or may be taken, to prevent a recurrence of the incident; • The action that has been taken or is proposed to be taken to prevent a similar incident occurring in the future.	Within 3 days of notification of incident (NOPSEMA) Within 7 days after submission to NOPSEMA (MRT & NOPTA)	NOPSEMA - submissions@nopsema.gov.au NOPTA – reporting@nopta.gov.au Tasmanian MRT – [redacted]
Vessel strike with cetacean is reported to the DoEE.	Within 72 hours of incident.	Upload information to: https://data.marinemammals.gov.au/report/shipstrike

8.11.3 External Routine Notification and Reporting Requirements

Review of statutory and stakeholder requirements with respect to routine external notification and reporting is provided in **Table 8-2**. These actions are the responsibility of the 3D Oil Project Manager (or delegate).

Table 8-2: External Routine Notification and Reporting Requirement

REQUIREMENTS	TIMING	CONTACT
ROUTINE PERFORMANCE REPORTING		
OPGGSER Regulation 26C Submit an EP Performance/Compliance Report to NOPSEMA. This reports compliance against each of the EPOs and EPSs as outlined in Section 7 of this EP and provides the results of monitoring as outlined in **Table 8-3**	Within 3-months of the completion of the Dorrigo MSS activity	NOPSEMA - submissions@nopsema.gov.au
Provide cetacean observation data to the DoEE. This report will include: • The location, date and start-up time of the survey; • Name, qualifications and experience of MFOs involved in the survey; • The location, times and reasons when ocservations were hampered by poor visibility or high winds; • The location and time of any start-up delays, powerdowns or stop-work procedures instigated as a result of whale sightings; • The location, time and distance of any cetacean sightings; and • The date and time of completion of the survey.	Within 2 months of activity completion	Upload information to: https://data.marinemammals.gov.au/csa
ACTIVITY NOTIFICATIONS		
Survey Funding		
Notify relevant fishing stakeholders of survey funding approval (as requested)	Within 1 week of funding approval	All relevant stakeholders listed in the stakeholder register
EP Submission		

REQUIREMENTS	TIMING	CONTACT
Provision of SIV with a copy of the EP when it is submitted to NOPSEMA (privacy provisions will apply to information)	Within 1 week of submission	SIV Email [redacted]
EP Acceptance		
Notify DNP and SETFIA on EP Acceptance	Within 48 hrs of EP acceptance	DNP Email: marineparks@environment.gov.au SETFIA: [redacted]
Commencement		
Notify all non-government stakeholders in the stakeholder register with the "pending activity" commencement date.	At least 1 month prior to activity commencement	All relevant stakeholders listed in stakeholder register
Provision of OPEP to EPA Tasmania and AMSA prior to the commencement of survey operations	At least 2 weeks prior to survey operations	EPA: [redacted] Epa.enquiries@epa.tas.gov.au AMSA: [redacted]
Notify NOPSEMA of the activity commencement date	At least 10 days prior to activity	NOPSEMA - submissions@nopsema.gov.au
Notify AHS of the commencement date and durationof MSS to facilitate issue of a Notice to mariners.	At least 4 weeks prior to activity	Nautical Assessment and Maintenance datacentre@hydro.gov.au, 02 4223 6590
Notify the Director of National Parks of the commencement of the MSS activity	Within 14 days prior to commencement	Email: marinereserves@environment.gov.au
Notify all other non-government stakeholders in the stakeholder register with the MSS commencement date	At least 5 days prior to activity commencement date	All relevant stakeholders listed in the stakeholder register
Notify MRT and DNP of commencement of Dorrigo MSS	24hrs prior to MSS commencment	Tasmanian MRT – [redacted] DNP Email: marineparks@environment.gov.au
Notify all other non-government stakeholders in the stakeholder register with the MSS commencement date	At survey commencement	All relevant stakeholders listed in stakeholder register
Notify AMSA to issue AusCoast Warnings for MSS activity	At least 24hrs prior to activity commencement Reconfirm on activity commencement	Email: rccaus@amsa.gov.au
During survey notify Otway/King Island Fishing Fleet via SMS through SETFIA	Daily for the duration of the survey	Simon Boag [redacted]
Cessation		
Notify AMSA to cease AusCoast Warnings for IMR activity	On vessel demobilisation from the field	Email: rccaus@amsa.gov.au
Notify Otway/King Island Fishing Stakeholders via SMS through SETFIA	On vessel demobilisation from the field	Simon Boag ([redacted]
Notify NOPSEMA, DNP and MRT with the survey completion date	Within 10 days of survey completion	NOPSEMA - submissions@nopsema.gov.au Tasmanian MRT – [redacted] DNP Email: marineparks@environment.gov.au
Notify all other non-fishing stakeholders with the activity completion date	Within 10 days of survey completion	All relevant stakeholders listed in stakeholder register
End of Environment Plan		
Notification of EP Completion	At activity finalisation and obligation completion	NOPSEMA - submissions@nopsema.gov.au

8.12 Environmental Performance Monitoring, Inspection, Audit and Reporting

The objective of the monitoring, audit and review program for the Dorrigo MSS is to ensure that the MSS EPOs/EPSs are observed, verified and measured; EP controls are implemented and performance standard verified; environmental emissions/discharges are recorded and overall environmental performance assessed and the EP implementation strategy is assessed for effectiveness. These activities assist 3D Oil to review environmental performance with a view to continuous improvement of environmental management and implementation strategies.

Collation of information provided by control measure 'custodians', EPO incident records and emissions/discharge records allows the 3D Oil Offshore Representative to assess environmental performance against nominated EPOs and standards as outlined in **Section 7.**

All breaches of EPO and EPSs in this EP are considered non-compliances. Non-compliances may be identified during an audit, inspection, general observation or as a consequence of an incident.

8.12.1 Emission/Discharge Monitoring, Quantification & Reporting

3D Oil will maintain a quantitative record of emissions and discharges as required by OPGGSER Regulation 16(7). For vessel-based records, the 3D Oil Offshore Representative is responsible for collecting the data. A summary of these results will be reported in the Dorrigo MSS Environmental Performance Report to be submitted to NOPSEMA 3 months after the completion of the Dorrigo MSS activities.

Parameters detailed in **Table 8-3** provide a summary of the emission, discharge and interaction parameters which will be monitored for the Dorrigo MSS program.

Table 8-3: Dorrigo MSS Operational Discharge/Fauna Monitoring Program

Discharge/Incident	**Parameters**	**Record**	**Responsibility**
Atmospheric Emissions			
Machinery exhaust	Quantity of Marine diesel used by the vessel(s)	Daily Fuel Use Log	Vessel Master(s)
Incinerated waste	Volume of waste incinerated.	Garbage Record Book	Vessel Master(s)
Ozone Depleting Substances	Volume Released	ODS Record Book	Vessel Master(s)
Discharges to Sea			
Oily water discharges	The volume of oily water discharge from vessel(s).	Oil Record Book (by whole Tank Volume)	Vessel Master(s)
Food-scraps	The volume of food-scraps discharged from vessel(s)	Garbage Record Book	Vessel Master(s)
Sewage/Grey water discharge	The volume of potable water consumed	Water Use Records	Vessel Master(s)
Disposal of Wastes			
Hazardous wastes	Volume of hazardous wastes transferred onshore.	Garbage Record Book/Oil Record Book	Vessel Master(s)

Discharge/Incident	Parameters	Record	Responsibility
Solid Non-biodegradable wastes	Volume of non-hazardous wastes transferred onshore	Garbage Record Book	Vessel Master(s)
Food-scraps	The volume of food-scraps discharged to shore based facilities	Garbage Record Book	Vessel Master(s)
Marine Fauna Interaction			
Cetacean sightings	Details required on the Whale and Dolphin Sighting Reports (DOE)	MMO Records	MMO
	Record of soft start commencements, shutdowns and visual checks undertaken before the commencement of arrays and actions taken if whale sightings within 2km of vessel during seismic acquisition Daily log of seismic acquisition by Party Manager	MMO Records Daily Seismic Report	MMO
Marine User Interaction			
Vessel Interaction/Complaints	Communications with other vessels.	Incident Records	Vessel Master(s)
Spill/Release Incidents			
Spill/release incidents from Vessel(s)	Location, volume, duration and type of spill/waste Response actions taken	POLREP & SITREP Reports Incident Records	Vessel Master(s)
Equipment release incidents	Location, equipment type and duration of incident Response actions taken	Incident Records	Vessel Master(s)
Whale & Dolphin Collision Incidents	Location, time, type of whale, expected injury Any response actions taken	Incident Records	MMOs/ Vessel Master(s)
Operational/Scientific Monitoring			
Operational/Scientific Monitoring Resoults	As per content of OSMP	OSMP Records	3D oil Project Manager

8.12.2 Oil Spill –Scientific Monitoring

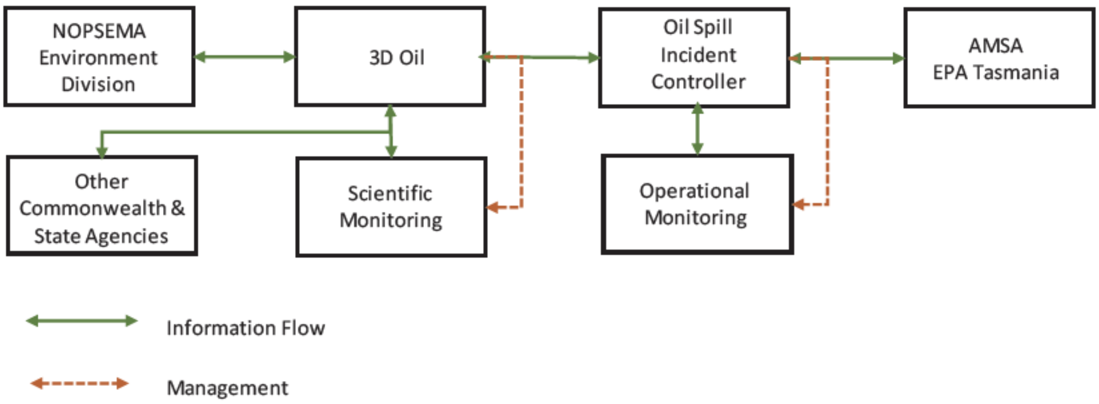
General: The Dorrigo MSS Operational and Scientific Monitoring Plan (OSMP) contains details relating to the triggers for commencing operational/scientific monitoring, who will conduct the monitoring and what will be monitored. This document supports the Dorrigo MSS OPEP by:

- Detailing operational monitoring (Type 1) to be performed by 3D oil resources to be implemented in a Level 2 spill event to indform spill response activities; and
- Scientific monitoring (Type 2) to quantify the nature of the extent, severity and persistence of environmental impacts from a Level 2 spill event and inform appropriate remediation activities.

3D Oil have identified and provided detail of the scientific monitoring requirements to GHD to provide suitably qualified scientific resources to assist in the implementation of the OSMP. Predictive modelling identifies there is a 2% probability of coastal impacts > 100g/m^2 and 3% probability of low sea surface oil exposures > 0.5µm entering Tasmanian State waters (RPS, 2018). The minimum timeframe for sea surface spill residues entering State waters in 30 hours (ROS, 2018). Prior to survey commencement, 3D Oil will review the terms and conditions of these providers to ensure their capability is adequate. An agreement will be in place prior to the commencement of the Dorrigo MSS to ensure GHD resources are available in the event of an oil spill.

In the event of a Level 2 oil spill, operational monitoring will also be undertaken at the direction of AMSA to support the response activities (refer **Section 7.14**). This is detailed in the OSMP. AMSA as CA for vessel spills is responsible for operational monitoring in Commonwealth waters to inform response activities, however 3D Oil will assist where possible. All Type I monitoring information will be directed to AMSA and the EPA Tasmania to assist in these activities. Information resulting from scientific (Type II) monitoring will be directed to the relevant Commonwealth and Tasmanian environmental authorities as it becomes available. These monitoring and information flow management pathways are illustrated in **Figure 8-2** below.

Figure 8-2: Monitoring and Information Flow Management Framework



Scientific modules, in the event of a Level 2 oil spill from Dorrigo MSS vessels, will be initiated if MDO is detected at levels which may cause effects to environmental sensitivities. These modules detail monitoring performance outcomes, standards, monitoring methodology, sampling and analysis plan (including laboratory QA/QC where applicable), available baseline information (sites, sampling frequency, baseline data-sets, baseline custodian), impacts assessment approach (BACI or beyond BACI), competencies, responsibilities and reporting requirements. It is to be noted that monitoring parameters and methodologies selected will observe the requirements of conservation management plans with respect to individual species (where monitoring parameters are available). Also, where available, management plans provide details of relevant 'umbrella species' which are monitored over time (e.g. long-term indicators for RAMSAR sites) which measure the area's long-term health and meet objectives of management plans (e.g. water quality indicators, inter-tidal reef indicators). Relevant management plans for protected species, conservation parks, etc. will be consulted in the preparation of modules to identify these indicators (e.g. for bird species such as the hooded plover parameters such as population size and breeding success).

Operational/scientific monitoring details are provided in **Appendix 3**.

Consultation: 3D Oil will consult with relevant Commonwealth and Tasmanian state authorities prior to the implementation of any Type 2 monitoring studies to ensure that scientific monitoring is undertaken to the satisfaction of the Commonwealth and Tasmania. These authorities include:

- For Commonwealth waters:

  - Marine Research Organisations such as Blue Whale Study and/or CSIRO;
  - Director of Marine Parks;
  - AMSA;
  - Department of Energy & Environment (DoEE);
  - Australian Fisheries Management Authority (AFMA);
  - Other relevant parties which have an interest in the affected area;
- For Tasmanian waters:
  - EPA Tasmania (who coordinates Tasmanian Government advice);
  - DPIPWE (Conservation Assessment Section);
  - DPIPWE (Wild Fish Section.

3D Oil will notify these authorities on a Level 2 spill incident and provide available operational data. 3D Oil will consult with these authorities on the content of Type 2 studies (e.g. baseline, location of reference and control sites and confirmation of monitoring parameters) and obtain spill-specific feedback which will be incorporated into the Type 2 study design to ensure monitoring is to the satisfaction of the Commonwealth and State authorities. Based upon this feedback, the Type 2 modules may be modified. Note:

- Tasmania/Commonwealth have over-riding decision making authority on the requirements of scientific monitoring. If there is a conflict between the prepared scientific modules and State/Commonwealth feedback, regulator recommendations will be adopted. This liaison approach will be adopted throughout the spill event to ensure that changing impacts and risks are captured within the process.
- Scientific monitoring will also monitor for the impacts of spill response (e.g. marine fauna strikes due to monitoring activities). These incidents will be reported back to the CA.

8.12.3 Pre-mobilisation Inspection and Audit

Prior to mobilisation, the 3D Oil Project Manager (or delegate) will undertake:

- A vessel audit to confirm that the vessel and seismic contractor management system meets with the environmental constraints detailed in this EP. The activity will be documented and any corrective actions rectified prior to mobilisation.
- An audit of the on-board spill response capability of the vessels against SOPEPs will be made prior to survey mobilisation to verify spill preparedness for the Dorrigo MSS.

Additionally, during the survey activity the 3D Oil Offshore Representative will also:

- Conduct an EP compliance audit against EP requirements during the Dorrigo MSS. This will target the following:
  - Compliance with regulatory requirements detailed in this EP;
  - Independent verification that all EPOs and control measure performance standards have been monitored, measured and correctly evaluated;
  - Emissions and discharges are being correctly monitored, measured and documented; and
  - Management strategies and procedures to achieve the EPOs are in place and being implemented effectively.

  Any required remedial actions will be followed up immediately. A copy of the environmental audit can be forwarded to NOPSEMA upon request.

- Conduct an EP implementation review against the Dorrigo Project Specific HSE Plan to determine the effectiveness of the 'bridged' 3D Oil requirements into the Contractor's management system.

Non-conformances and opportunities for improvement will be identified and corrective actions will be tracked to completion utilising the seismic vessel's on-board action tracking system. Corrective actions will specify the remedial action required to fix the breach and prevent its reoccurrence and is delegated to the person deemed most appropriate to fulfil the action. Where more immediacy is required, non-compliances will be communicated to relevant personnel immediately and responded to as soon as possible.

3D Oil will carry forward any areas of non-conformance identified during the Dorrigo MSS campaign for consideration in future MSS campaigns to assist with continuous improvement in environmental management controls and performance outcomes.

8.12.4 Review

An end of survey HSE Review will be jointly conducted by 3D Oil and the seismic contractor during the Post Survey Meeting.

This activity will enable the review of management and mitigation strategies implemented during the MSS and, including reviews of performance, incident investigations, audits and field activity identify actions for future MSSs which can be implemented on a continuous improvement basis. The seismic survey close out report will include a 'Lessons Learnt' section to facilitate incorporation of any recommended improvement actions in future MSS activities.

8.13 Records Management

In accordance with the Commonwealth OPGGSER Regulation 27, 3D Oil will store and maintain documents or records relevant to the EP implementation for a period of 5 years in a way that makes retrieval reasonably practicable.

This will include all records nominated in **Section 7** (EIA/ERA Tables) together with the implementation strategy records outlined in this section which monitor and assess compliance.

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APPENDIX 1: Protected Matters Search Tool (Dorrigo MSS Area and EMBA)

APPENDIX 2: Oil Pollution Emergency Plan (OPEP)

APPENDIX 3: Operational and Scientific Monitoring Plan

APPENDIX 4: Commercial Fishing Report

APPENDIX 5: Acoustic Modelling Report

APPENDIX 6: Oil Spill Trajectory Modelling

Appendix 7: Reserve Management Plan Assessment

APPENDIX 8: Consultation Report